ASIC EKG INTERPRETATIO

Course Objectives

- Describe the anatomical structures and physiologic properties of the heart including electrophysiology and conduction systems
- Demonstrate correct placement of EKG monitoring leads
- Accurately identify and measure EKG waveforms and segments
- Employ a systematic process to evaluate and analyze EKG rhythm strips
- Identify basic cardiac arrhythmias

What Do I Need?

- ECGs Made Easy, 4th edition, Barbara Aehlert
- Calipers
- Inquiring mind
- Practice!!!!!

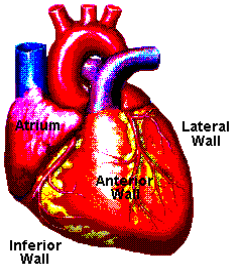
Course Outline

- Anatomy and Physiology
- Electrophysiology
- EKG Basics
- Sinus Mechanisms
- Atrial Rhythms
- Junctional Rhythms
- Ventricular Rhythms
- Atrioventricular Blocks
- Pacemaker Rhythms

Cardiac Anatomy
Location

- Lies in the middle of the chest in the mediastinum
- About the size of its owner's fist
- Base of heart is its upper portion
- Lower portion of heart known as the apex

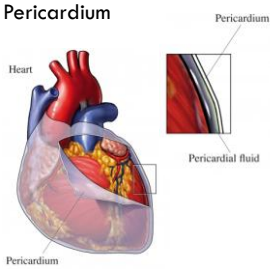
Cardiac Anatomy—Heart Surfaces



- Anterior surface
  - Lies behind sternum
  - Formed by both right & left ventricles
- Lateral surface
  - Heart's left side
  - Mostly left ventricle
- Inferior surface
  - Bottom most
  - Formed by both right & left ventricles

Cardiac Anatomy—Layers of the heart

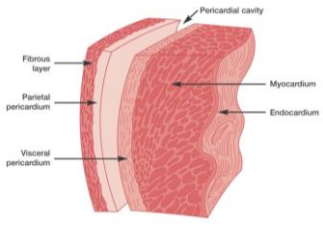
Pericardium



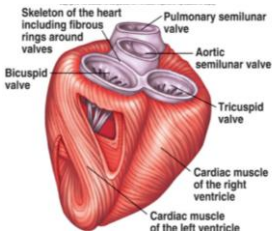
- Function is to protect the heart
- Double-walled sac
  - Parietal pericardium
  - Visceral pericardium
- Pericardial space
  - Contains 10-20 ml serous fluid
  - Fluid acts as a lubricant

Cardiac Anatomy—Layers of the heart

- Epicardium
  - Outermost layer
  - Visceral pericardium
  - Contains main blood vessels & fat
- Myocardium
  - Middle layer
  - Thick & muscular
  - Responsible for heart's pumping action
- Endocardium
  - Innermost layer
  - Smooth layer of epithelium



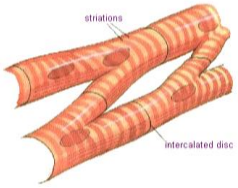
Cardiac Anatomy--Skeleton



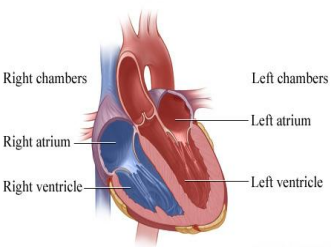
- Thick connective tissue
- Supports the heart valves
- Separates the atria from the ventricles

Cardiac Anatomy—cardiac mucscle cells

- Found only in heart
- Short, branched, and interconnected
- Fit together tightly at junctions called intercalated discs
- This collective mass of cells is known as a myocardium
- Electrical stimuli that originate in any cell can be transmitted to all the other cells

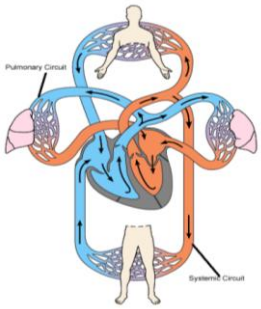


Cardiac Anatomy—Heart Chambers



- Two upper chambers known as the atria
  - Purpose is to ***receive*** blood
- Two lower chambers known as the ventricles
  - Purpose is to ***pump*** blood
- Septum
  - Separates right & left sides of heart

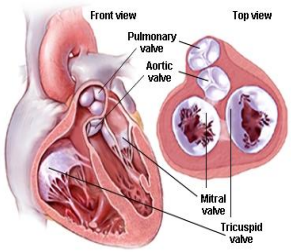
Cardiac Anatomy



- Two functional pumps
- Pulmonary circulation
  - Right side of heart
  - Low-pressure system
- Systemic circulation
  - Left side of heart
  - High-pressure system

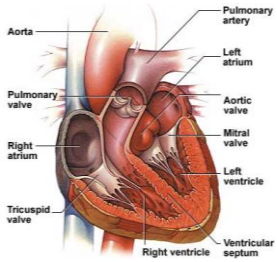
Cardiac Anatomy—Heart Valves

- Four valves
  - Two sets atroventricular (AV) valves
  - Two sets semilunar (SL) valves
  - Function passively
  - Purpose is to direct forward flow of blood
  - Heart sounds produced by closure of these valves



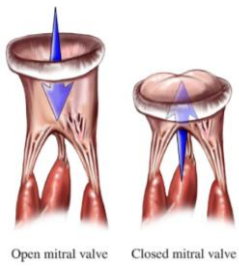
Cardiac Anatomy—Heart Valves

- Atrioventricular Valves
  - Mitral valve
    - Lies between left atrium & left ventricle
    - Has 2 cusps
  - Tricuspid valve
    - Lies between right atrium & right ventricle
    - Has 3 cusps

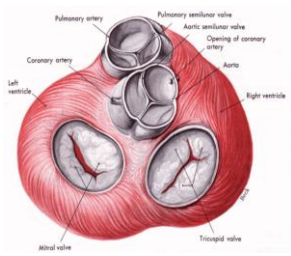


Cardiac Anatomy—Heart Valves

- Atrioventricular Valves
  - Open with the forward pressure of blood flow
  - Close with backward pressure created by ventricular contraction



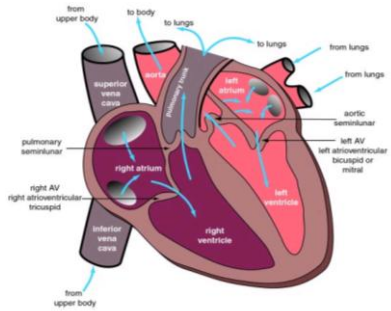
Cardiac Anatomy—Heart Valves



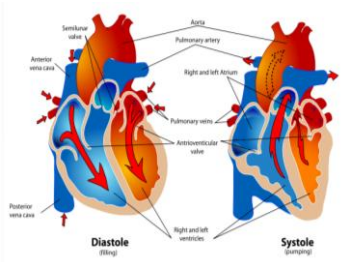
- Semilunar Valves
  - Pulmonic valve
  - Aortic valve
  - Prevent backflow of blood from pulmonary artery & aorta into the ventricles
  - SL valves close as pressure in the aorta & pulmonary artery exceed that of the ventricles

Cardiac Anatomy

Blood Flow Through The Heart



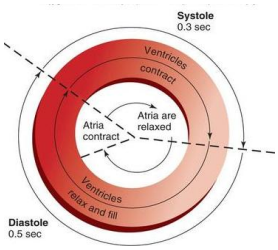
Cardiac Anatomy—Cardiac Cycle



- Two Phases
  - Systole
    - Contraction
  - Diastole
    - Relaxation
  - Occurs in both the atria & ventricles

Cardiac Anatomy—Cardiac Cycle

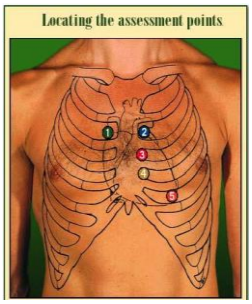
- Diastole
  - Ventricles relax
  - Atria contract
  - SL valves closed
  - AV valves open
- Systole
  - Atria relax
  - Ventricles contract
  - SL valves open
  - AV valves closed



Cardiac Anatomy—Heart Sounds

- Caused by closing of valves
- "Lub-dub"
- First heart sound (S_1) occurs with closing of AV valves
- Second heart sound (S_2) occurs with closure of SL valves
- S_1 marks onset of systole (ventricular contraction)
- S_2 marks end of systole
- Silent period between S_2 & S_1 represents diastole (ventricular relaxation/filling)

Cardiac Anatomy—Heart Sounds

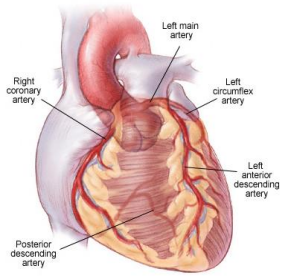


- 1-Aortic area
  - 2nd intercostal space, right sternal border
- 2-Pulmonic area
  - 2nd intercostal space, left sternal border
- 3-Erb's point
  - 3rd intercostal space, left sternal border
- 4-Tricuspid area
  - 4th or 5th intercostal space, left sternal border
- 5-Mitral area
  - 5th intercostal space, left midclavicular line

Cardiac Anatomy
Coronary Circulation

- Coronary arteries
  - Arise at base of aorta
  - Fill during diastole
  - Main arteries lie on the epicardial surface
  - Branches penetrate the heart's muscle mass and supply the subendocardium
- Coronary veins
  - Follow course of coronary arteries
  - Join to form the coronary sinus
  - Drain into right atrium

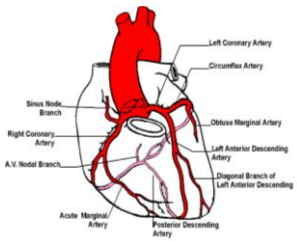
Cardiac Anatomy
Coronary Circulation



- Three major coronary arteries
  - Left anterior descending (LAD)
  - Circumflex (CX)
  - Right coronary artery (RCA)

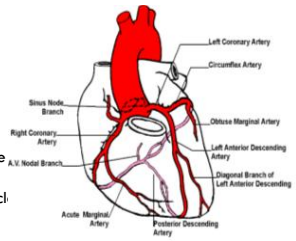
Cardiac Anatomy
Coronary Circulation

- Left coronary artery
  - First segment called left main coronary artery
  - Branches into LAD and CX
  - LAD supplies
    - Anterior surface left ventricle
    - Interventricular septum
  - CX supplies
    - Left atrium
    - Lateral surface left ventricle
    - Inferior surface left ventricle (15%)
    - Posterior surface left ventricle (15%)
    - Part of heart's conduction system



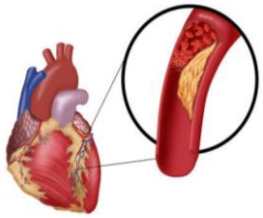
Cardiac Anatomy
Coronary Circulation

- The right coronary artery
  - Branches into marginal artery and posterior descending artery
  - Supplies blood to
    - Right atrium
    - Right ventricle
    - Inferior surface left ventricle (85%)
    - Posterior surface left ventricl (85%)
    - Part of heart's conduction system



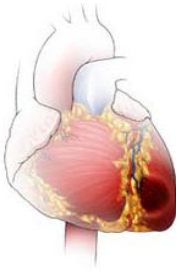
Acute Coronary Syndrome

- Temporary or permanent blockage of coronary artery
- Usual cause is rupture of atherosclerotic plaque
- Includes unstable angina & myocardial infarction
- Presence of collateral circulation may prevent infarction



Acute Coronary Syndrome

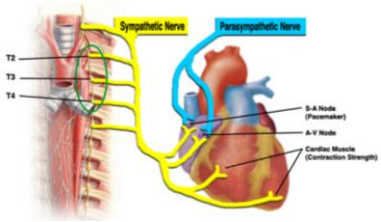
- Stages
  - Ischemia
    - Blood flow and oxygen demand out of balance
  - Injury
    - Prolonged ischemia prolonged long enough to damage affected area of heart
  - Infarction
    - Death of myocardial cells



Autonomic Nervous System

- Controls involuntary or visceral body functions
- Two divisions
  - Parasympathetic—"Rest and Digest"
  - Sympathetic—"Fight or Flight"
- Normally in a state of balance

Autonomic Nervous System



Parasympathetic Stimulation

- Increases blood flow to skin
- Increases gastric motility
- Causes bronchoconstriction
- Increases glycogen synthesis in the liver
- Effects on the heart
  - Decreases heart rate
  - Decreases conduction speed

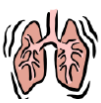
Sympathetic Stimulation

- Pupil dilation
- Shunts blood from skin & viscera to skeletal muscle
- Causes bronchodilation
- Releases glucose stored in the liver
- Effects on the heart
  - Increases heart rate
  - Increases conduction speed
  - Increases force of contraction

Sympathetic Receptors

- Alpha
  - Blood vessels
  - Vasoconstriction
- $Beta_1$
  - Heart
  - Increased HR, conductivity, & contractility
- $Beta_2$
  - Lungs
  - Bronchodilation
- Dopaminergic
  - Major vessels
    - Cerebral
    - Coronary
    - Renal
  - Vasodilation

$Beta_1$ $Beta_2$

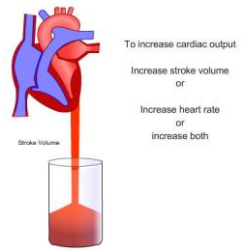


Definitions

- Chronotropic effect
  - Refers to a change in the heart rate
- Inotropic effect
  - Refers to a change in myocardial contractility
- Dromotropic effect
  - Refers to the speed of conduction through the AV junction

Cardiac Output

- Amount of blood ejected from heart each minute
- Determined by the formula of stroke volume X heart rate
- Normal values are 4-8 L/minute
  - CO at rest is ~ 5L/min



Quiz Time!

- A patient has a stroke volume of 62ml and his heart rate is 86 beats per minute. What is his cardiac output?
- Is his cardiac output normal, decreased, or increased?

Stroke Volume

- Stroke volume determined by
  - Amount of ventricular filling during diastole (preload)
  - Pressure against which ventricle must pump (afterload)
  - Myocardium's contractile state

Preload

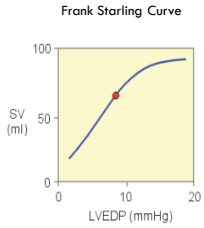
- End-diastolic volume (EDV)
- Influenced by venous return
  - Increased blood return ↑ preload
  - Decreased blood return ↓ preload

Afterload

- Pressure against which ventricles must pump
- Influenced by arterial blood pressure
  - Increased afterload (increased resistance) ↓ SV
  - Decreased afterload (decreased resistance) ↑ SV

Contractility

- Ability of muscle fibers to stretch in response to volume
- Stretch of myocardial fiber is influenced by EDV (preload)
- Frank-Starling law of the heart



Break Time!!

Electrophysiology
Types of Cardiac Cells

- Myocardial Cells
  - Contain contractile filaments
  - Worker or mechanical cells
  - Do not generate electrical impulses

Electrophysiology
Types of Cardiac Cells

- Pacemaker Cells
  - Specialized cells of heart's electrical system
  - Spontaneously generate and conduct electrical impulses

Properties of Cardiac Cells

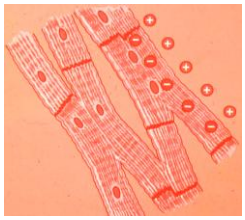
- Automaticity
  - The ability of cardiac pacemaker cells to spontaneously generate an electrical impulse
- Excitability (Irritability)
  - Ability of cardiac muscle cells to respond to a stimulus (depolarization)
- Conductivity
  - Ability to transmit an impulse
- Contractility
  - Ability of myocardial cells to shorten in response to a stimulus

Electrophysiology

- **Action Potential**
  - Term used to describe electrical changes in the heart that stimulate mechanical contraction
  - These changes occur at the cell membrane
  - The difference in electrical charges (voltage) across the cell membrane is known as the ***transmembrane potential***

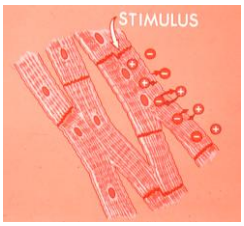
Polarization

- A cell at rest is said to be polarized
- Potassium leaks out of a resting cell leaving it more negatively charged on the inside
- When the inside of a cell is more negative than the outside, a resting membrane potential exists (-90mV)



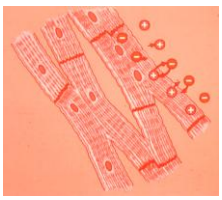
Depolarization

- When the cell is stimulated, depolarization occurs
- Cell membrane becomes permeable to Na+
- Depolarization stimulates muscular contraction



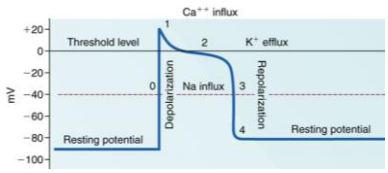
Repolarization

- Recovery phase that returns the cell to its resting state
- Sodium channels close
- Sodium-Potassium pump returns Na+ to the outside of the cell & K+ to the inside



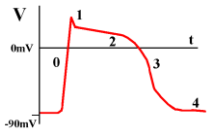
Action Potential—Depolarization

- Phase 0
  - Cell is stimulated resulting in depolarization
  - Occurs with the rapid influx of sodium through the sodium channels



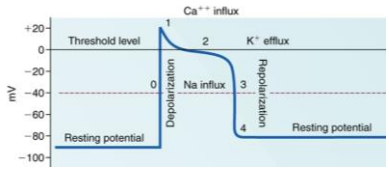
Action Potential—Repolarization

- Phase 1
  - Early repolarization
  - Na+ channels partially close
  - K+ & Cl- leave the cell
- Phase 2
  - Plateau phase
  - Ca+ enters through Ca+ channels & prolongs the contraction
- Phase 3
  - Final rapid repolarization
  - Na+ & Ca+ channels close
  - K+ rapidly departs cell

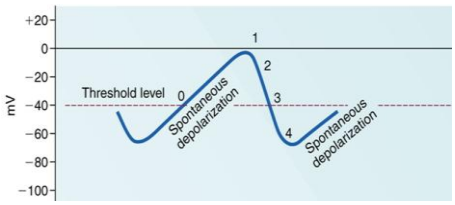


Restoration of Resting Membrane Potential (RMP)

- Phase 4
  - Return to resting state
  - Ready to receive another stimulus

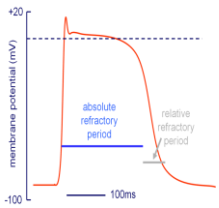


Action Potential of Pacemaker Cell



Refractory Periods

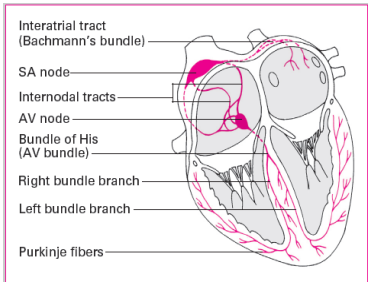
- Absolute Refractory Period
  - Cell cannot respond to stimulation
- Relative Refractory Period
  - Cell can be stimulated by a very strong stimulus
- Supernormal Refractory Period
  - Weaker than normal stimulus can cause depolarization



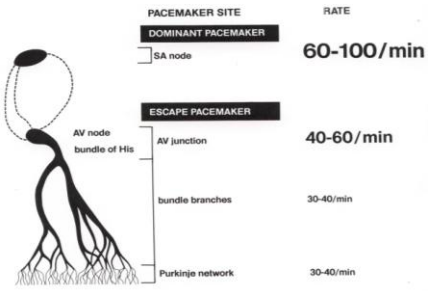
Conduction System

- Specialized electrical (pacemaker) cells make up the conduction system of the heart
- These cells are interconnected
- They have a faster conduction velocity than all other myocardial cells
- The pacemaker site with the fasting firing rate controls the heart

Conduction Pathways

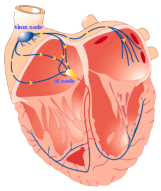


Automaticity Rates



Abnormal Conduction

- Abnormal heart rhythms are usually due to
  - Enhanced automaticity
  - Triggered activity
  - Reentry (circus movement)

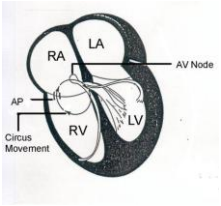


Abnormal Conduction—Enhanced Automaticity

- Enhanced automaticity
  - Cells not usually associated with a pacemaker function begin to depolarize spontaneously
  - Pacemaker site other than the SA node increases its rate above what is considered normal for that site

Abnormal Conduction—Reentry

- Reentry
  - The spread of an impulse through tissue already stimulated by that same impulse
  - Caused by presence of an accessory pathway or a block or delay in the conduction circuit
  - Results in short periods of an abnormally fast heart rate



Abnormal Conduction—Triggered Activity

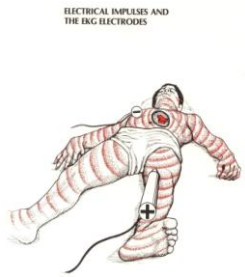
- Triggered Activity
  - Results from abnormal electrical impulses that sometimes occur during repolarization
  - Occurs when pacemaker cells from a site other than the SA node depolarize more than once after being stimulated by a single impulse
  - Can result in atrial or ventricular beats occuring singly, in pairs, or in runs
  - ***Ectopic*** refers to an impulse originating from a source other than the SA node

Abnormal Conduction—Escape Beats

- Lower pacemaker site takes on responsibility of pacing heart when SA node slows down or fails
- Protective mechanism to preserve cardiac output

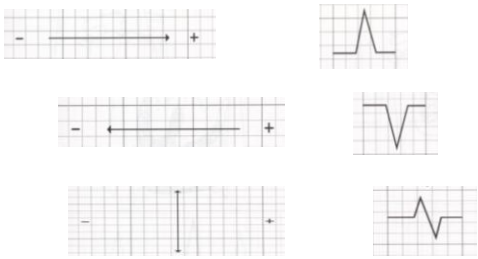
EKG Basics—Electrodes

- Electrical currents radiate to the skin's surface
- Electrodes sense and transmit those currents to an EKG monitor as waveforms

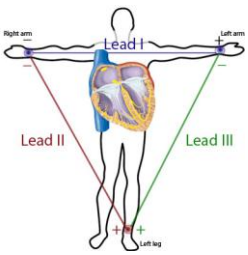


EKG Basics—Electrodes

The positive electrode serves as the "camera"



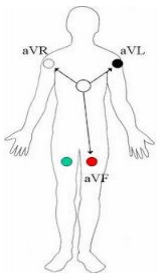
EKG Basics—Leads



- Standard limb leads
  - Leads I, II, & III
  - Considered bipolar as each lead has both a negative & positive electrode

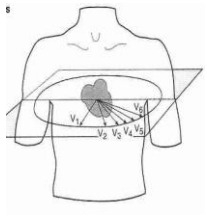
EKG Basics—Leads

- Augmented Chest Leads
  - Leads aVR, aVL, & aVF
  - EKG machine augments the amplitude
  - Unipolar leads
  - Heart serves as the "negative electrode"



EKG Basics—Leads

- Chest or precordial leads
  - Each V electrode is considered positive
  - The heart makes up the negative electrode
  - Views the heart in the horizontal plane



Lead Selection—Arrhythmia Monitoring

- Bedside monitoring systems may have from 3-5 lead wires
- Lead selector is used to select monitoring lead
- Nurse or tech decides monitoring lead
- Lead II
  - Best for atrial activity
- Lead V_1
  - Ventricular rhythms

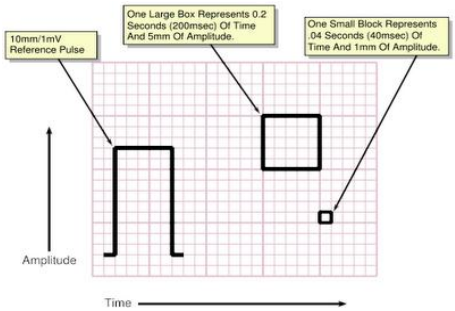
Review

- Circus movement is caused by an _____.
- Escape beats serve as an _____ mechanism.
- The _____electrode serves as the "eye."
- The standard limb leads and the augmented limb leads view the _____ plane.
- Current traveling away from the positive electrode creates a _____ deflection
- Ventricular activity is best viewed in which monitoring lead?

Review

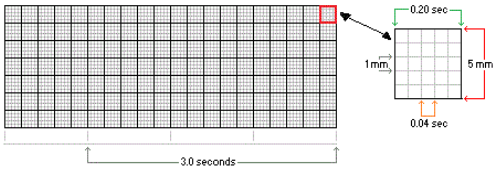
- The intrinsic rate of the AV junction is_____.
- Which pacemaker controls the heart?
- What serves as the "negative electrode" in the precordial leads?

EKG Basics—EKG Paper



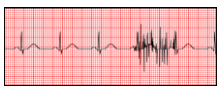
EKG Basics—EKG Paper

- Each small box is .04 seconds
- Each large box is 5 X .04 = .2 seconds
- 5 large boxes = 1 second
- 15 large boxes = 3 seconds
- 30 large boxes = 6 seconds



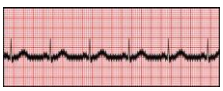
EKG Basics—Monitoring problems

- Artifact



- Wandering baseline

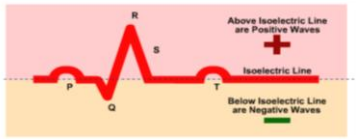
- Electrical interference



EKG Basics—Monitoring problems

EKG Basics—Terminology

- Baseline—a straight line recorded when no electrical activity is detected
- Waveform—movement away from the baseline in either a negative or positive fashion
- Segment—a line between waveforms
- Interval—a waveform and a segment
- Complex—component containing several waveforms

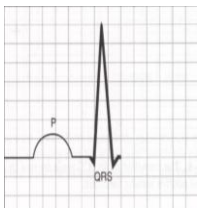


EKG Basics—P Waves

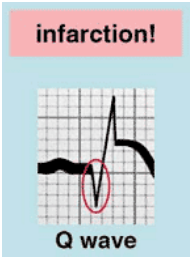
- Normal characteristics of the P wave
  - Precedes the QRS complex
  - Smooth and rounded (normally)
  - No more than 2.5mm high
  - No more than 0.11 sec long

EKG Basics—QRS Complex

- Normally follows each P wave
- Represents ventricular depolarization
- Consists of Q wave, R wave, & S wave
- May not have all of the above waveforms
- Normal duration is .10 or less



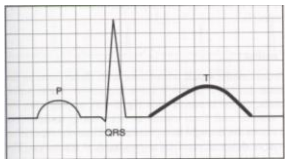
EKG Basics—QRS Complex



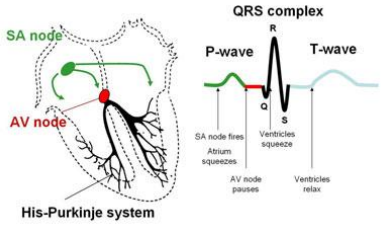
- Normal Q waves should measure no wider than .04 seconds and should be less 1/3 the height of the R wave
- Deep wide Q waves may represent an MI

EKG Basics—T wave

- T wave
  - Represents ventricular repolarization
  - Direction of T wave normally same as the QRS

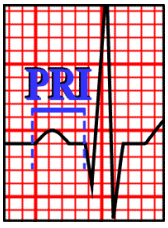


All together, now!

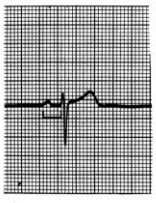


EKG Basics—PR Interval

- PR interval includes P wave and the PR segment
- Tracks the atrial impulse from the atria through the AV node, bundle of His, and right & left bundle branches
- Measured from the beginning of the P wave to the beginning of the QRS complex
- Normal duration is .12-.20 seconds

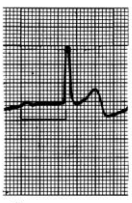


EKG Basics—PR Interval



A
Normal PR interval of 0.20 seconds (0.04 seconds × 5 squares).

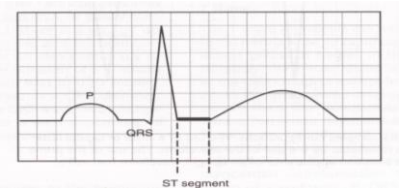
B
Short PR interval of 0.08 seconds (0.04 seconds × 2 squares).



C
Long PR interval of 0.48 seconds (0.04 seconds × 12 squares).

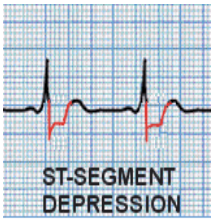
EKG Basics—ST segment

- Beginning of ventricular repolarization
- Normally isoelectric
- Depression = ischemia
- Elevation = injury



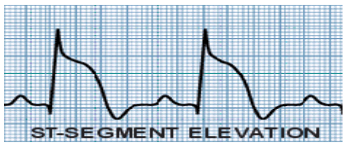
EKG Basics
Abnormal ST segments

- ST depression
  - ST segment depression of more than .5 mm is indicative of myocardial ischemia



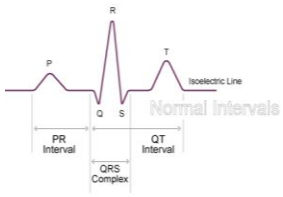
EKG Basics
Abnormal ST segments

- ST elevation
  - Considered elevated when 1mm or more above baseline
  - ST elevation suggests myocardial injury



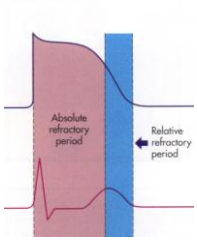
EKG Basics—QT interval

- Represents total ventricular activity
- Measured from beginning of QRS to end of T wave
- Normal interval is less than half of R-R interval



EKG Basics—QT interval

- Importance of QT interval
  - A prolonged QT indicates a lengthened relative refractory period (vulnerable period)
  - Pt is at greater risk for life threatening arhythmias such as torsades de pointes



Analyzing a Rhythm—Step One

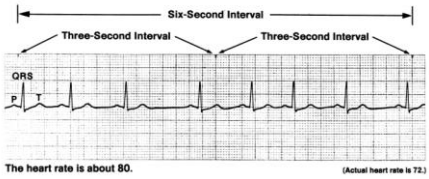
- Assess rhythm for regularity
  - Use R-R interval to evaluate ventricular rhythm
  - Use P-P interval to evaluate atrial rhythm
  - R-R intervals or P-P intervals should be evaluated across an entire 6 second strip

Analyzing a Rhythm—Step Two

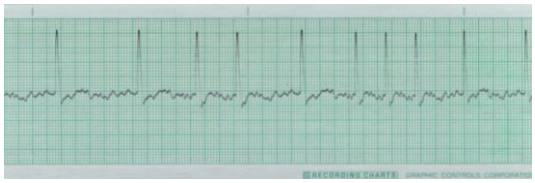
- Calculate the heart rate
  - A tachycardia exists if rate is more than 100/min
  - A bradycardia is present with rate less than 60/min
- Methods to calculate rate
  - Six-second method
  - Large Box method
  - Small Box method

Analyzing a Rhythm Calculating Rate

- Six second method
  - Number of QRS complexes in a 6 sec strip X 10
  - May be used for regular or irregular rhythms
  - Most inaccurate

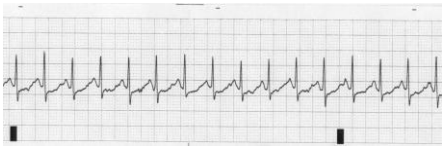


Analyzing a Rhythm
Calculating Rate



Analyzing a Rhythm
Calculating Rate

- Large Box method
  - Count # large boxes between R-R interval
  - Divide 300 by # large boxes
  - Variation called sequence method



Analyzing a Rhythm
Calculating Rate

- Small Box method
  - Count # small boxes between R-R interval
  - Divide 1500 by # small boxes
  - Most accurate

Analyzing a Rhythm—Step Three

- Examine P waves
  - Normally one P wave before each QRS
  - Is P wave upright
  - Early Ps?

Analyzing a Rhythm—Step Four

- PR Interval
  - Measure PR interval, normal .12-.20 seconds
  - Is the PR interval constant or the same
  - If PR intervals different
    - Lengthening
    - variable

Analyzing a Rhythm—Step Five

- QRS Complex
  - Measure duration, normal .06-.10 seconds
  - Are all QRS complexes of the same configuration
  - QRS after every P?

Analyzing a Rhythm—Extras

- QT Interval
  - Considered normal if less than ½ of R-R interval
- ST segment
  - Presence of ST elevation or depression
- T wave
  - Tall, pointed with hyperkalemia
  - Negative or flipped Ts with ischemia or evolving MI

Review

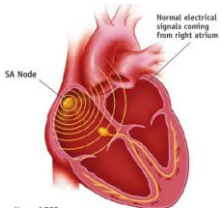
- What is a rhythm with a rate less than 60?
- An impulse firing from outside the SA node is called a _____.
- Which waveform denotes depolarization of the atria?
- The T wave represents _____.
- On EKG paper, the vertical axis measures _____.
- List some possible causes of "wandering baseline."

Review

- What life threatening arrhythmia can occur with a prolonged QT interval?
- How many large boxes in one second?
- What method of calculating the rate should be used with an irregular rhythm?
- What might cause a "lumpy" T wave?

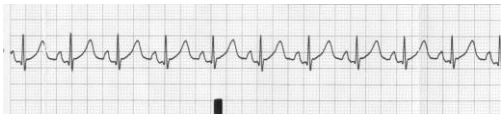
Sinus Mechanisms

- Sino-atrial node (SA node) is primary pacemaker
- Most rhythms originating in the SA node are regular
  - Normal sinus rhythm (NSR)
  - Sinus bradycardia
  - Sinus tachycardia
  - Sinus arrhythmia
  - Sino-atrial (SA) block
  - Sinus arrest

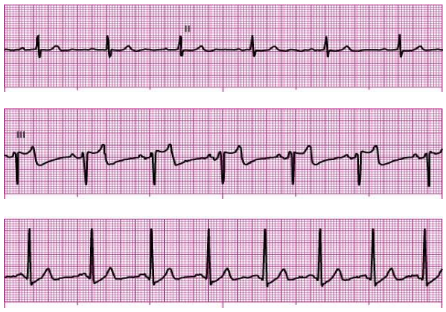


Normal Sinus Rhythm

- Characteristics
  - Regular rhythm
  - Rate is 60-100 beats/min
  - P wave for every QRS, Ps look alike
  - PR interval of normal duration & constant
  - QRS usually normal



Normal Sinus Rhythm



Sinus Bradycardia

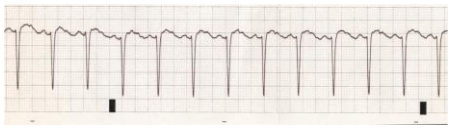
- Characteristics
  - Regular rhythm
  - Rate less than 60 beats/min
  - P wave for every QRS, Ps look alike
  - PR interval of normal duration & constant
  - QRS usually normal

Sinus Bradycardia

- Causes
  - Sleep
  - Inferior MI
  - Hyperkalemia
  - Vagal stimulation
  - SA node disease
  - Well conditioned heart
  - Medications
    - Calcium channel blockers, dig, beta-blockers, amiodarone

Sinus Tachycardia

- Characteristics
  - Regular rhythm
  - Rate 101-160
  - P wave for every QRS, Ps look alike
  - PR interval of normal duration & constant
  - QRS usually normal



Sinus Tachycardia

- Causes
  - Sympathetic stimulation
  - Myocardial infarction
  - Hypovolemia
  - Exercise
  - Fever
  - Shock
  - Drugs

Sinus Arrhythmia

- Characteristics
  - Irregular but "regularly irregular"
  - Rate varies
  - P wave for every QRS, Ps look alike
  - PR interval of normal duration & constant
  - QRS usually normal

Sinaoartrial Block—sinus exit block

- Characteristics
  - Irregular due to pause
  - Rate varies
  - P wave for every QRS, Ps look alike
  - PR interval of normal duration & constant
  - QRS usually normal

Sinus Arrest

- Characteristics
  - Irregular due to pause
  - Rate varies
  - P wave for every QRS, Ps look alike
  - PR interval of normal duration & constant
  - QRS usually normal

Atrial Rhythms

- Most common rhythm disturbance
- Originate in areas outside of the SA node
- May be associated with extremely fast ventricular rates leading to decreased ventricular filling times
- May do away with "atrial kick"

Atrial Arrhythmias—Mechanisms

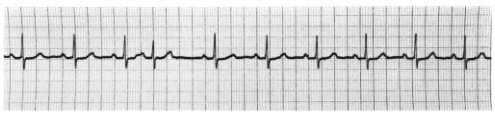
- Enhanced automaticity
  - Cells not usually associated with a pacemaker function begin to depolarize spontaneously
- Reentry
  - The spread of an impulse through tissue already stimulated by that same impulse
- Triggered activity
  - Results from abnormal electrical impulses that occur during repolarization
  - These impulses, called afterdepolarizations, lead to atrial or ventricular beats occurring singly, in runs or as a sustained ectopic rhythm

Premature Atrial Contractions

- Result from an irritable focus in the atria taking over as pacemaker
- P wave of PAC may look similar to P from SA node or may be biphasic, flattened, pointed or lost in preceding T wave
- PACs are followed by a pause
- PACs may occur in bigeminy, trigeminy, or couplets
- A PAC occurring too early may not be conducted to ventricles and is called a nonconducted PAC

Premature Atrial Contractions

- Characteristics
  - Underlying rhythm regular with premature beats
  - Rate varies
  - Early Ps differing in shape from sinus P
  - PRI may be normal or prolonged



Wandering Atrial Pacemaker

- Pacemaker site shifts from SA node to another area in the atria or AV junction
- PR interval variable
- Rhythm slightly irregular
- Rate usually normal at 60-100

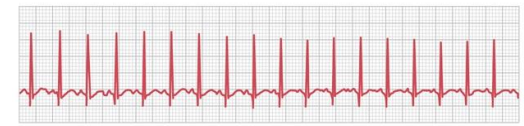
Mutifocal Atrial Tachycardia (MAT)

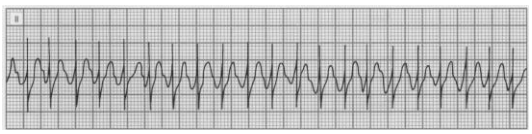
- Pacemaker site shifts from SA node to another area in the atria or AV junction
- Rate greater than 100 beats/min

Atrial Tachycardia

- Regular rhythm
- Rate 150-250
- P wave for every QRS
  - Ps look alike but different than sinus Ps
  - Ps may be lost in T waves if rate very fast
- PR interval usually normal
- QRS usually normal

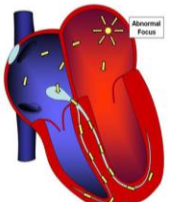
Atrial Tachycardia





Atrial Tachycardia

- Causes
  - Stimulant use
  - Cor pulmonale
  - Infection
  - Electrolyte imbalances
  - Dig toxicity
- Significance
  - Decreases filling time
  - Increases myocardial oxygen demand
  - Decreases myocardial perfusion

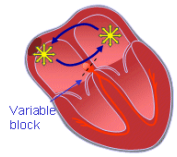


Atrial Flutter

- Atrial rhythm regular
- Ventricular rhythm regular or irregular
- Atrial rate 250-350
- P waves are not identifiable, instead "flutter waves" present
- PRI not measurable
- QRS usually normal

Atrial Flutter

- Causes
  - Ischemic heart disease
  - Electrolyte imbalance
  - Hypoxia
  - Pulmonary embolus
  - Cardiomyopathy
- Significance
  - Decreases filling time
  - Increases myocardial oxygen demand
  - Decreases myocardial perfusion
  - Absence of atrial kick



Atrial Fibrillation

- Irregular rhythm
- Ventricular rate varies
- No P waves
  - Wavy baseline
- PRI not measurable
- QRS usually normal

Atrial Fibrillation

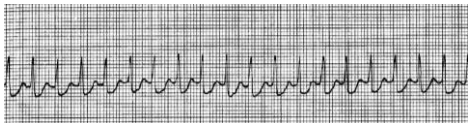
- Causes
  - Hypertensive heart disease
  - Electrolyte imbalance
  - Advanced age
  - Hypoxia
  - CHF
- Significance
  - Decreases filling time
  - Increases myocardial oxygen demand
  - Decreases myocardial perfusion
  - Absence of atrial kick
  - Increased risk of stroke

Supraventricular Tachycardia

- AV Nodal Reentrant Tachycardia
  - Occurs in pts with 2 conduction pathways within the AV node
- AV Reentrant Tachycardia
  - Occurs in pts with accessory pathways
    - Wolff-Parkinson-White Syndrome (WPW)

Supraventricular Tachycardia--AVNRT

- Regular rhythm
- Rate 150-250
- P waves hidden in QRS
- PRI interval not measurable
- QRS usually normal



Supraventricular Tachycardia—AVRT or WPW

- Regular rhythm
- Rate 60-100
- P waves
- PRI less than .12 sec
- QRS .12 or more

Junctional Rhythms

- Rhythms originating in the AV junction are called junctional arrhythmias
- If the atria depolarize before the ventricles, retrograde depolarization of the atria results in inverted P waves with a PRI of < .12
- If atria and ventricles depolarize together, P wave will be hidden in QRS
- If atria depolarize after the ventricles, P wave will follow QRS

Premature Junctional Contractions--PJCs

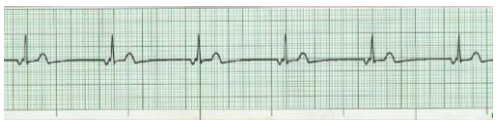
- Regular rhythm with premature beats
- Rate usually within normal range, depending on underlying rhythm
- P waves may occur before, during, or after the QRS
- PRI of < .12 sec if P wave precedes QRS
- QRS usually normal

Junctional Escape Beats

- Rhythm is regular with late beats
- Rate usually within normal range, depending on underlying rhythm
- P waves may occur before, during, or after the QRS
- PRI of < .12 sec if P wave precedes QRS
- QRS usually normal

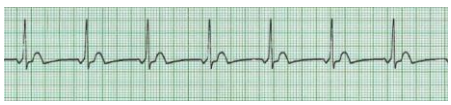
Junctional Escape Rhythm

- Regular rhythm
- Rate 40-60
- P waves may occur before, during, or after the QRS
- PRI of < .12 sec if P wave precedes QRS
- QRS usually normal



Accelerated Junctional Rhythm

- Regular rhythm
- Rate 61-100
- P waves may occur before, during, or after the QRS
- PRI of < .12 sec if P wave precedes QRS
- QRS usually normal



Junctional Tachycardia

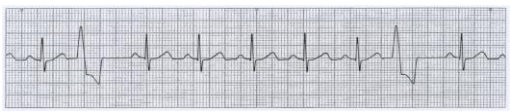
- Regular rhythm
- Rate 101-140
- P waves may occur before, during, or after the QRS
- PRI of < .12 sec if P wave precedes QRS
- QRS usually normal

Ventricular Rhythms

- Ventricles may pace the heart if
  - SA node fails to discharge or is blocked
  - SA rate is slower than the ventricles
  - Irritable ventricular site produces early beat or rapid rhythm
- Ventricular beats/rhythms have
  - Abnormally shaped QRS measuring ≥ 0.12 seconds
  - Abnormal depolarization results in abnormal repolarization
    - QRS and T wave deflect in opposite directions

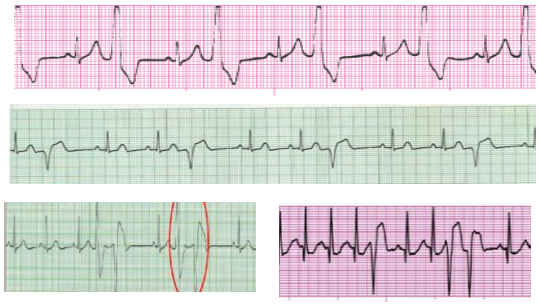
Premature Ventricular Contractions (PVCs)

- Underlying rhythm regular with ***premature*** beats
- Rate varies depending on underlying rhythm
- P waves usually absent or may appear after the QRS
- QRS "wide & bizzarre" ≥ 0.12 sec
- QRS followed by compensatory pause



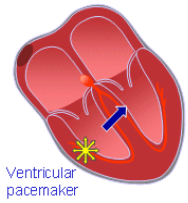
Premature Ventricular Contractions (PVCs)

Premature Ventricular Contractions (PVCs)



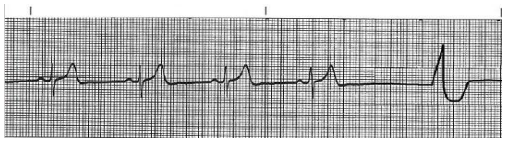
Premature Ventricular Contractions (PVCs)

- Causes
  - anxiety
  - Idiopathic
  - Dig toxicity
  - Advanced age
  - Acid-base imbalance
  - Electrolyte imbalance
  - Myocardial ischemia/infarction
- Significance
  - Can reduce cardiac output
  - Can lead to more serious arrhythmias



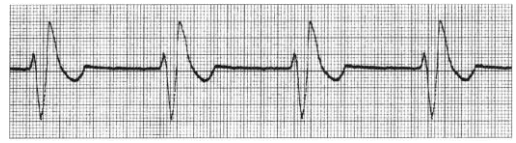
Ventricular Escape Beats

- Underlying rhythm regular with ***late*** beats
- Rate varies depending on underlying rhythm
- P waves usually absent or may appear after the QRS
- QRS "wide & bizzarre" $\geq$ 0.12 sec



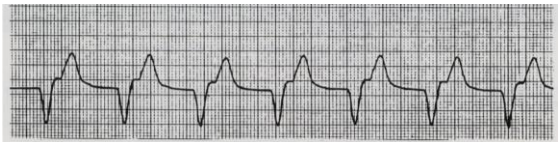
Idioventricular Rhythm

- Regular rhythm
- Rate 20-40 beats/minute
- P waves usually absent or may appear after the QRS
- QRS $\geq$ 0.12 sec



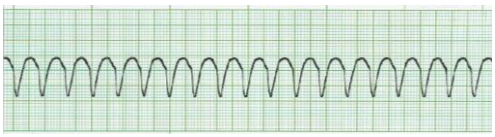
Accelerated Idioventricular Rhythm

- Regular rhythm
- Rate 41-100 beats/minute
- P waves usually absent or may appear after the QRS
- QRS $\geq$ 0.12 sec

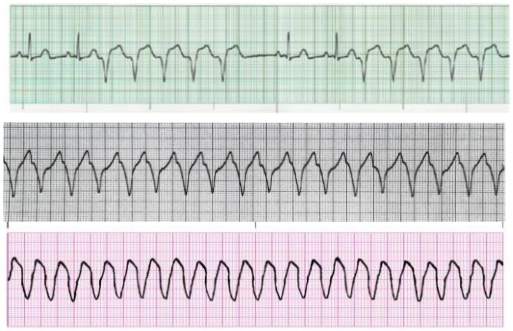


Ventricular Tachycardia

- Essentially regular rhythm
- Rate 101-250 beats/min
- P waves may be present or absent
  - If present will be dissociated from the QRS
- QRS $\geq$ 0.12 sec



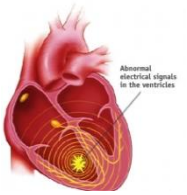
Ventricular Tachycardia



Torsades de pointes

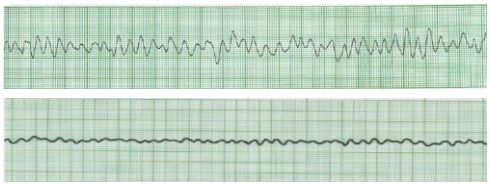
Ventricular Tachycardia

- Causes
  - Digoxin toxicity
  - Acid-base imbalance
  - Electrolyte imbalances
  - Invasive cardiac procedures
  - Myocardial ischemia/infarction
- Significance
  - Reduced cardiac output
  - Rhythm may further deteriorate



Ventricular Fibrillation

- Rhythm is rapid and chaotic
- Rate cannot be determined
- P waves not discernible
- QRS not discernible



Asystole

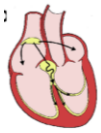
- No ventricular rate or rhythm
- If P waves present, called ventricular standstill
- Must be confirmed in two leads
- CPR & ACLS

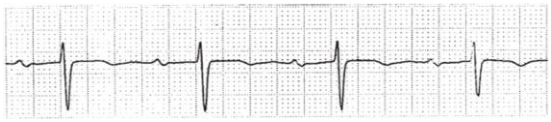
Atrioventricular Blocks

- Interruption in conduction between atrial & ventricles
- That interruption can result in delayed, partial, or total blockage of an impulse
- Blockage can occur at the AV node, the bundle of His, or bundle branches
- AV blocks are classified by their severity or "degree"
- PR interval is key to classifying the type of AV block

First-Degree AV Block

- Regular rhythm
- Rate usually normal
- P waves normal
- PRI is > 0.20 sec and constant
- QRS usually normal



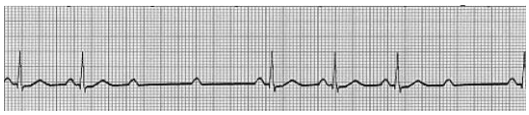


Second Degree Block Type I
(Wenckebach)

- Atrial rhythm regular, ventricular rhythm irreg
- Atrial rate greater than ventricular rate
- More Ps than QRSs
- PRI progressively lengthens until a P wave appears without a QRS complex
- QRS usually normal in size but is periodically dropped

Second Degree Block Type II

- Atrial rhythm regular, ventricular rhythm irreg
- Atrial rate greater than ventricular rate
- More Ps than QRSs
- PRI normal or slightly prolonged but are constant
- QRS normal or wide



Third Degree AV Block

- Atrial rhythm is regular as is ventricular rhythm
- Atrial rate is greater than ventricular rate
- No true PRI as atria and ventricles beating independently of one another
- QRS normal or wide