

CARDIAC DYSRHYTHMIAS

Pathophysiology and Therapeutic Approaches Self Study

Various diagrams were found on internet sources.
Search engines as Google images and ask.com images were utilized.

15.0 Contact Hours
California Board of Registered Nursing CEP#15122

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CARDIAC DYSRHYTHMIAS
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15.0 CONTACT HOURS CEP #15122 70% is Passing Score

Please note that C.N.A.s cannot receive continuing education hours for home study.

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1. Please **print** or **type** all information.
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Please place your answers on this form.

- | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|
| 1. _____ | 11. _____ | 21. _____ | 31. _____ | 41. _____ | 51. _____ |
| 2. _____ | 12. _____ | 22. _____ | 32. _____ | 42. _____ | 52. _____ |
| 3. _____ | 13. _____ | 23. _____ | 33. _____ | 43. _____ | 53. _____ |
| 4. _____ | 14. _____ | 24. _____ | 34. _____ | 44. _____ | 54. _____ |
| 5. _____ | 15. _____ | 25. _____ | 35. _____ | 45. _____ | 55. _____ |
| 6. _____ | 16. _____ | 26. _____ | 36. _____ | 46. _____ | 56. _____ |
| 7. _____ | 17. _____ | 27. _____ | 37. _____ | 47. _____ | 57. _____ |
| 8. _____ | 18. _____ | 28. _____ | 38. _____ | 48. _____ | 58. _____ |
| 9. _____ | 19. _____ | 29. _____ | 39. _____ | 49. _____ | 59. _____ |
| 10. _____ | 20. _____ | 30. _____ | 40. _____ | 50. _____ | 60. _____ |

My Signature indicates that I have completed this module on my own. _____

(Signature)

EVALUATION FORM

| | Poor | | | | | Excellent | | | | | |
|--|------|---|---|---|------|-----------|---|----|---|----|-----|
| 1. The content of this program was: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 2. The program was easy to understand: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 3. The objectives were clear: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 4. This program applies to my work: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 5. I learned something from this course: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 6. Would you recommend this program to others? | | | | | | Yes | | | | | No |
| 7. The cost of this program was: | | | | | High | | | OK | | | Low |

Other Comments:

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Choose the Single Best Answer for the Following Questions and Place Answers on Form:

1. The purpose of the heart is to:
 - a. Allow for conduction of beats through the ventricle.
 - b. Pump oxygenated blood to the tissues.
 - c. Bring venous blood to the tissues.

2. Exhaled gas is approximately _____ oxygen.
 - a. 10%
 - b. 16%
 - c. 21%
 - d. 100%

3. The opening to the coronary arteries is at the:
 - a. Sinus of Valsalva
 - b. Tricuspid Valve
 - c. Coronary Sinus
 - d. Pulmonic Valve

4. The right coronary artery supplies blood to the:
 - a. Apex
 - b. Left Ventricle
 - c. Sinus Node
 - d. Lateral Wall of the Left Ventricle

5. Atrial Kick accounts for _____% of ventricular filling.
 - a. 10%
 - b. 20%
 - c. 40%
 - d. 60%

6. The filling of the cardiac chamber before contraction is termed:
 - a. Preload
 - b. Afterload
 - c. SVR
 - d. PVR

7. A term that is associated with afterload is:
 - a. Chamber filling
 - b. Atrial filling
 - c. Resistance
 - d. Infarction

8. Heart Rate X Stroke Volume is the formula for:
 - a. Right ventricular filling
 - b. Left ventricular filling
 - c. Preload
 - d. Cardiac output

9. With the conduction system, conduction begins with the:
 - a. Purkinje Fibers
 - b. AV Node
 - c. SA Node
 - d. Bundle of HIS

10. The rule of thumb for the heart is:
 - a. As you get older, atherosclerosis will develop.
 - b. The part of the heart that beats the fastest will be the pacemaker of the heart.
 - c. Atherosclerosis is always caused from hypertension.
 - d. Persons with heart rates between 60-70 will do better over their lifetime.

Match the following:

- | | |
|---|------------------------------|
| 11. Inherent rate of the Ventricle | a. 20 – 40 times per minute |
| 12. Inherent rate of the Atria | b. 40 – 60 times per minute |
| 13. Inherent rate of the AV Junctional Tissue | c. 60 – 100 times per minute |

Match the following:

- | | |
|--|------------------------|
| 14. Atrial depolarization | a. QRS Complex |
| 15. PR Interval | b. P wave |
| 16. QRS duration | c. T wave |
| 17. Ventricular depolarization | d. Q wave |
| 18. May be indicative of myocardial infarction | e. 0.12 – 0.20 seconds |
| 19. Ventricular repolarization | f. 0.04 – 0.10 seconds |

For the following criteria indicate A for normal, B for abnormal:

- | | |
|------------------------------|-------------|
| 20. Rhythm Irregular | A. Normal |
| 21. PR interval 0.24 seconds | B. Abnormal |
| 22. T wave inverted | |
| 23. Ventricular rate 96 | |
| 24. P wave for every QRS | |
| 25. Atrial rate 70 | |

26. One small box horizontally on the ECG paper represents:
- 0.01 seconds
 - 0.02 seconds
 - 0.20 seconds
 - 0.04 seconds
27. How many wires or electrodes are needed to make 1 lead?
- 2 – both are positive
 - 3 – two negative, one positive
 - 2 – one negative, one positive
 - 1 – positive
28. On the 12 lead EKG, the 6 limb leads are:
- I, II, III, V1, V2, V3
 - I, II, III, aVR, aVL, aVF
 - V1, V2, V3, V4, V5, V6
 - V1, V2, V3, aVR, aVL, aVF
29. Which of the following IS NOT part of the three I's of myocardial infarction?
- Injury
 - Infarct
 - Inverted
 - Ischemia
30. The leads that will show changes for an inferior M.I. are:
- V2 – V4
 - II, III, aVF
 - V1 – V3
 - V1 – V6
31. Abnormal conduction and effects include:
- re-entry
 - blocks
 - irritability
 - all of the above
32. The main hemodynamic consequence of atrial fibrillation is:
- Bradycardia
 - Tachycardia
 - Loss of atrial kick
 - No ventricular conduction.
33. The two characteristics for identifying atrial fibrillation are:
- Heart rate below 60, PR Interval prolonged.
 - Irregular with no P waves.
 - More than 1 P wave for each QRS, regular rhythm.

34. A PAC has criteria of:
- An early beat that is wide and bizarre.
 - An early beat with no P wave.
 - A regular rhythm with a prolonged PR Interval.
 - An early beat that looks much like the normal beat.
35. In atrial flutter, the atria is depolarizing or firing at approximately:
- 50 times per minute
 - 80 times per minute
 - 150 times per minute
 - 300 times per minute.
36. Which of the characteristics below is NOT found in Sinus Rhythm?
- Heart rate 60-100
 - Rhythm is regular
 - PR Interval 0.24 seconds
 - QRS duration 0.06 seconds
37. Sinus rhythm, sinus bradycardia, sinus tachycardia and atrial tachycardia are rhythms that have the same criteria except for:
- Rate
 - Regularity
 - PR Interval
 - QRS duration
38. Junctional Rhythms all have an abnormal:
- P wave
 - QRS complex
 - PR Interval
 - Heart rate
39. The hemodynamic consequence of rhythms originating from the junction is usually:
- Prolonged PR Interval
 - Tachycardia
 - Loss of atrial kick
 - No ventricular conduction.

Match the Heart Block to the Description below:

| | |
|---|--|
| 40. _____ Extra P waves, PR Interval Constant | a. 1 st Degree AV Block |
| 41. _____ Extra P waves, PR Interval prolongs then drops QRS Complex | b. 2 nd Degree Type I, Mobitz 1 |
| 42. _____ Extra P waves, PR Interval variable, ventricular rhythm is regular | c. 2 nd Degree Type II, Mobitz II |
| 43. _____ Extra P waves, PR Interval variable, ventricular rhythm is irregular | d. Complete Heart Block |
| 44. _____ Indicates no correlation in conduction between the atria and the ventricles | |
| 45. _____ PR Interval above 0.20, rhythm regular | |

46. Ventricular tachycardia is always pulseless:
 a. True b. False
47. Ventricular fibrillation is always pulseless:
 a. True b. False
48. All of the interventions below are correct for the treatment of ventricular fibrillation. Which intervention is essential?
 a. Lidocaine
 b. Amiodarone
 c. Epinephrine
 d. Defibrillation
49. CPR must be done for all of the following rhythms except:
 a. PEA
 b. Asystole
 c. Ventricular Fibrillation
 d. Supraventricular Tachycardia
50. The first line drug to administer for all pulseless rhythms is:
 a. Atropine
 b. Lidocaine
 c. Adenosine
 d. Epinephrine

Rhythm Strips

Please match the item below with the strips on the following pages. There is only one answer for each strip, but there are more answers than strips. All strips are 6 seconds in length.

- A. Sinus Rhythm
- B. Sinus Bradycardia with First Degree AV Block
- C. Supraventricular Tachycardia
- D. Sinus Rhythm with 1 Premature Atrial Contraction (PAC)
- E. Atrial Tachycardia
- F. Atrial Flutter, 4:1 Conduction
- G. Atrial Fibrillation
- H. Junctional Rhythm – rate 50
- I. Junctional Rhythm – rate 30
- J. Sinus Rhythm with 1st degree AV Block
- K. 2nd Degree AV Block, Type I, Wenckebach
- L. 3rd Degree AV Block or Complete Heart Block
- M. Ventricular Tachycardia
- N. Ventricular Fibrillation
- O. Asystole

51.

52.

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58.

59.

60.

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Objectives

At the completion of this module, the learner will be able to:

1. Describe the structure and function of the heart.
2. Describe the electrical conduction system of the heart
3. Identify hemodynamic consequences of various rhythms
4. State normal criteria for ECG measurements.
5. Identify the criteria for sinus, atrial, junctional, heart blocks and ventricular rhythms.
6. Identify treatments for various Dysrhythmias.
7. Given rhythm strip examples identify the name of the rhythm.
8. Complete exam components at 70% competency.

CARDIOVASCULAR STRUCTURE AND FUNCTION

The purpose of the heart is to pump oxygenated blood to body tissues. Oxygen is carried on the hemoglobin of the red blood cell. The blood carries oxygen via the arteries to capillaries where all body tissues are perfused with oxygen. When tissues are not perfused, they simply die. The heart has the job of pumping blood to all body tissues.

Anatomy

The heart is a four chambered muscular pump. These chambers are the right atrium, right ventricle, left atrium, and left ventricle. The right side of the heart pumps deoxygenated blood to the lungs, and the left side of the heart pumps oxygenated blood to the peripheral tissues via the arterial system which then delivers oxygenated blood to the capillaries. Since the left side of the heart has to pump to so much more than the right side, the muscles of the left side are much thicker than the right. To put it simply, the heart is one huge plumbing system. The heart, or pump, has to be strong enough to get blood through the blood vessels (pipes). The pump and the pipes have to be in good working order for the tissues to receive blood. This blood carries oxygen that provides nutrition to the tissues of the body.

0

<http://en.wikipedia.org/wiki/Heart>

Flow of Blood through the Cardiovascular System

It is best to think of the right and left sides of the heart as separate systems with different jobs. Although both sides of the heart pump together, each ventricle pumps blood to different destinations. The right ventricle pumps blood to the lungs, while the left ventricle pumps to the systemic circulation.

Unoxygenated or deoxygenated blood comes from the systemic circulation after oxygen has been delivered to the tissues. This blood returns via the venous system to the right atrium via the inferior and superior vena cava and the coronary sinus. As the blood enters the right atrium, it travels through the tricuspid valve to the right ventricle. The valves of the heart are one-way valves that allow blood to pass through them. As the right ventricle fills, the pressure of blood in the right ventricle closes the tricuspid valve. When the right ventricle contracts,

Blood then passes through the pulmonic valve into the pulmonary artery. An artery is any vessel carrying blood away from the heart. The pulmonary artery is the only artery in the body that carries deoxygenated blood. The pulmonary artery branches to pulmonary arterioles, then branches to capillaries. They branch to over 1 million capillaries, where each capillary 'hugs' an alveolus (air sac). It is at the alveolar-capillary membrane that the exchange of gases takes place. We have been told many times that we inhale oxygen and exhale carbon dioxide. The oxygen we inhale at room air is 21% oxygen. Although we do exhale carbon dioxide, included in this exhaled gas is approximately 16 to 17% oxygen. If you think about it, if we did not exhale oxygen, CPR would not work.

Once the carbon dioxide and oxygen is exhaled, oxygen is inhaled and an exchange of gases or diffusion occurs at the millions of alveolar capillary membranes in the lungs. It is at this location that oxygen attaches to the hemoglobin receptor sites on the red blood cell. The oxygenated blood is carried by the pulmonary vein to the left atrium. From the left atrium, blood passes through the mitral valve into the left ventricle. When the left ventricle fills with blood, the mitral valve closes. As the left ventricle contracts, blood flows through the aortic valve, to the aorta.

At the base of the aorta, positioned on top of the aortic valve, is an area called the Sinus of Valsalva. The Sinus of Valsalva provides the opening to the coronary arteries which supplies the heart muscle itself with blood. The aorta carries blood via the vasculature to the capillaries which provide nutrients to the body tissues. At the capillary level, oxygen is delivered to the tissues and carbon dioxide is picked up. The blood then travels through the venous system back to the right side of the heart.

Coronary Arteries

<http://www.clevelandclinic.org/heartcenter/images/guide/disease/cad/coronary%20arteries.JPG>

The coronary arteries supply the heart muscle with blood. This is not the circulation that flows through the heart, but is the blood supply that feeds the heart muscle. The coronary arteries arise at the base of the aorta directly above the aortic valve. At the Sinus of Valsalva the right and left coronary arteries arise. As a result of the structural location of the coronary arteries on top of the aortic valve, filling occurs during diastole, or the backflow of the coronary arteries. Systolic contraction of the ventricles is too strong for filling to occur during systole.

The right coronary artery feeds the right side of the heart while the left coronary artery divides into the left anterior descending and the circumflex branches. The circumflex branch wraps around the back of the heart. The heart muscle receives oxygen and nutrients via capillaries. Venous blood from the coronary arteries returns via the coronary veins to the coronary sinus, located at the base of the right atrium. It is blockage of these coronary arteries from emboli, atherosclerosis or spasm that causes a heart attack or myocardial infarction.

The right and left coronary arteries each feed or perfuse different areas of the heart. Blockage of a specific area may predispose the patient to different types of dysrhythmias. This table outlines the possible effects of blockage of each of the coronary arteries.

| RIGHT CORONARY ARTERY | LEFT CIRCUMFLEX | LEFT ANTERIOR DESCENDING |
|--|---|--|
| <ul style="list-style-type: none"> ♥ Right Atrium ♥ Right Ventricle ♥ SA Node ♥ AV Bundle ♥ Posterior Portion of the Left Ventricle | <ul style="list-style-type: none"> ♥ Anterior 2/3 or the Septum ♥ Anterior Left Ventricle ♥ Lateral Left Ventricle ♥ Apex | <ul style="list-style-type: none"> ♥ Posterior Left Ventricle |

An important concept to understand is that anatomically people differ. As a result, not everyone's coronary arteries predictable feed the same portion of the heart

Coronary Artery Occlusion:

<http://www.centenarycardiology.com/Conditions/blockage.gif>

http://www.hmc.psu.edu/cardiovascular/patient/articles/images/rca_blockage.jpg

Phases of the Cardiac Cycle

The heart also has phases of contraction and relaxation or filling that occurs in the atria and ventricles. The contractile or pumping phase is called systole, while the relaxation or filling phase is called diastole. During diastole, blood enters the atria and flows passively into the relaxed ventricles. Remember, the valves of the heart are one-way valves allowing the blood to flow passively. When atrial systole occurs and the atria contract, blood is pumped into the ventricles allowing for better filling of the ventricles. As the ventricles begin to contract. This pressure causes the tricuspid and mitral valves to close. As the ventricles contract, blood is pushed out of the pulmonic and aortic valves. Therefore, blood flows into the ventricles in two phases; the passive ventricular filling phase (70 - 80% of blood) and the contraction of the atria (20 - 30% of blood). The contribution of the atrial contraction to ventricular filling is called **atrial kick**.

Hemodynamic Parameters

Knowledge of hemodynamic parameters in the heart is important to understanding disease processes, interventions, and drug treatments. Hemodynamics is the movement of the blood and the forces involved. To understand this concept, you need to know about preload, afterload, and cardiac output. These concepts are probably very new to you, yet understanding them will help you in your care of patients.

Preload is the **fluid** or filling of the cardiac chamber before contraction. The heart muscle is much like a rubber band. The more you stretch it, the better it will contract. This stretch is accomplished in the heart through filling of the chambers with blood. Therefore, preload is related to the amount of blood in the ventricle before contraction. If a person is overhydrated, preload will increase. If a person is dehydrated, preload will decrease.

Afterload is what comes after contraction, or the resistance against which the heart must pump blood. Afterload is determined by two conditions; the **blood volume ejected** from the ventricle and the compliance of the vascular space into which the blood is ejected or **resistance**. Think of afterload as a hose nozzle. If the hose nozzle is wide open, afterload is decreased due to increased compliance and decreased resistance. If the hose nozzle is almost closed, afterload will increase because the water has so much resistance to push against. Now, if you increase or decrease the amount of water that comes from the nozzle, there will be a further effect on the afterload. Think of afterload of the left ventricle as blood pressure or systemic vascular resistance and afterload of the right ventricle as pulmonary vascular resistance. Increased blood pressure is increased afterload, while decreased blood pressure is decreased afterload.

Each side of the heart has its own preload and afterload. Preload is the filling of each chamber while afterload is the pressure and volume of blood the chamber has to pump against. Most of the time these measurements are obtained via the use of a pulmonary artery (Swan-Ganz) catheter which is placed in the right side of the heart. The preload of the right side of the heart is reflected as the central venous pressure (CVP) and the afterload of the right side is reflected as the pulmonary vascular resistance (PVR). The preload of the left ventricle is the pulmonary capillary wedge pressure (PCWP) and the afterload is the systemic vascular resistance (SVR).

The body is constantly trying to maintain cardiac output. Cardiac output is affected by the heart rate and stroke volume. Heart rate is the pulse, or the number of ventricular contractions per minute. Stroke volume is the amount of blood ejected by the heart with each beat. The formula for cardiac output is:

$$\text{Cardiac Output} = \text{Heart Rate} \times \text{Stroke Volume}$$

Conduction System of the Heart

The heart has its own conduction system which is able to function as a result of the cardiac muscle properties listed above. The electrical impulses of the heart usually begin in the sinoatrial node (SA), an area located in the upper part of the right atrium. From the SA node, the impulse travels via interatrial tracts to the left atrium and through internodal tracts to the atrioventricular node (AV). At this point, the impulse pauses to allow time for the ventricles to fill with blood. The impulse then travels to the Bundle of His, then to the right and left bundle branches. From the bundle branches, the impulse goes to the Purkinje fibers which line the inside of the ventricular musculature. After the Purkinje fibers are innervated, contraction should occur. As a result, electrical conduction of the heart precedes contraction.

| |
|--|
| Left Bundle Branch Posterior Fascicle |
|--|

To review, the conduction system of the heart proceeds in the following order:

- 💡 **SA Node**
- 💡 **Interatrial and Internodal Tracts**
- 💡 **AV Node**
- 💡 **Bundle of His**
- 💡 **Right and Left Bundle Branches**
- 💡 **Purkinje Fibers**

Under normal circumstances, the SA node is the **pacemaker**. The reason the SA node is usually the pacemaker is because it has a leakier cell membrane that allows cells to depolarize spontaneously without waiting for an outside source. Sinus node cell membranes are *more leaky* to sodium ions, therefore activate more rapidly to pace the heart. ***The rule of thumb is that the part of the heart that beats the fastest will be the pacemaker of the heart.*** For example, if the ventricles beat faster than the SA node, the ventricles will become the pacemaker of the heart, as happens in ventricular tachycardia. Other areas of the heart, besides the SA node have the property of automaticity and can be the pacemaker of the heart. The SA node is usually the pacemaker of the heart because it beats the fastest. The part of the heart that beats the fastest will be the pacemaker for the time being. Each area of the heart has inherent rates for initiating impulses:

Inherent Rates

| | |
|--|-------------------------------|
| Sinus Node (pacemaker): | 60 to 100 times/minute |
| AV Junctional Tissue (1° backup pacemaker): | 40 to 60 times/minute |
| His Purkinje System in Ventricles (2° backup pacemaker): | 20 to 40 times/minute |

The pacemaker sites other than the SA node are backup systems for the heart. If the SA node were to fail for some reason, the AV nodal area could take over as the pacemaker. If the AV nodal area were to fail, the ventricles could pace the heart at 20 to 40 times per minute. These areas can be enhanced or suppressed by the Autonomic Nervous System which innervates the heart.

ELECTROCARDIOGRAPHY, MONITORING AND ECG

The electrocardiogram or ECG (EKG) represents electrical activity of the heart. This book provides methods to learn to read the ECG. ECG or EKG may be used interchangeably, since they both represent the electrocardiogram. The electrocardiogram **only** measures electrical activity of the heart. The ECG does not verify contraction of the heart. This can be determined only by pulse or blood pressure. The wave of depolarization and repolarization spreading through the heart can be recorded on paper through the use of the ECG. The ECG waveform has specific names that correlate with various activities occurring in the heart.

Configuration of the ECG

<http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif>

J POINT The J point may not always be seen. It is important to identify the J point to determine accurate measurement of the QRS duration. The J point is seen when there is a distinct change from the QRS to the ST segment. The J point is at the end of Ventricular depolarization and at times can be hard to find. Occasionally the only hint of the J point is a slurring of the wave. Location of the J point is utilized to determine if there is elevation or depression of the ST segment.

<http://www.monroecc.edu/depts/pstc/backup/parasec1.htm#JPT>

Correlation of the ECG waveform with conduction sequence

<http://pspl.technion.ac.il/projects/2004s22/ecg1.JPG>

Definition of components of the ECG configuration

- ♥ **Isoelectric line** - baseline that indicates no electrical activity is occurring
- ♥ **P wave** - represents depolarization of the atria or the spread of electrical activity through the atria. The P wave is normally upright in Lead II. If the P wave is of normal size and shape, it may be assumed that the stimulus began in the SA node.
- ♥ **PR Interval** - the period from the start of the P wave to the beginning of the QRS complex. It is the time taken for the original impulse to reach the ventricles, including the delay at the AV node. A prolonged PR interval indicates a delay in the impulse getting through the AV node.
Normal Range = 0.12 - 0.20 seconds.
- ♥ **QRS Complex** - represents depolarization of the ventricles.
- ♥ **Q wave** - first negative wave (in front of a positive wave) Q waves that are at least 1/3 the depth of the R wave are abnormal and may be indicative of a myocardial infarction.
- ♥ **R wave** - positive wave (above the isoelectric line)
- ♥ **S wave** - negative wave after a positive wave

Note: *Not all ECG complexes will have all of the components of the QRS. Some may only have an R, or an R and an S. Others may only have a Q wave.*

- ♥ **QRS Duration** - measured from the beginning of the QRS to the end of the QRS. A prolonged QRS duration may indicate a block in the bundle branches.

Normal Range = 0.04 - 0.10 seconds.

- ♥ **Q-T Interval** - includes the QRS complex and T wave. Normal ranges will vary with age and heart rate.
Normal Range = 0.36 - 0.44 seconds
- ♥ **T wave** - represents repolarization or recovery of the ventricles. The T wave is normally upright in lead II. Inversion of the T wave may indicate ischemia occurring in the heart. Flat T waves may be an indication of potassium deficiency, while tall, peaked T waves may indicate hyperkalemia.
- ♥ **S-T segment** - the interval between the completion of depolarization & repolarization of the ventricular muscle. The S-T segment seen from the end of the QRS to the beginning of the T wave. Elevation of the S-T segment may indicate an injury pattern occurring in the heart.
- ♥ **U wave** – May indicate potassium deficiency or ischemia.
- ♥ **J point** - the point on the S wave where a distinct change is seen from the QRS to the ST segment. The J point may not always be seen. It is important to identify the J point to determine accurate measurement of the QRS duration.

Configurations of the QRS Complex

Not all components of the QRS complex are present on each person's ECG. In fact, a large Q wave is abnormal and may indicate that an MI has occurred in the past. Below are some examples of variations of the QRS complex. Even though parts of the QRS may not be present, it is still referred to as the QRS complex.

The prime (') indicates a second wave of the same. The second R wave is termed prime. The capital letter or lower case letter of the Rr' indicates which peak is the tallest. If the first R is taller, it gets the capital. If the second R is taller, it gets the capital letter.

As you can see, the QRS complex can have many different shapes. It is important to understand this so that you can correctly measure intervals such as the PRI and the QRS duration.

| | | | |
|------------------------------|------------------|----------------|--------------|
| | | | |
| P R S T | P Q R S T | P R S T | P R T |
| | | | |
| P r s R' t (inverted) | P R S T | Q S | P R T |

Identification of the P,Q,R,S and T Waves:

On the strips below, correctly label the P, Q, R, S, and T wave.

Practice Strip 1

Practice Strip 2

Answers to Strips: Strip 1 – P R S T

Strip 2 - P Q R S T

The ECG paper that comes out of the cardiac monitor is a graph paper that comes out at a speed of 25 mm/Sec. Some machines can have a paper speed of 50 mm/Sec. or other variations, but the standard is 25 mm/Sec.

Rule #1: Horizontal measurement on the paper = TIME

- 1 small box = 0.04 seconds
- 1500 small boxes = 60 seconds or 1 minute

- 1 large box = 0.20 seconds
- 5 large boxes = 1.0 second
- 300 large boxes = 60 seconds or 1 minute

- 1 inch on the ECG paper = 1 second of time
- 6 inches on the ECG paper = 6 seconds

Time and Voltage

ETSCS2

<http://www.monroecc.edu/depts/pstc/backup/parasegf.htm>

The ECG paper will usually have some sort of marking on the paper to indicate a 1 second, 3 second or 6 second period of time. This paper has markings in 1 second intervals on the top of the page.

Rule #2: Vertical measurement on the paper = VOLTAGE

- 1 small box = 1 mm (millimeter) or 0.1 mV (millivolt)
- 1 large box = 5 mm 0.5 mV
- 10 small boxes = 10 mm 1.0 mV

Rule #3

After an event occurring on the heavy black line, the rate will be 300 per min. on the next line!

Boxes:

| | | |
|------------------------------|-------------------------------|-------------------------------|
| 1 box rate = 300 per minute | 2 boxes rate = 150 per minute | 3 boxes rate = 100 per minute |
| 4 boxes rate = 75 per minute | 5 boxes rate = 60 per minute | Little Boxes |

Calculating Heart Rates

Each time an ECG strip is analyzed, the heart rate must be calculated. Since we don't always have a full minute strip, we need to determine ways to calculate the heart rate with a smaller strip. Before determining the method for calculating heart rate, it is important to know if the heart rhythm is **regular** or **irregular**. A regular heart rhythm is one that has an equal distance from one QRS complex to the next QRS complex. An irregular rhythm would not have the same distance from one QRS complex to the next.

R R R R R R **These R's are regular** r r r r r r r r **These r's are irregular**

One method that can aid in determining regularity is to take a blank piece of paper and mark a line for 3 QRS complexes in a row on the blank sheet of paper. Then take the 3 lines of the paper and move them to the next set of QRS complexes. Another method is to use calipers to march out the regularity of a strip. If the lines match up or "march out" with the new QRS's, the rhythm is regular. If they do not match, the rhythm is irregular. Look at the rhythm strips below and determine if they are regular or irregular:

Methods for Calculating Heart Rate

Six Second Method - approximate

1. Take six seconds on the ECG paper
2. Count the number of QRS complexes in the six seconds
3. Multiply this number by 10 to give the minute heart rate
4. Accuracy
 - A. Safe to use with **irregular** rhythms
 - B. May also be used with **regular** rhythms

Large Box Method

1. One large box on the ECG paper equals 0.20 seconds, so there are 300 large boxes in a minute or 60 seconds
2. Count the number of large boxes between 2 QRS complexes.
3. Divide this number into 300 For Example:
 - A. if there are 3 large boxes between two QRS complexes, divide 3 into 300 = 100/min
 - B. if there are 5 large boxes between two QRS complexes, divide 5 into 300 = 60/min
4. **Accurate for regular rhythms only**

Small Box Method

1. One tiny box on the ECG paper equals 0.04 seconds, so there are 1500 small boxes in 60 seconds
2. Count the number of small boxes between two QRS complexes
3. Divide this number into 1500
For Example:
 - A. if 15 small boxes between two QRS complexes then divide 15 into 1500 = 100/min
 - B. if 25 small boxes between two QRS complexes then divide 25 into 1500 = 60min
4. **Accurate for regular rhythms only**
The most accurate method for regular rhythms other than taking a full minute strip

ECG Ruler Method

To use an ECG ruler you **must** read the ruler first and find the scale that reads 25 mm/Secs. Find the reference arrow for the scale and place that arrow on one QRS complex. Read the ruler to tell you if you follow over to 2 or 3 R to R's from the reference arrow. Read the scale below for the heart rate.

Table Method

The table method basically takes the Small Box Method and divides the numbers ahead of time for easy reference. The following page will give you tables for the Large Box and the Small Box Method. **This method can only be used for regular rhythms.**

Table for Small Box Method

To calculate the heart rate, count the number of 0.04 squares (or small boxes) between two QRS complexes (1500 divided by X = HR)

| | | | | | | | | |
|------------------|----------|----------|---------|---------|---------|---------|---------|---------|
| Small Box | 9 = 168 | 14 = 107 | 19 = 79 | 24 = 63 | 29 = 52 | 34 = 44 | 39 = 38 | 44 = 34 |
| 5 = 300 | 10 = 150 | 15 = 100 | 20 = 75 | 25 = 60 | 30 = 50 | 35 = 43 | 40 = 37 | 45 = 33 |
| 6 = 250 | 11 = 136 | 16 = 94 | 21 = 72 | 26 = 58 | 31 = 48 | 36 = 42 | 41 = 37 | 46 = 33 |
| 7 = 214 | 12 = 125 | 17 = 88 | 22 = 68 | 27 = 56 | 32 = 47 | 37 = 41 | 42 = 36 | 47 = 32 |
| 8 = 188 | 13 = 115 | 18 = 83 | 23 = 65 | 28 = 54 | 33 = 45 | 38 = 40 | 43 = 35 | 48 = 31 |

Table for Large Box Method

To calculate the heart rate, count the number of 0.20 squares (or large boxes) between two QRS complexes (300 divided by X = HR)

| | | | | | | | |
|------------------|---------|---------|---------|--------|--------|--------|--------|
| Large Box | 1 = 300 | 2 = 150 | 3 = 100 | 4 = 75 | 5 = 60 | 6 = 50 | 7 = 43 |
|------------------|---------|---------|---------|--------|--------|--------|--------|

You really only need to know 1 or 2 methods for calculating heart rate. The important factor is to know that in the absence of a full minute strip to count heart rate, you may use any of these methods for regular rhythms. For irregular rhythms the six second method is the only method that can be used.

Calculating the PR interval (PRI)

Normal Range 0.12 – 0.20 seconds (between 3 to 5 tiny boxes)

The PR interval (PRI) is the distance from the beginning of the P wave to the beginning of the QRS complex. This reflects the time from atrial depolarization to the beginning of ventricular depolarization. A delay in the PR interval usually indicates that there is a delay in the AV node. Short PR intervals most often indicated a junctional rhythm.

Do yourself a favor and find a P wave that begins on a heavy line. For example the **5th** QRS. That complex has a P wave that starts on a heavy line. Count over the number of small boxes to the beginning of the QRS.

Calculating the QRS duration

Normal Range below 0.10 seconds (2 ½ tiny boxes)

The QRS represents the time it takes for ventricular depolarization. The QRS duration is measured from the beginning of the QRS to the end of the QRS. If there is no Q, it is measured from the beginning of the R to the end of the R or S if one is shown.

Again, do yourself a favor and find a QRS that begins on a heavy line. Count the number of small boxes over to determine the QRS duration. Remember you have to include all of the QRS in your calculation.

LEAD SYSTEMS

Leads are a method of recording electrical activity within the heart. It takes two wires, one positive (+) and one negative (-) to make a lead. The leads view the heart from different angles. There are 12 established leads, each viewing the heart from a different angle. The electrical field extends to the body surface where it is measured by electrodes and then waveforms on paper. Electrodes are patches that the wires attach to and measure the **voltage difference** between two electrodes. There are 4 principles of electrocardiography that you must know to understand lead systems:

Only 2 wires make a lead, one positive, one negative.

| Electrical Forces Toward | Yield | Example |
|-------------------------------|---|---------|
| Positive Electrode (+) | Upright | |
| Negative (-) | Inverted | |
| Perpendicular | Biphasic, Equiphasic (As much up as it is down.) | |

Remember, the leads only view the heart from different angles. The electrical forces of the heart progress from the SA node down to the ventricles. That is saying that the electrical forces go down and to the left of the heart. This is called the **mean cardiac vector**. Any lead with its positive electrode down at the left or at the foot area should record an upright P wave and QRS complex. This is because the electrical current (of the heart) is flowing toward a positive electrode.

12 Lead ECG

The 12 lead ECG views the heart from 12 different views. The frontal plane or limb leads comprise six of the leads while the Precordial or chest lead view the heart from a horizontal view. Generally, the 12 lead ECG is done to determine rhythm, rate, axis determination, chamber hypertrophy, bundle branch blocks, special drug effects on the ECG and left ventricular myocardial infarction. To diagnose a right ventricular myocardial infarction, the ECG is done differently with lead placements across the right side of the chest.

6 Limb Leads

Views the Frontal Plane

I
II
III
AVR (Augmented Vector Right)
AVL (Augmented Vector Left)
AVF (Augmented Vector Foot)

6 Precordial Chest Leads

Views the Horizontal Plane

V1
V2
V3
V4
V5
V6

Limb Leads - measure the cardiac electrical activity between two extremities.

THE 3 LIMB LEADS (I, II, III)

The 3 Limb Leads (AVR, AVL, AVF)

Precordial Leads - are unipolar with the heart as the negative electrode and V1 to V6 positions as positive.

The 6 Precordial Leads V1, V2, V3, V4, V5, and V6

LEAD II

The most common monitoring lead is lead II since it produces an upright P wave and QRS that are easy to see. The disadvantage of lead II is that the negative, right arm electrode is on the chest in a position where defibrillation paddles are placed.

MCL 1

MCL 1 stands for modified chest lead I and is an acceptable lead that does not interfere with defibrillation or auscultation. MCL 1 produces an EKG complex different to that of Lead II.

Negative electrode: is 2cm lateral to Left Midclavicular line
Positive electrode: is at the 3rd or 4th intercostal space at right border of sternum

GROUND LEAD

As stated before, it takes two electrodes to make a lead. Often times a 3rd electrode is placed as a **GROUND** to stabilize the electrical forces. It is not important where the ground is placed since the machine is only viewing the heart from the positive and negative electrodes. You may see as many as 5 or six electrodes on a patient. This is done so that the EKG machine can view the heart from different angles at the flip of a switch without having to change electrode position.

12 LEAD WAVE FORMS

This diagram illustrates the position of the 12 leads in relation to the heart. If you notice, Lead II has the tallest R wave. This is because the electrical forces of the heart (down and to the left) are going towards the positive (LL) electrode on lead II. The farther away the particular lead is from lead II, the smaller the R wave and more inverted the R wave (AVR) becomes.

Hexaxial reference circle

A normal 12 Lead EKG with all the different leads

<http://www.ispub.com/xml/journals/ijh/vol1n2/ekg4.jpg>

When current passes to the positive end of the bipolar (2-sided) electrode, it causes a positive deflection, which corresponds to an upward movement of the pen on the ECG paper. Passage of current away from the positive pole of the bipolar electrode causes a negative deflection and a downward movement of the pen on the ECG paper. Current flowing at an oblique angle to the electrode causes smaller deflection, and current flowing perpendicular to the electrode does not cause any deflection in the recorder. Thus each lead "sees" the heart in a different way. This information is recorded on paper as a series of deflections and waves

ECG CHANGES THAT OCCUR WITH ACUTE MI

THE THREE I'S

The "road" to an MI (myocardial infarction) includes 3 predictable changes on the ECG. These changes will show only on the leads that view the part of the heart where the injury occurs.

NORMAL EKG COMPLEX

ISCHEMIA (inverted T waves) - The first change to occur.

INJURY (elevated ST segments) - The second change to occur.

Myocardial Infarction and the 12 Lead EKG

INFARCTION (development of Q waves) - The last and permanent change.

As mentioned before, Q waves are abnormal if they are 1/3 the depth of the R wave and at least 0.04 seconds wide. During the acute phase of a myocardial infarction, T waves will initially invert, then ST segments will elevate. Q waves may not show up for over a day. Eventually, the ST segments will return to normal, T waves will return to an upright position, but the Q waves will remain forever as the wave of depolarization passes through dead or infarcted tissue. The location of an MI is determined by analyzing the 12 lead EKG. Changes will be seen in the leads that correlate with the infarction in that area.

Acute Changes - T wave inversion, ST segment Elevation

Old MI - Q waves with T waves upright and ST segment Isoelectric

| Site of infarction | Changes seen |
|---------------------------|---|
| *Large anterior wall | V ₁ – V ₆ : ST segment elevation |
| *Anterior wall | V ₂ – V ₄ : ST segment elevation |
| *Anteroseptal | V ₁ – V ₄ : ST segment elevation |
| *Anterolateral | I, aVL, V ₃ – V ₆ : ST segment elevation |
| *Lateral wall | V ₅ , V ₆ , I, aVL: Pathologic Q wave, ST segment elevation, inverted T wave |
| *Inferior wall | II, III, aVF: Pathologic Q wave, ST segment elevation, inverted T wave |
| Posterior wall | V ₁ – V ₃ : ST segment depression, tall, upright, symmetrical R wave, and tall, symmetrical T wave. |
| Right ventricle | V _{3R} – V _{6R} : ST segment elevation Requires a right sided 12 lead order. |

Adapted from <http://rnweb.com/rnweb/article/articleDetail.jsp?id=110108>

VENTRICULAR REFRACTORY PERIODS

During repolarization, the individual cardiac cells regain normal excitability, and during this process go through varying periods of excitability known as refractory periods. There are times in these periods when the cells are partially or completely resistant to any stimuli, when another beat could not occur.

ARP V RRP SN

ARP (absolute refractory period) **V** (vulnerable period)
RRP (relative refractory period) **SN** (supernormal period)

1. **Absolute Refractory Period** - Cardiac cells are unable to respond to any stimulus regardless of strength.
This area extends from the Beginning of the QRS to the initial part of the T wave.
2. **Relative Refractory Period** - A **strong** stimulus can cause an impulse.
This area is on the T wave.
3. **Vulnerable Period** - A stimulus hitting at this time is sensitive and vulnerable to electrical chaos such as ventricular tachycardia or ventricular fibrillation.
This area is located at the tip of the T wave.
4. **Supernormal Period** - A **weak** stimulus can initiate the heart.
This occurs after the T wave.

Normal Mechanism of Rhythm Formation

The area of the heart that beats the fastest will pace the heart.

- ♥ The sinus node is the pacemaker of the heart because its cell membrane leaks Na⁺ ions more readily and therefore, the sinus node is the first to reach an action potential and depolarize the rest of the heart.
- ♥ Other areas of the conduction system such as the AV node or the ventricles are merely **potential** pacemakers that become active solely in the case of emergency.
- ♥ The sinus node may **DEFAULT** as pacemaker due to **DECREASED AUTOMATICITY**. This sinus slowing allows the escape of lower pacemaker centers which are now firing faster than the SA node.
 - Junctional rhythms - escape rhythms from the junction or AV nodal area
 - Idioventricular - escape rhythms from the ventricles
Even though these rhythms are abnormal, the escape mechanism that takes over is **normal**, thus placed under normal mechanisms of rhythm formation.

- ♥ Causes of decreased automaticity and depression of cardiac cells leading to bradycardia and possible escape rhythms are:
 - Vagal stimulation
 - Electrolyte imbalance as hyperkalemia & hypercalcemia
 - Hypothermia
 - Drugs such as digoxin and Inderal

Abnormal Rhythm Formation

1. The sinus node may lose its job as the pacemaker due to INCREASED AUTOMATICITY of other myocardial cells that now beat faster than the sinus node.
2. The sinus node pacemaker loses its function because the other area of the heart beat faster, shutting off the sinus node mechanism. This is called USURPATION of the pacemaker function. This is not because the SA node failed; another pacemaker fired faster.
3. May be seen as premature beats or tachycardia from the atria, junction, or ventricles.
4. Causes of increased automaticity leading to premature beats or tachycardia rhythms:
 - ♥ sympathetic stimulation
 - ♥ hyperthermia
 - ♥ electrolyte imbalance such as hypokalemia and hypocalcemia
 - ♥ hypoxia and hypercapnia
 - ♥ cardiac dilatation
 - ♥ ischemia and injury
 - ♥ drugs - toxins
 - ♥ stimulants as caffeine, alcohol, or tobacco
 - ♥ metabolic diseases (hyperthyroidism)
 - ♥ mechanical stimulation (Swan-Ganz & pacemaker placement)
 - ♥ acquired damage (trauma)
 - ♥ diseases of the heart itself such as valve disease, hypertrophy, and aneurysms
 - ♥ congenital abnormalities

Normal Impulse Conduction

The conduction system is one continuous electrical system. Impulses will travel in either direction depending upon where the stimulation occurs. If the impulse starts at the SA node, impulses will travel downward or antegrade. However, if the impulse starts at the AV node the impulse will travel down to the ventricle and back or retrograde up to the atria.

1. **Antegrade Conduction** - normal impulses proceed downward from the sinus node to the Purkinje system.
2. **Retrograde Conduction** - reverse conduction is possible from the Purkinje system to the atria. Premature ventricular contractions (PVCs) may conduct through the system in a retrograde manner and activate the atria. In this situation, the P wave may appear inverted or may be seen following the QRS.

Abnormal Impulse Conduction

Conduction disturbances and dysrhythmias occur if there is a delay or block somewhere in the conduction system.

- ♥ A block in the sinus node would not allow the impulse to progress to the atria (**no P wave**).
- ♥ With a block in the AV node, the impulse may have trouble getting from the atria to the ventricles (**1st, 2nd, 3rd degree block**).
- ♥ A block in the bundle branches causes abnormal ventricular conduction (**a wide, bizarre QRS**).

Conduction disturbance in a small area can develop into a unidirectional block and may cause **re-entry dysrhythmias**. Re-entry occurs when an impulse is able to re-enter an area that was just recently depolarized and repolarized. Conduction occurs in a circuit. Re-entry phenomena usually allow for faster depolarization and are the cause of many tachycardias.

CONDUCTION AND DEFECTS

Normal - impulse travels down the Purkinje fiber and terminates at the ventricular muscle.

Reentry - impulse travels down the Purkinje fiber, reaches the ventricular muscle, but does not terminate there. The impulse re-enters the conduction system, permitting re-excitation of the ventricular muscle.

Block - impulse travels down the Purkinje fiber but is blocked before reaching the ventricular muscle. Can also lead to reentry.

BLOCK

<http://davidge2.umaryland.edu/~emig/gif/reentry3.g>

SYSTEMATIC APPROACH FOR ANALYZING CARDIAC RHYTHMS

When analyzing an individual ECG, it is essential that the analysis be done in a standard, sequential manner. Failure to analyze the strip systematically can result in missing important details and drawing incorrect conclusions.

Each and every time you analyze a strip, follow this step-by-step approach:

Regularity

- ✓ Determine the **regularity of the QRS** complexes (rhythm) This allows you to determine the method for obtaining rate.
- ✓ REGULAR? - use any method
- ✓ IRREGULAR? - use the six second method or obtain a full minute strip

Calculate the heart rate

- ✓ determine the atrial rate (P)
- ✓ determine the ventricular rate (QRS)
- ✓ If there is one P wave for every QRS, the atrial and ventricular rates are the same.

Examine the P waves

- ✓ First, determine if P waves are present.
- ✓ Examine the contour.
- ✓ P waves should be upright in leads II, III, and AVF.
- ✓ Each P wave should be the same shape.
- ✓ Observe the position of the P waves in respect to the QRS's. Normally each P wave should be followed by a QRS, and each QRS should be preceded by a P wave.

Measure the PR interval.

- ✓ Normal range 0.12 – 0.20 seconds
- ✓ Prolonged, may be 1st degree AV block
- ✓ Short, inverted may be junctional origin

Measure the QRS duration

- ✓ Normal range below 0.10 seconds
- ✓ Prolonged may be ventricular delay.

Identify the T wave.

There is always a T wave following a QRS. The ventricles have to repolarize.

Search for any ectopic beats and determine their origin and mechanism.

Determine the origin of the rhythm:

- ✓ Sinus?
- ✓ Atrial?
- ✓ Junctional?
- ✓ Heart Block?
- ✓ Ventricular?
- ✓ Pacemaker (artificial)?

*****Follow this procedure for analyzing all rhythms.***

ATRIAL FIBRILLATION

In atrial fibrillation the atria become so irritable that they are no longer beating but quivering ineffectively. The atria fire at a rate of 350 to 600 times per minute. The AV node takes these impulses through to the ventricles randomly, resulting in an irregular, chaotic rhythm. Atrial Fibrillation is thought to be a rhythm of multiple areas of re-entry into the atria.

Controlled - ventricular response below 100
Uncontrolled - ventricular response above 100

Fine - fibrillatory line almost straight
Coarse - fibrillatory line more bumpy

□ *Significance*

1. Loss of Atrial Kick - since atria are fibrillating, there is no distinct atrial contraction to provide extra filling to the ventricles.
2. Thrombus formation - can occur with fibrillating atrium. When rhythm is converted to sinus rhythm the resulting atrial contraction can result in pulmonary emboli (right atrium) or a cerebrovascular accident (left atrium).

□ *Treatment – Narrow Complex Tachycardia Algorithm*

Review of Atrial Rhythms

This completes the section on atrial rhythms. Remember, atrial rhythms originate in the atria, not the sinus node. Since the impulse originates in the atria, the P wave will be of a different shape than that of the sinus node. PAC's are early beats coming from the atrium. They are called ectopics. You will have two jobs: identifying the underlying rhythm and identifying the ectopic.

Atrial tachycardia and PAT are rhythms originating in the atria at a rate of 140 to 250 per minute. The difference between the two is that PAT is paroxysmal, and has a sudden start or sudden stop. Atrial flutter has the atria fluttering at 250 to 350 times a minute with a saw tooth baseline. The AV node usually takes impulses through in a rhythmic pattern, resulting in block of 2:1, 3:1, 4:1, or other variations. Atrial fibrillation has the hallmarks of an irregular rhythm and no P waves. WAP has the pacemaker of the heart wandering between the SA node, atria, and AV node. Characteristics are different shaped P waves and, usually, an irregular rhythm.

Review of Junctional Rhythms

This completes the section on junctional dysrhythmias. The most important thing to remember, is that **ALL JUNCTIONAL RHYTHMS SHARE A JUNCTIONAL TYPE BEAT**. This junctional beat has the criteria of an inverted P wave before the QRS, buried in the QRS, or after the QRS. In addition, the PR interval of the P wave before the QRS is **short** and is below 0.12 seconds. For instance, you may see a rhythm with a P wave that is inverted with a normal PR interval. Since the PR is normal, that rhythm would not be a junctional rhythm, but probably a sinus rhythm with an inverted P wave.

A premature junctional contraction is an ectopic beat that comes early. This ectopic beat has the junctional P wave. Junctional rhythm, accelerated junctional, and junctional tachycardia are all the same except they differ in rate criteria. All three of these rhythms share a junctional type p wave but the rate varies:

Junctional - 40 to 60 Accelerated - 60 to 100 Tachycardia - over 100

A junctional escape beat is much like sinus arrest. In sinus arrest there is a pause, and the next beat that comes in has a sinus P wave in front of it. In a junctional escape beat the beat after the pause has a junctional type P wave

To review junctional rhythms, I will make a chart of only the **abnormal** criteria for each rhythm. The best way to learn the rhythms is to know which abnormal criteria makes the rhythm different from another.

Heart Blocks

Heart blocks are basically caused from a sick AV node. The impulse originates in the SA node, but has trouble getting through the AV node. Heart blocks are classified by degrees: **The key to differentiating all of the heart blocks is the PR interval.** Since the impulse originates in the SA node, the sinus P waves are fired from the SA node at a regular rate. Therefore, the P to P intervals in all of the heart blocks will be regular. The changes that will be seen will be in the PR intervals.

FIRST DEGREE AV BLOCK

In first degree AV block, the sinus impulse is delayed in traveling through the AV node, resulting in prolonged PR intervals. As we go through the different heart blocks, the etiology will remain the same. It is the degree of dysfunction at the AV node that determines the severity of heart block.

| RHYTHM & ▼ ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|--|---|-----------------------|
| <p style="text-align: center;">1st degree AV Block</p> <ul style="list-style-type: none"> ♥ Insult to the AV node ♥ Hypoxemia ♥ M.I. ♥ Digitalis toxicity ♥ Ischemic diseases of the conduction system ♥ Hyperkalemia | <p>RHY – Regular PRI – above 0.20 QRS – 0.04 – 0.10</p> | <p>PRI above 0.20</p> |

☐ **Significance** - usually there are no other signs or symptoms. May progress to 2nd or 3rd degree blocks.

Treatment - usually none, but atropine may reverse.

SECOND DEGREE AV BLOCK Type I (Mobitz I or Wenckebach)

This type of block is a form of incomplete block, since only some of the sinus impulses are prevented from reaching the ventricles. With Wenckebach, the impulses are progressively delayed through the AV node, being a little slower with each beat. The PR interval gets progressively longer until the QRS is dropped. I like to use the analogy of school for this rhythm. The first day students show up on time. The second day the student is a little late, the third day later, and the fourth day doesn't show at all. Since this rhythm is cyclic, on the fifth day the student shows up on time again, thus starting the pattern over again. Remember - The 'W' in Wenckebach has a beginning sound like 'one', in other words, **Mobitz I (won) = Wencke**

| RHYTHM & ▼ ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|---|--|
| <p style="text-align: center;">2nd degree AV Block Type I – Mobitz I, Wenckebach</p> <ul style="list-style-type: none"> ♥ Same as 1st degree | <p>RHY – Irregular PRI – vary QRS – 0.04 – 0.10</p> | <p>Irregular EXTRA Ps PRI longer & longer, Dropped QRS</p> |

Cyclic Pattern

Significance

1. Usually transient and **does not progress to further blocks**
2. There may be no hemodynamic changes unless the rate is very slow
3. With an inferior MI it is viewed as benign with an anterior MI, may be a warning sign that a higher degree of block may occur at any time

Treatment – Bradycardia Algorithm

SECOND DEGREE AV BLOCK Type II (Mobitz II)

Second degree AV block, Type II is another form of incomplete block, but is thought to occur at the bundle branches rather than at the AV node. This is a fixed-ratio block because impulses are usually blocked at the AV node at regular intervals. Type II block has a greater chance of progressing to complete heart block.

Remember: two = trouble

| RHYTHM & ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|--|----------------------------------|
| 2nd degree AV Block Type II or Mobitz II ♥ Same as 1 st degree | RHY – Regular or Irregular PRI – constant QRS – normal or wide | Regular or Irregular EXTRA Ps |

If there are 2 P waves for every QRS - 2:1 Block, 3P's -3:1 Block, 4P's - 4:1 Block
 If the block varies it is a variable block. With variable block, the rhythm will be irregular.

Significance

1. Slow heart rate can decrease cardiac output and blood pressure resulting in shortness of breath, restlessness, and chest pain.
2. **Usually not transient** and may progress to complete heart block or ventricular standstill.

Treatment – Bradycardia Algorithm

Pacemaker often used since this block can progress to 3rd degree heart block.

THIRD DEGREE AV BLOCK (complete heart block)

In third degree block the AV node shuts down completely. The SA node fires, but no impulses are conducted through to the ventricles. Backup pacemakers, such as the AV junction or the ventricles, will hopefully reestablish or allow some heart rate.

| RHYTHM & ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|--|---|---|
| 3rd degree AV Block, Complete Heart Block ♥ Same as 1 st degree | RHY - Regular PRI – vary QRS – usually wide | Regular EXTRA Ps PRI varies greatly |

Significance

1. Hemodynamic status is dependent upon the ventricular rate
 - a. near normal rate probably no symptoms
 - b. slow rate - decreased cardiac output
2. **Extremely Dangerous** - the lower pacemakers are usually very slow and unreliable, particularly if the pacemaker is from ventricular escape. The slow rate may cause irritability or ventricular standstill

Review of Heart Blocks

To review, heart blocks occur because the AV node is sick. The sinus node fires impulses at a normal rate, but the impulse is delayed or blocked when attempting to get through the AV node. Heart blocks are categorized by degrees, with third degree being the most dangerous.

THE KEY TO IDENTIFYING HEART BLOCKS IS THE PR INTERVAL

First degree AV block is just like sinus rhythm except the PR interval is constantly prolonged above 0.20 seconds. There are 2 types of second degree AV block. Type I is often called Wenckebach and is characterized by a PR interval that gets longer and longer until a QRS is dropped. This is a cyclic rhythm. The P to P will be regular, but the **R to R is irregular in Wenckebach**. Type II second degree heart block has intermittent blocking of impulses through the AV node. The PR interval will be fixed on the beats conducting through to the ventricles. Type II block is more dangerous than Type I and is more likely to progress to complete heart block. Third degree AV block is the most dangerous because there is total block at the AV node. The sinus node beats on its own as does a backup pacemaker which may be the junction or the ventricles. There is no relation between the P waves and the QRS's. AV dissociation is a term to describe a situation where the sinus node and the ventricles compete to be the pacemaker. Some sinus beats will be conducted and others will have no relation to the

VENTRICULAR RHYTHMS

Ventricular dysrhythmias originate in the ventricle. Since these rhythms do not originate above the AV node, depolarization of the ventricles is usually slower resulting in a wide and bizarre QRS complex. Since it is the ventricles that produce the cardiac output, disturbances in this area are very serious and can be a precedent of cardiac arrest.

PREMATURE VENTRICULAR CONTRACTIONS/DEPOLARIZATIONS (PVC/PVD)

When an irritable ectopic focus from the ventricle fires, a PVC occurs. The correct term for this irritable beat is a PVD, premature ventricular depolarization. Since we don't see "contractions" on the EKG, the term PVC is actually incorrect, but the misnomer has remained. Most facilities will refer to the term PVC rather than PVD. PVC's may result from an automatic focus or reentry.

When frequent and unifocal, the morphology (shape) and coupling interval (distance from the normal beat to the PVC) remains the same. This is because the same irritable focus is firing.

Unifocal PVC's



COUPLING INTERVAL (ARROWS)

When multiple or multifocal, both the morphology and the coupling interval of the QRS vary.

Multifocal PVC's



COUPLING INTERVAL (ARROWS)

A complete or fully compensatory pause is usually present

Timing of PVC's

1. bigeminy - every other beat a PVC
2. trigeminy - every third beat a PVC
3. quadrigeminal - every fourth beat a PVC
4. coupled or paired - two PVC's in a row
5. Salvo - three PVC's in a row (also called a short run of ventricular tachycardia)
6. Interpolated - PVC sandwiches between two normal sinus beats that doesn't disturb sinus rhythm

□ **Significance of PVC's**

1. One of the most common dysrhythmias and can occur in most anyone at some time.
2. In the normal heart are not considered dangerous or significant.
3. In ischemic heart disease or electrolyte imbalance, they are considered dangerous beats that warn of ventricular irritability that can lead to serious and lethal rhythms such as ventricular tachycardia or ventricular fibrillation.
4. Individually, PVC's have no real hemodynamic significance but the rhythms that can result from a PVC do:
 - **R on T Phenomenon** - PVC hitting on the vulnerable period of the T wave (peak) can initiate ventricular tachycardia or ventricular fibrillation.
 - **Interpolated beats** – may be more dangerous because there may be R on T phenomenon and they don't recognize or disrupt the normal rhythm. No compensatory pause.
5. **Always significant after an acute M.I.**

□ **Treatment Treat underlying causes first**

1. PVC's found in normal, healthy hearts - treatment usually doesn't work, so don't treat.
2. PVC's occurring in a critically ill but non-cardiac patient, treat the cause - i.e. hypoxia, hypokalemia.
3. Always treat in a patient with acute M.I.
4. Dangerous PVC's that should be treated:
 - a. more than 6 per minute (when indicated. Usually treat the cause rather than PVC's)
 - b. increasing in frequency.
 - c. occurring in pairs or triplets.
 - d. Multifocal - indicates more than one irritable site.
 - e. R on T phenomenon.
5. Drug Therapy/treatment
 - a. Lidocaine is an old friend with poor rationale. Treat the cause first.
 - b. Procainamide
 - c. Overdrive pacing if drugs do not suppress the ectopic focus.

Nonacute patient with chronic PVC

 - a. procainamide, propranolol, quinidine
 - b. Dilantin - if from digitalis toxicity
 - c. potassium infusion if from hypokalemia

VENTRICULAR TACHYCARDIA

Ventricular tachycardia is due to rapid discharge from an ectopic ventricular focus. The rhythm is usually preceded by PVC's and indicates advanced myocardial irritability. This is probably a reentry rhythm. The rate of ventricular conduction usurps the SA node as the pacemaker.

| RHYTHM & ♥ ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|---|--------------------------------------|
| <p style="text-align: center;"><i>Ventricular Tachycardia</i></p> <p>♥ Same as PVCs ♥ R on T PVC</p> | <p>RHY – Regular R – Above 100 P – None PRI –None QRS – Wide, Bizarre</p> | <p>R over 100 All Vent beats</p> |

Significance

1. Indicates extreme myocardial irritability and can cause loss of consciousness.
2. May proceed to ventricular fibrillation and death.
3. May be tolerated in some but causes a decrease in cardiac output leading to dizziness, angina, CHF, pulmonary edema or shock.

Treatment – Wide Complex Tachycardia Algorithm

Torsade de Pointes or Polymorphic Ventricular Tachycardia

Torsade de Pointes - a rare form of V-tach that can be aggravated by traditional treatment to V-tach. It means "twisting of the points". The QRS complexes rotate from a negative to positive deflection within a period of 5 to 20 beats. Torsade usually has a rate of 200 to 250 beats per minute. Common causes are hypokalemia and quinidine therapy.

Eliminate the cause such as drug toxicity or electrolyte imbalance. **See Ventricular Fibrillation Algorithm.**

VENTRICULAR FLUTTER

Ventricular flutter is similar looking to a ventricular tachycardia except the rate is faster at 200 to 300 times per minute. Often, a reference will not distinguish between ventricular flutter and ventricular tachycardia. It is introduced here so that you are familiar with the term.

- **Significance** - severe derangement of the heartbeat that is usually fatal within 3 to 5 minutes unless treated.
- **Treatment – Ventricular Fibrillation Algorithm**

VENTRICULAR FIBRILLATION

| RHYTHM & ▼ ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|--|---|
| <p style="text-align: center;"><i>Ventricular Fibrillation</i></p> <ul style="list-style-type: none"> ♥ Following V Tach ♥ Acute MI ♥ Hypothermia ♥ R on T PVC ♥ Electrolyte Imbalance ♥ Electrical Shock ♥ Suddenly without cause. | <p>RHY – Chaotic waves R – None P – None PRI –None QRS – none, fibrillatory line</p> | <p>Chaotic wavy line. No pulse.</p> |

Ventricular fibrillation is a chaotic ventricular rhythm where the entire ventricular muscle twitches and quivers erratically. There are no effective contractions of the heart. There is no cardiac output. In most cases the rhythm is triggered by PVC's or V-tach but can occur spontaneously without preceding signs of ventricular irritability.

Significance

1. **No cardiac output** - patient is apneic, pulseless and clinically dead.
2. Therapy must be instituted within two to three minutes or the chance for survival is poor. Irreversible brain death occurs within four to six minutes.

Treatment – Ventricular Fibrillation Algorithm

VENTRICULAR ESCAPE BEAT

A ventricular escape beat occurs when the SA node fails to fire and the junctional area fails to back up the SA node.

- Significance*** - overall rate may be slow, but this is an escape rhythm that is working to keep the overall rate of the heart adequate to maintain cardiac output.

Treatment

1. **DO NOT SUPPRESS** - treat the overall slow rate.
2. Treat symptomatic patients as you would sinus bradycardia.

VENTRICULAR ESCAPE RHYTHM OR IDIOVENTRICULAR RHYTHM

| RHYTHM & ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|--|------------------------------|
| <i>Idioventricular Rhythm or Ventricular Escape</i> ♥ When all higher pacemakers have failed. | RHY – Regular R – below 40 P – None PRI – None QRS – Wide, Bizarre | R below 40 All Vent beats |

The ventricles act as a backup pacemaker. Ventricular escape rhythm occurs when the entire rhythm arises from the ventricles because the higher pacemakers have ceased function. The rate of this rhythm is at the inherent rate of the ventricles (20 to 40 per minute).

Significance

1. Rate is very slow and undependable. The pacemaker may stop firing at any time, leaving the patient in ventricular standstill.
2. Rate may be too slow to maintain cardiac output.
3. Since there are no P wave, loss of atrial kick.

Treatment – Bradycardia Algorithm

ACCELERATED VENTRICULAR RHYTHM

Accelerated ventricular rhythm occurs when an automatic focus in the ventricles fires between 40 and 100 times per minute.

| RHYTHM & ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|---|----------------------------|
| <i>Accelerated Ventricular</i> ♥ An automatic focus in the ventricle fires. | RHY – Regular R – 40 - 100 P – None PRI –None QRS – Wide, Bizarre | R 40-100 All Vent beats |

Significance - this is a backup pacemaker mechanism.
DO NOT SUPPRESS.

Treatment - **DO NOT SUPPRESS**
 Heart Rate 70

AGONAL RHYTHM

Agonal rhythm is a term to describe a dying heart. Waves of electrical activity occur with very wide, slurred-looking QRS complexes. Treatment would be the same as asystole.

| RHYTHM & ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|---|--|---|
| <p>Agonal</p> <ul style="list-style-type: none"> ♥ Dying heart ♥ Drugs used in cardiac arrest provide some electrical waves. | <p>RHY – Regular R – Slow P – None PRI – None QRS – very very wide</p> | <p>Slow wide bizarre stretched out waves. No Pulse</p> |

ASYSTOLE

In asystole there is no electrical activity occurring. Asystole may be a primary event in cardiac arrest or may follow ventricular tachycardia or ventricular fibrillation. The rhythm shows up on the strip as a straight line.

| RHYTHM & ETIOLOGY | CRITERIA OVERVIEW | UNIQUE CRITERIA |
|--|--|---|
| <p>Asystole</p> <ul style="list-style-type: none"> ♥ Primary event in cardiac arrest. ♥ Untreated V-tach or V-fib | <p>RHY – None unless only Ps R – No Vent rate P – may be present PRI – None QRS – None</p> | <p>Straight line or only Ps No Pulse</p> |

B. Important points to consider with asystole:

1. If the rhythm is unclear and possible ventricular fibrillation, treat as V-fib.
2. Asystole should be confirmed in 2 leads

Significance - patient is clinically dead. Pulseless, breathless.

Treatment - ACLS Protocol for asystole- CPR, epinephrine, or atropine.

Review of Ventricular Rhythms

This completes the section on ventricular dysrhythmias. The ventricular rhythms are the most life threatening and require immediate recognition and treatment. All ventricular rhythms share a ventricular looking QRS which is wide above 0.11 second, has a bizarre looking QRS. This is part of what makes the complex look wide and bizarre. P waves are generally not present since the impulse originates in the ventricles. If P waves are present, they bear no relation to the QRS complexes.

PVC's are early beats originating in the ventricle. They can occur in any rhythm, come early, and have a ventricular looking QRS. A fusion beat is a PVC and a regular beat coming together at the same time. The result is a premature ventricular looking beat with a P wave. Rhythms that come entirely from the ventricle and are differentiated by rate alone are:

| Rhythm | Rate Criteria |
|--|----------------------|
| Ventricular Tachycardia | 100 to 220 |
| Ventricular Flutter | 200 to 300 |
| Accelerated Ventricular | 40 to 100 |
| Idioventricular or Ventricular Escape Rhythm | 20 to 40 |

Torsade de Pointes is a type of ventricular tachycardia where the QRS's flip from upward to downward. A ventricular escape beat, like a junctional escape beat, occurs after a pause from the sinus node. The next beat that comes in is a ventricular shaped beat.

Ventricular standstill is differentiated by primary and secondary. With primary standstill, only P waves occur with no QRS complexes at all. In secondary standstill, QRS complexes show at a rate of 10 to 30 but there is no pulse to correspond. Asystole occurs when there is no electrical activity occurring and shows as a flat line.

PACEMAKERS

Purpose

A pacemaker is an electrical device with a pulse generator that delivers an electrical stimulus to the heart through electrodes placed in contact with the endocardium, attached directly to the epicardium, or placed on the skin. This electrical current will depolarize or activate the heart at a predetermined rate or cycle.

Indications

A. Slow Heart Rate

- symptomatic bradycardia
- second degree AV block
- third degree AV block
- prophylactically during surgical procedures
- medication toxicity (digitalis, quinidine)

B. Fast Heart Rate

To override a tachycardic arrhythmia as PAT, atrial fibrillation, or atrial flutter.

C. Diagnostic

- Atrial pacing to increase the heart rate and thereby produce a stress test that may provoke electrocardiographic, biochemical or hemodynamic signs of ischemia with coronary artery disease.
- Atrial premature beats may be delivered for electrophysiology studies to assess changes of heart rate on AV conduction.
- Ventricular premature beats may be delivered for studies to assess best drug treatment for a particular patient with a history of ventricular dysrhythmias.

Dual Chamber Pacemaker

<http://connection.lww.com/Products/morton/documents/images/Ch18/pdf/Ch18-034.pdf>

B. Pacemaker Capture When the spike does occur and is followed by a waveform, then capture has occurred. The rhythm has been activated. Spike can be upright or inverted.

V. Pacing Modalities

- A. Fixed-rate pacemaker (continuous asynchronous) The pacemaker fires at a set rate regardless of the patient's own intrinsic rate.
Danger: pacemaker stimulus may fall on the vulnerable period of the T wave causing a serious ventricular dysrhythmia.
Pacers are rarely ever placed on fixed-rate, however, most transcutaneous pacers are fixed-rate pacers.
- B. Demand Pacemaker A demand pacemaker fires only when the patient's heart is below a present level. It "senses" the patient's heart beat and fires only when needed. These pacers can work in two ways:
1. rate - pacer rate is set at 70, if patient's heart rate falls below 70 pacer is activated or "pacing"
 2. timing intervals - if it is a preset time set in milliseconds until the next P wave or QRS comes in, If the patient's own P wave or QRS does not come in, the pacer will fire. These are programmable pacers that can have parameters set individually for the P wave or QRS depending upon whether there are pacing wires in atria, ventricle, or both.

C. Dual Chamber Pacing When a pacer wire is placed only in the ventricle, there is loss of atrial kick that can provide up to 20% of a person's cardiac output. Dual chamber pacemakers have pacemaker wires in the right atrium and right ventricle. Pacing of each chamber is determined by timing intervals.

D. Pacemaker Terminology Since there are many types of pacemakers, an international coding system has been developed to identify various pacing modes and sensing modes.

1st letter = chamber paced

V = ventricle

A = atrium

D = both (dual)

2nd letter = chamber sensed

V = ventricle

A = atrium

D = both (dual)

3rd letter = mode of response

I = inhibited or blocked by a sensed signal

T = triggered (discharged) by sensed signal

D = inhibited and triggered

O = specific comment not applicable

For example:

VVO = ventricular fixed rate, asynchronous

VVI = ventricular demand pacemakers.

The QRS or R wave inhibited the demand. A demand pacemaker

DDD = both chambers paced, senses, inhibited by QRS or triggered needed

The most common type of pacemaker is the VVI. What may happen is that you get a patient admitted with a pacemaker. These patients often carry identification cards that indicate the type of pacemaker that they have. If you look on their card and see that the pacer is a VVI, then you will know that they have a pacing wire set in the ventricles on the demand mode.

DDD mode pacemakers, Dual Chamber Pacemakers

A dual-chamber pacemaker typically requires two pacing leads: one placed in the right atrium, and the other placed in the right ventricle.

A dual-chamber pacemaker monitors (senses) electrical activity in the atrium and the ventricle to see if pacing is needed. When pacing is needed, the pacing pulses of the atrium and ventricle are timed so that they mimic the heart's natural way of pumping.<http://www.medtronic.com>

Patients who have a DDD pacemaker have initiation of a P wave or a QRS based on timing intervals. On these pacers you may see any combination of the following:

1. No pacer spikes - all of the patient's own rhythm
2. Pacer spike to P, patient's own QRS
3. Patient's own P, pacer spike to the QRS
4. Pacer spike to the P wave and the QRS

Rate-responsive Pacing Systems

A normal heart rhythm slows down or speeds up many times during the day. The heart beats slower while resting or sleeping. Exercise or emotional excitement makes a heart beat faster because, in an excited state, a body requires greater amounts of oxygen. And, oxygen is brought to all parts of the body through the blood. When a heart is unable to adjust its pumping rate, a rate-responsive pacemaker is used.

A rate-responsive pacemaker mimics the heart's natural function to adjust the heart rate. A rate-responsive pacemaker uses one or more special sensors to recognize changes in how much blood and oxygen are needed by the body. Based on this information, the heart rate is adjusted to meet the body's changing needs for blood flow.

How Rate-responsive Pacemakers Function

A rate-responsive pacemaker uses one or more special sensors to detect changes in the body that indicate more oxygen is needed. Some sensors may detect motion or how often you breathe. When a change is detected, the pacing rate is increased according to how the doctor programmed the pacemaker.

A pacemaker may have one or more sensors . The two most common sensors are an activity sensor and a minute ventilation sensor.

Benefits of Rate-responsive Pacing

For people whose heart rate does not increase when needed, rate-responsive pacing:

- Provides people with a more appropriate heartbeat for their current activity.
- Allows people to perform ordinary, daily activities more effectively.
- Allows people to perform more vigorous exercise.
- Gives people a greater sense of well-being in their day-to-day lives.

Rate-responsive pacemakers vary the pacing rate in response to the body's needs, similar to how a healthy heart works. Such variations in pacing rate allow better performance in everyday activities. When engaged in physical activity such as walking, exercising, or gardening, the pacemaker automatically adjusts the pacing rate to match the level of activity. When you slow down, rest, or sleep, the pacemaker allows the pacing rate to decrease accordingly.

Individuals who have rate-responsive pacing report feelings of well-being and the ability to resume more active and satisfying lifestyles. In diaries kept during clinical studies of rate-responsive pacemakers, individuals reported feeling better and enjoying a higher quality of life because they could participate in activities that previously were not possible.

You do not need to engage in very strenuous activity to benefit from a rate-responsive pacemaker. For example, the simple act of walking may require a rate of more than 100 beats per minute.

Rate-responsive pacing can be done with a dual- or single-chamber pacing system.

<http://www.medtronic.com>

VI. Complications

A. Pacemaker Failure

1. Failure to Capture

- a. Pacer spike noted not followed by a wave form
- b. The catheter is either in the wrong position or the milliamps (MA) are set too low.
- c. Nursing Action: - check connection (on temporary pacer)
 - turn patient on either side
 - call doctor
 - *increase voltage or milliamps (MA)
 - *atropine or isoproterenol as needed
 - CPR if needed

2. Failure to Sense

- a. Pacer undersenses and fires in competition with the patient's own rhythm. Spike will come in an inappropriate place such as after the QRS.
- b. Nursing Action:
 - increase sensitivity (dial on demand side)
 - check batteries
 - reposition patient
 - call doctor if no results
- c. Danger: may fire on vulnerable period of T wave creating an R on T phenomenon

3. Failure of pacer to fire appropriately or undersensing

- a. Pacemaker does not fire when it should
- b. May be due to outside electrical interference
 - drill, shaver, microwave oven
- c. Pacer will sense outside electrical current thinking it is the heartbeat. It will turn itself off and not fire.
- d. Nursing Action:
 - remove patient from electrical source
 - check batteries or may need a new generator

Review of Pacemakers

This completes the section on pacemakers. A brief overview of pacemakers has been given. Pacemakers are electronic devices with a pulse generator that delivers an electrical stimulus to the heart. With the cardiac muscle when one fiber is stimulated, the rest are depolarized in succession much like a stack of dominoes.

Although pacemakers can be used for various diagnostic purposes, the most frequent indication is for bradydysrhythmias. Pacemakers can be single chamber (ventricular) or dual chamber (atrial and ventricular). Dual chamber pacemakers are hemodynamically more compatible with the heart since the "atrial kick" is intact. Ventricular pacemakers originate from the ventricle and generator a ventricular beat that is wide and bizarre.

Pacemakers can be temporary or permanent. Temporary pacemakers have a generator box outside of the body, while permanent pacemakers have a generator placed under the skin. Temporary pacing can be achieved through transcutaneous, transthoracic, or transvenous methods. Permanent pacing can be accomplished with transvenous or an epidural approach.

On the EKG, a pacer beat will show with a vertical spike. The spike can be up or down, but must precede the chamber paced and capture the chamber producing a marked P wave and/or QRS complex. Pacemakers are classified according to the chamber paced. The most common pacemaker is a VVI, which indicates the pacemaker is seated in the ventricle.

Pacemakers can be demand or asynchronous (fixed rate). Fixed rate pacers are rarely used because of the danger of R on T phenomenon. Demand pacemakers are set to come in "on demand" only. The pacemaker is set to come in either when the heart rate falls below a preset limit or by timing intervals.

Pacemaker complications can occur because of improper placement, inappropriate voltage to capture, or generator battery failure. A pacemaker that is not functioning properly can exhibit failure to fire, inappropriate sensing, or failure to capture. Other complications can be infection, pericarditis, ventricular perforation, or lethal dysrhythmias.

Dysrhythmia Dictionary

Appendix A

| Term | Definition |
|-----------------------------|--|
| 12-lead ECG | Views the heart from 12 angles to help in determining infarction, hypertrophy, axis deviation, and bundle branch blocks. |
| Aberrant Conduction | Conduction that takes a different pathway through the Atrium. Usually results in a wider QRS complex. |
| Acute MI | Blockage of the coronary artery from atherosclerosis, spasm, |
| Afterload | Affected by pressure and preload. The force that heart has to pump against after contraction. Forward pressure. |
| Antegrade conduction | Conduction that occurs in a downward manner from atria to ventricles. |
| Antegrade Conduction | Conduction occurring in a downward manner toward the ventricles. |
| Aortic Valve | The valve between the left ventricle and the aorta. |
| Apex | The bottom portion of the heart. |
| Arrhythmia | A rhythm that is disturbed. |
| Arteriole | Smaller arteries located between arteries and capillaries. |
| Artery | A vessel carrying blood away from the heart. With the exception of the pulmonary artery, carries oxygenated blood |
| Artifact | Extra events recorded on the ECG that do not relate to actual electrical activity of the heart. |
| Asymptomatic | Patient is free of symptoms even though an abnormal rhythm is present. |
| Atrial Kick | The amount of blood contributed by atrial contraction into the ventricles. Accounts for 20 to 30 %t of cardiac output. |
| Augmented Leads | Leads aVR, aVL, and aVF that view the heart on the frontal plane. |
| Automaticity | The ability to generate an impulse |
| Automaticity | Quality of the conduction system that automatically initiates a stimulus. |
| AV node | Located between the atria and ventricles. Also called the junctional area |
| Bigeminal PVC | Every other beat is a PVC. |
| Block | Impulse is prevented from continuing on the conduction pathway. |
| Bradycardia | In general, a heart rate below 60. |
| Capillary | The area in the circulatory system where the exchange of nutrients takes place. |
| Cardiac Output | Hemodynamic calculation of heart rate X stroke volume. |
| Compensatory Pause | The timing and spacing to the next beat after an ectopic. PVC's usually have a full or complete compensatory pause. |
| Conductivity | The ability to transmit impulse |

| Term | Definition |
|-------------------------------------|--|
| | |
| Contractility | The ability to respond with pump action (pulse) |
| Coronary Arteries | Supply the heart muscle with oxygenated blood. |
| Coronary Sinus | Located at the base of the right atrium. It is the area where the coronary veins return venous blood from the coronary arteries. |
| Coupling Interval | The distance from the normal beat to the ectopic. |
| Demand Pacing | Pacemaker comes in only when needed as determined by preset intervals. |
| Deoxygenated or Unoxygenated | Venous blood is deoxygenated. The venous blood carries 16-17% oxygen, while the arteries have 21% oxygen. |
| Depolarization | The electrical stimulation of cells. |
| Diastole | The relaxation phase of the cardiac cycle. |
| Dissociated | Not related to each other. For example, the P waves do not have any relation to conduction of the QRS. |
| Dual Chamber | Pacemaker wires are placed in the right atria and right ventricle. Helps provide atrial kick. |
| Dysrhythmia | A rhythm that is disturbed |
| Escape Beat | Occurs when a higher pacemaker doesn't fire. The beat 'escapes' from a lower pacemaker as a backup. |
| Etiology | The cause of a problem. |
| Excitability | The ability to respond to stimulation |
| 'f' waves | Fibrillatory waves. |
| 'F' waves | Flutter waves. |
| Fibrillation | A quivering chamber resulting from multiple firings. |
| Fixed rate | Pacing modality where rate is set regardless of what is happening with the patient's own rhythm. |
| Flutter | Rhythmic, rapid firing within a chamber. |
| Fusion beat | Premature beats where a PVC and a normal beat come together at the same time. |
| Idiojunctional | The same as junctional escape rhythm. |
| Inverted | Upside down (as in the P waves in junctional rhythm). |
| J point | The location at the end of the S wave which indicates the change from the S wave to the ST segment. |
| Junction Tissue | Area surrounding the AV node |
| Junctional Beat | A complex that has an inverted P wave before or after the QRS. PRI is shortened or there is no P wave seen. |
| Large box method | A method for determining heart rate on regular rhythms. The number of large boxes between two QRS complexes is divided |

| Term | Definition |
|---------------------------------------|--|
| | into 300 to obtain the minute heart rate. |
| Limb Leads | I, II, III, aVR, aVL, and aVF to view the frontal plane of the heart. |
| Mitral Valve | The valve located between the left atrium and left ventricle. |
| Multifocal | Occurring from different sites. Beats have different shapes. |
| Nonconducted | An area in heart fired, but did not progress through the conduction system. |
| Opposite Polarity | Description of a PVC's where the QRS is in an upward direction while the T wave is downward, or the T is up and QRS is down. |
| Oxygenated | With oxygen. Arteries carry oxygenated blood at 21%. |
| P wave | Wave representing atrial depolarization. |
| Parasympathetic Nervous System | Part of the autonomic nervous system. Stimulation slows heart rate. Associated with the vagus nerve. |
| Paroxysmal | Referring to sudden start or stop. |
| PMI | Point of maximal impulse where the apical pulse can be palpated. Usually at 5th intercostal space, midclavicular line. |
| PR interval | Time interval from the beginning of the P wave to the beginning of the QRS complex. Normal range is 0.12 - 0.20 seconds. |
| Precordial Leads | Leads V1, V2, V3, V4, V5, and V6 that view the heart from the horizontal plane. |
| Preload | Amount of fluid coming to the heart chamber before contraction. |
| Premature | Occurring early. |
| Pulmonary Artery | Carries deoxygenated blood from right ventricle to the pulmonary capillary membrane in the lungs. |
| Pulmonary Vein | Carries oxygenated blood from the lungs to the left atrium. |
| Pulmonic Valve | Valve located between the right ventricle and the pulmonary artery. |
| QRS duration | Interval from the beginning of the QRS to the end of the S wave. Normal range is below 0.10 seconds. |
| Q-T interval | Interval from the beginning of the QRS to the end of the T wave. |
| R on T Phenomenon | PVC that hits in the vulnerable portion of the T wave. May precipitate ventricular fibrillation or tachycardia. |
| Re-entry | When an impulse re-enters the conduction system in a retrograde manner rather than terminating. |
| Refractory Periods | Various periods in the ECG complex where the heart can or cannot accept a new impulse. |
| Repolarization | The passive recovery phase of the ECG which occurs after depolarization. |
| Retrograde conduction | Conduction that returns backwards through the conduction system. |
| Retrograde Conduction | Conduction that returns to the atria in a backwards manner. |
| Sinus of Valsalva | Located at the base of the aorta on top of the aortic valve. Is the location where the left and right coronary arteries arise. |
| Six-second method | A method for determining heart rate with regular or irregular rhythms. The number of QRS complexes in 6 seconds is |

| Term | Definition |
|-----------------------------------|--|
| | multiplied by 10 to calculate minute heart rate. |
| Small box method | A method for calculating heart rate for regular rhythms. The number of small boxes between two QRS complexes is divided into 1500 to obtain minute heart rate. |
| Somatic tremor | Electrical artifact that results from muscle shaking; seizures. |
| S-T segment | Interval from end of the S wave to the beginning of the T wave. |
| Standardization artifact | Artifact placed on the 12-lead ECG to equilibrate equipment. |
| Supraventricular | Occurring above the ventricle. Can include rhythms that are sinus, atrial, and junctional. |
| Sympathetic Nervous System | Part of the autonomic nervous system. Stimulation increases heart rate. |
| Symptomatic | When the patient has symptoms such as hypotension, dizziness, or chest pain. |
| Systole | The contractile phase of the cardiac cycle. |
| T wave | Repolarization of the ventricle. |
| Table method | Method for calculating heart rate for regular rhythms. |
| Tachycardia | In general, a heart rate above 100. |
| Time | Measured on the horizontal plane of the ECG. One very small box is equal to 0.04 seconds. |
| Transcutaneous | Electrodes are placed on the skin to pace. |
| Transient | Temporary |
| Transthoracic | Pacemaker inserted via needle through the chest wall. |
| Transvenous | Pacemaker inserted through a venous route for entry into the right atria or ventricle. |
| Tricuspid Valve | The valve located between the right atrium and right ventricle. |
| U wave | At times is seen after the T wave. May be indicative of ischemia or hypokalemia. |
| Usurpation | When a pacemaker takes over. |
| Vagal maneuvers | Intention interventions to stimulate the vagus nerve. Examples are the Valsalva Maneuver, coughing, or carotid massage. |
| Vagal stimulation | Stimulation of the parasympathetic nervous system resulting in a decrease in heart rate. |
| Vein | Vessel carrying blood to the heart. Carries deoxygenated blood. |
| Venule | A smaller vein. Part of the circulatory system located between the capillary and the vein |
| Voltage | Measured on the vertical plane of the ECG. |
| Vulnerable period | The area on the tip of the T wave. Early beats hitting on this area may result in Ventricular Tachycardia or Ventricular Fibrillation. |

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