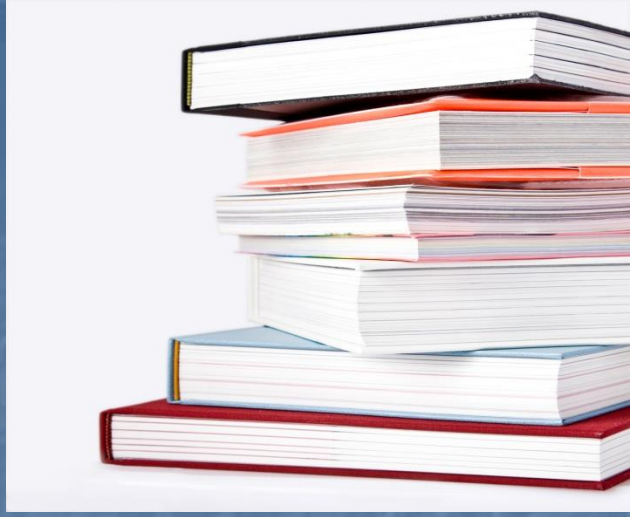
The ABCs of EKGs/ECGs for HCPs

Al Heuer, PhD, MBA, RRT, RPFT
Professor, Rutgers School of Health Related Professions

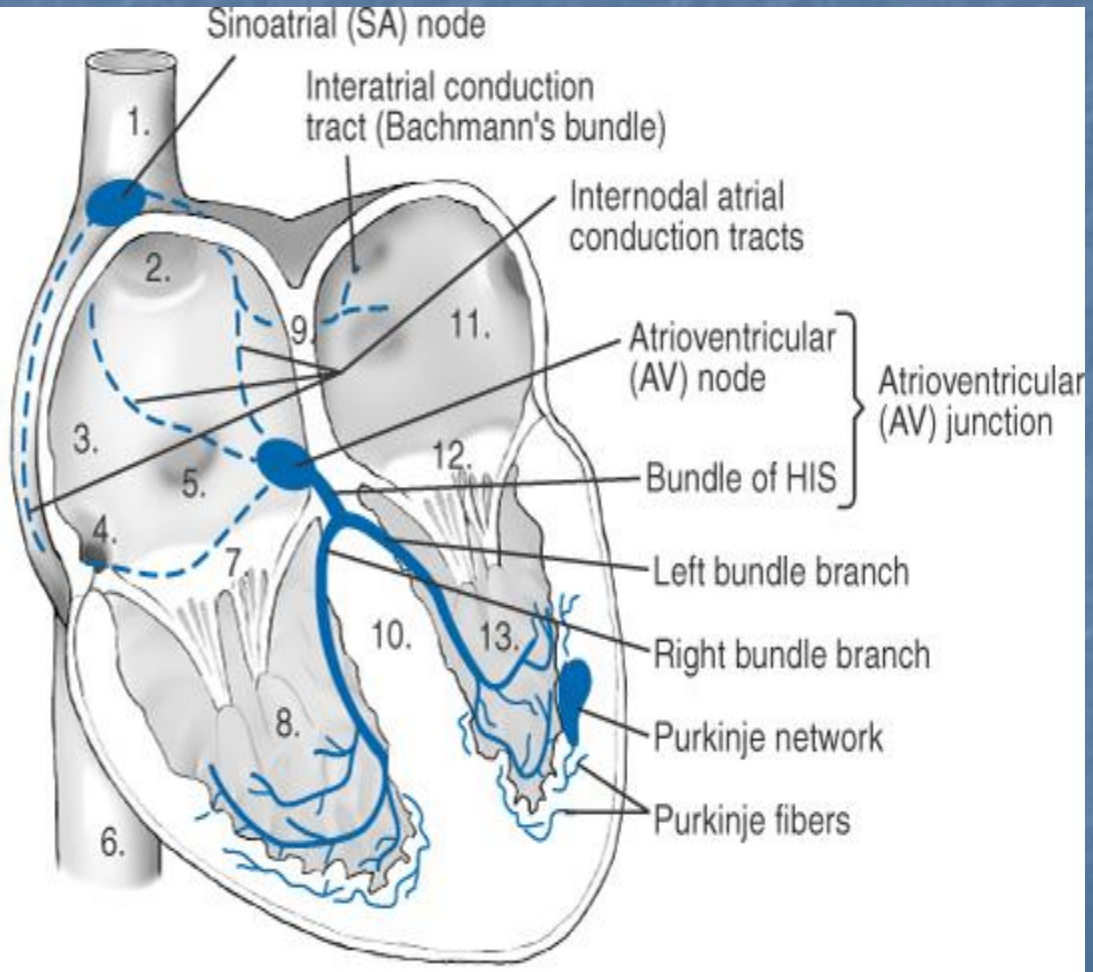
Learning Objectives



- Review the basic anatomy of the heart
- Describe the cardiac conducting system
- Discuss the indications for EKGs
- Summarize the basics of how to analyze an EKG rhythm
- Review common rhythms, causes and treatment
- Furnish additional resources

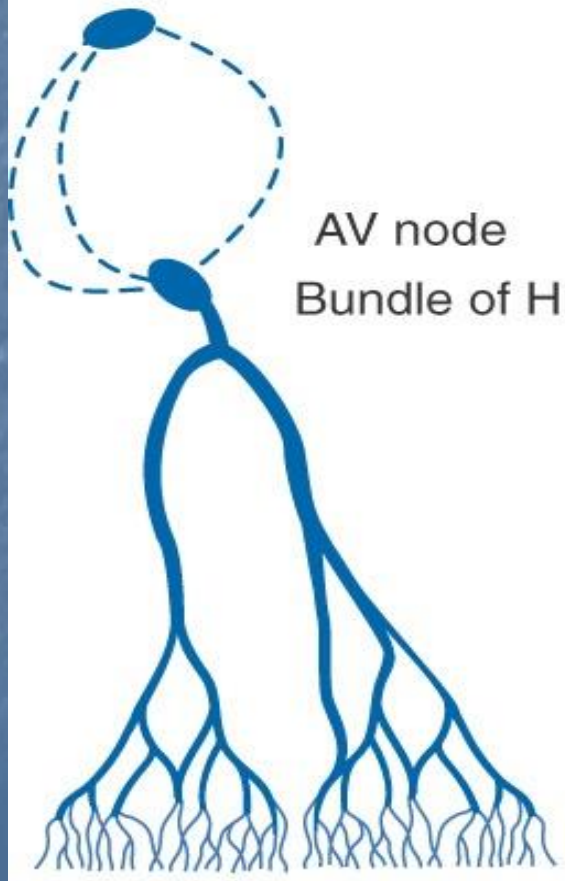
Conducting Pathway of the Heart

1. Superior vena cava
2. Inlet of the superior vena cava
3. Right atrium
4. Inlet of the inferior vena cava
5. Coronary sinus
6. Inferior vena cava
7. Tricuspid valve
8. Right ventricle
9. Interatrial septum
10. Interventricular septum
11. Left atrium
12. Mitral valve
13. Left ventricle



(Redrawn from Huszar RH: *Basic dysrhythmias: interpretation and management*, ed 2, St Louis, 1994, Mosby.)

Conduction (Cont.)



PACEMAKER SITE	RATE
DOMINANT PACEMAKER	
SA node	60-100/min
ESCAPE PACEMAKER	
AV junction	40-60/min
Bundle branches	30-40/min
Purkinje network	30-40/min

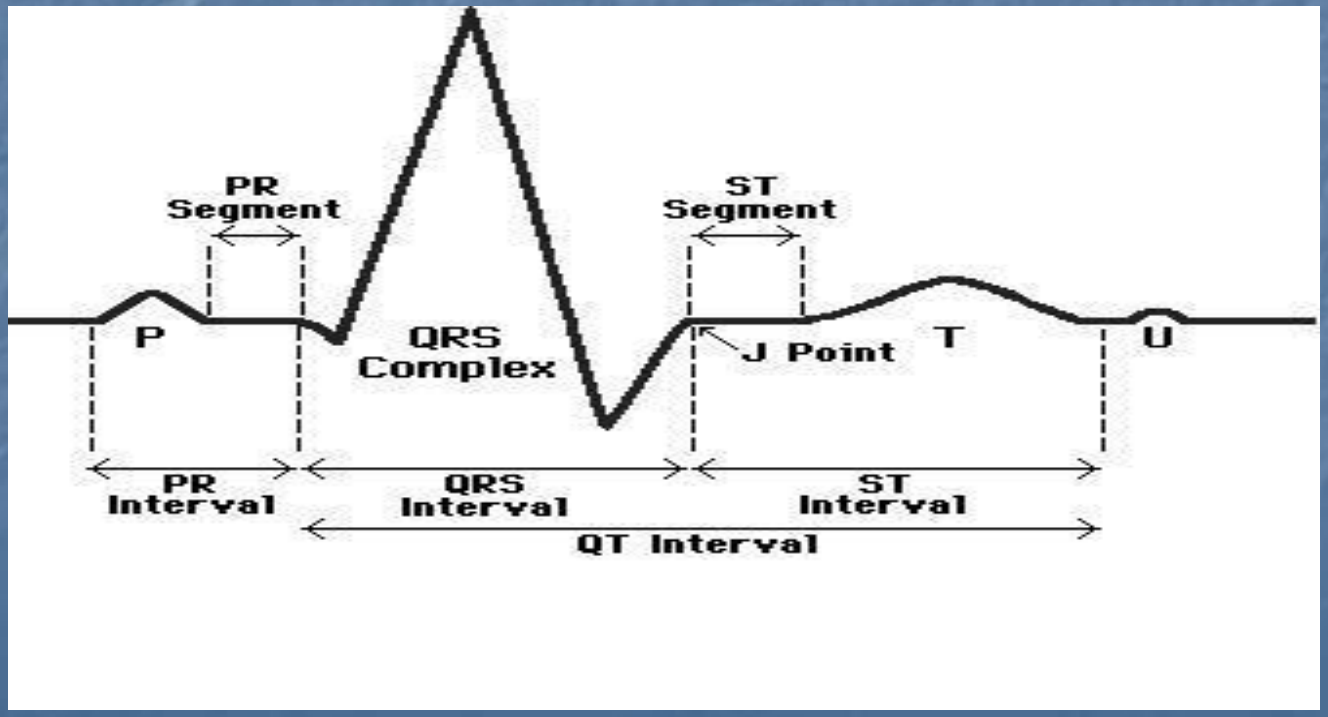
EKG = Graphical Depiction of Cardiac Cycle

Atrial Depolarization

Ventricular Depolarization

Ventricular Repolarization

"after potential"



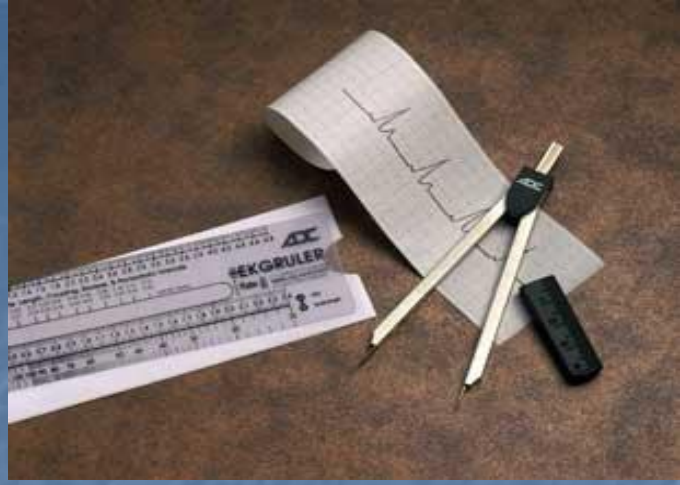
Indications for EKGs

- Chief complains:
  - Chest pain
  - Dyspnea on exertion
  - Orthopnea
  - Pedal edema
  - Fainting spells
  - Palpitations
- Past medical hx:
  - Hx of heart disease
  - Hx of cardiac surgery
- Physical examination
  - Unexplained tachycardia at rest
  - Hypotension
  - Decreased capillary refill
  - Abnormal heart sounds and murmurs
  - Cool, edematous, cyanotic extremities
  - Diaphoresis
  - (+) JVD

Limitations of EKGs

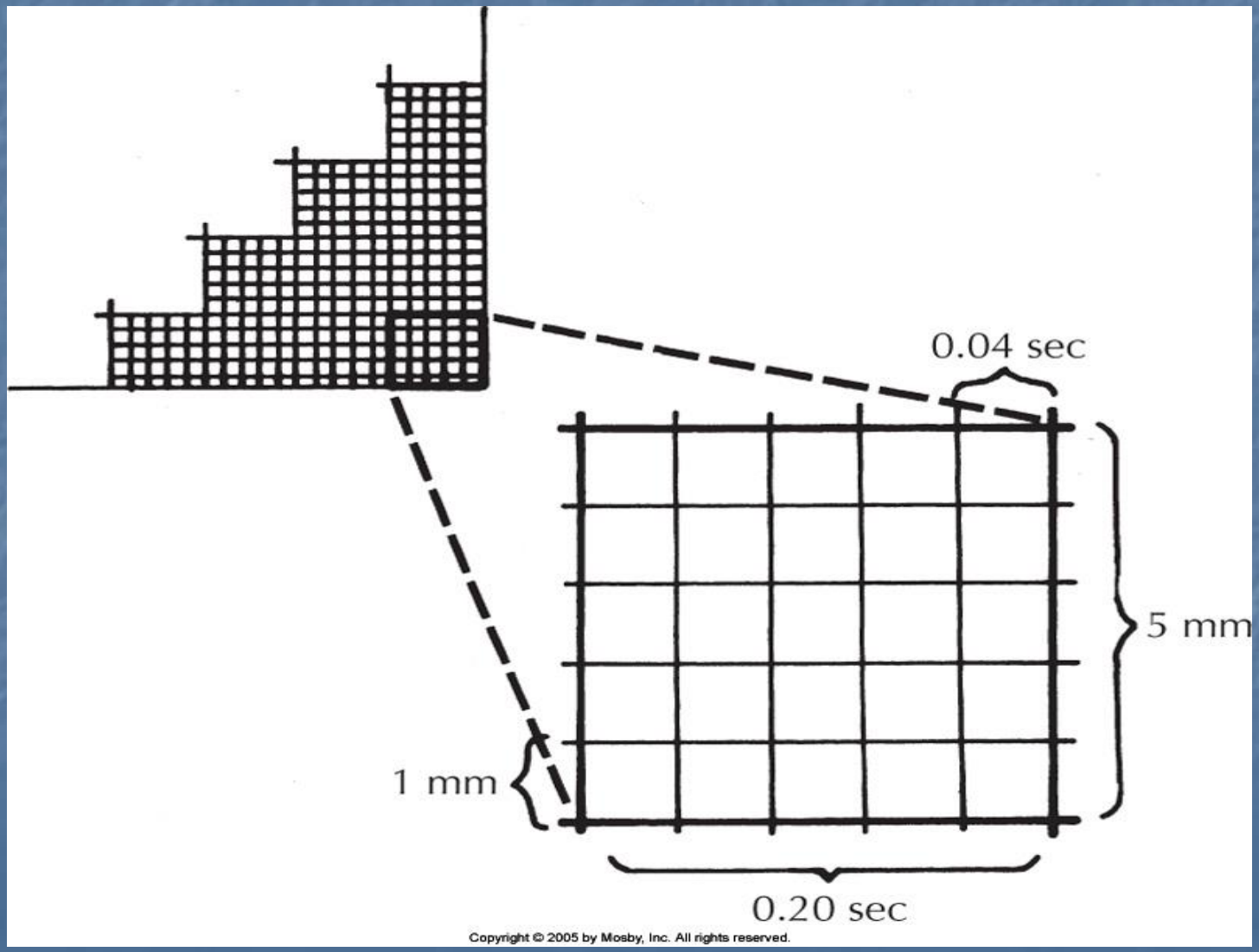
- Does *not* measure the pumping ability of the heart
- Does *not* show abnormalities on cardiac structure
- Does *not* have predictive value
- Artifact
- Operator technique
- Lead placement limitations
- Technical issues

EKG Analysis



- Lethal rhythm requiring immediate attention?
- Is the rate normal, slow or fast?
- Is the rhythm regular?
- *Is there a "P" Wave?*
- *What is the PR Interval?*
- *What is the QRS configuration?*
- Are there other characteristics?
  - ST depression
  - Axis deviation
- What is the final interpretation?
- What is the recommended action/treatment

Gridlines = Time Interval



Estimating Rate - If Irregular

- 6-second technique (irregular rhythms)
  - Select a 6 sec interval strip (30 large boxes)
  - Count the # of QRS complexes
  - Multiply by 10

  - e.g. 7 'QRSs' x 10 = ~70 beats/min

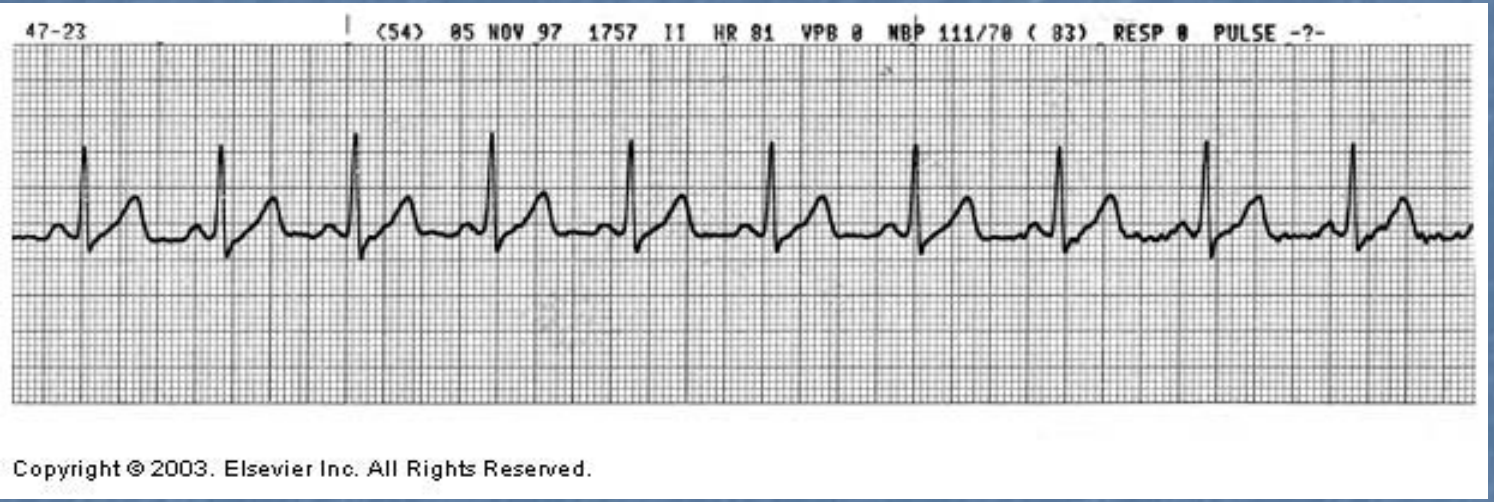
Estimating Rate - If Regular

1. **Pick a complex that falls on a heavy line**
2. **Then estimate the rate by counting heavy boxes**
3. **Using 300, 150, 100, 75, 60, 50, 40, 30**

Calculating HR

- Count the number of large boxes between two beats.
- Divide this number into 300.
- Examples:
  - 2 large boxes: 300/2 = 150
  - 4 large boxes : 300/4 = 75
  - 6 large boxes : 300/6 = 50

Normal EKG Rhythm & Values



- Normal Values (Adult)
  - Rate = 60-100
  - P-R Interval = 0.12- 0.20 sec.
  - QRS $\leq$ 0.12 sec.

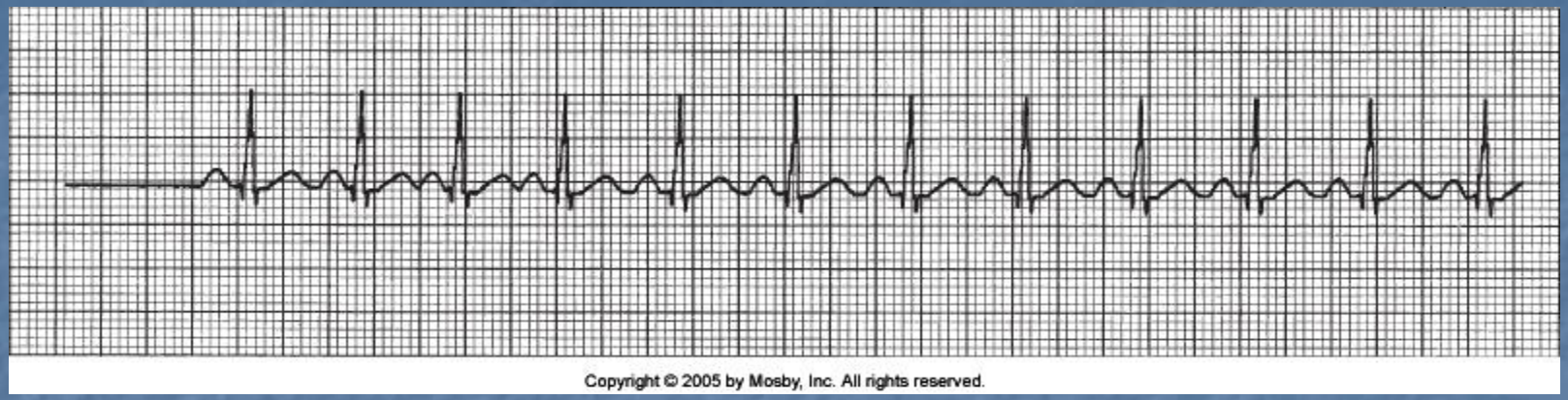
Arrhythmia Etiology

- Disturbance in *automaticity*
  - Pacemaker speeds up
  - New pacemaker takes over
- Conduction problem: Slowing or blockage of conduction or electrical pulse
- Combination of these two

Sinus Bradycardia

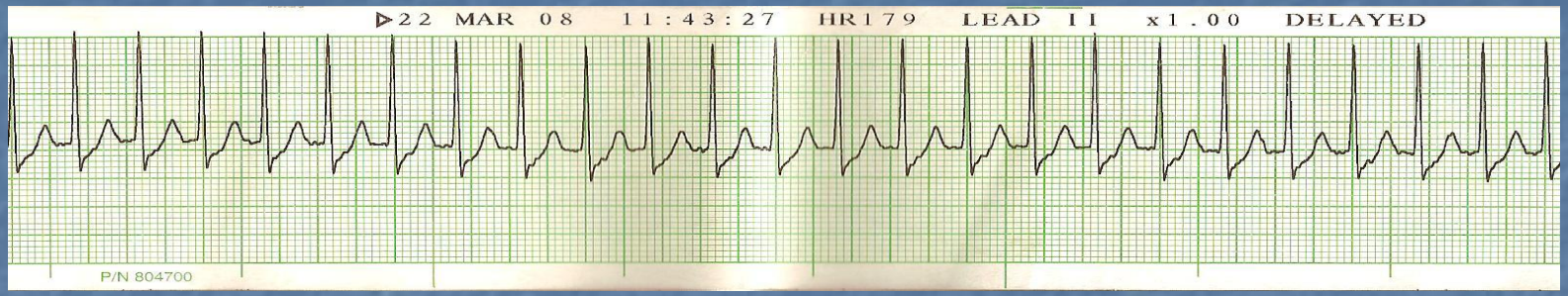
- Why Sinus Bradycardia?
  - Regular
  - Rate < 60
  - 1 P for every QRS
  - PRI between .12 & .20 seconds
  - QRS width = 0.12 seconds
- Common Causes?
  - MI
  - Vagal stimulation
  - Increased ICP
  - Normal athletic heart???
- Treatment?
  - Nothing, if patient asymptomatic
  - Atropine
  - Pacing

Sinus Tachycardia



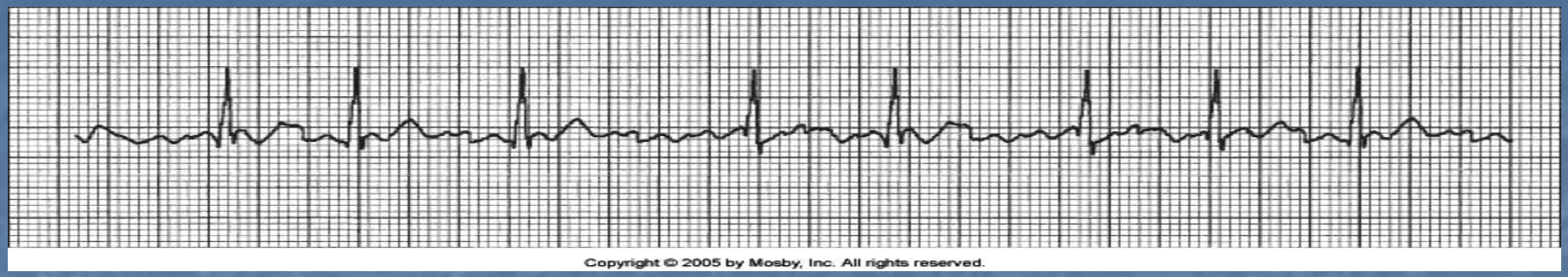
- Why?
  - HR between 100 & 150
  - Rhythm and intervals OK
- Common Causes?
  - Hypovolemia
  - Fever
  - Pain
  - Anxiety
  - Activity
  - Catacholamines
- Treatment?
  - Treat underlying cause

Supraventricular Tachycardia (SVT)



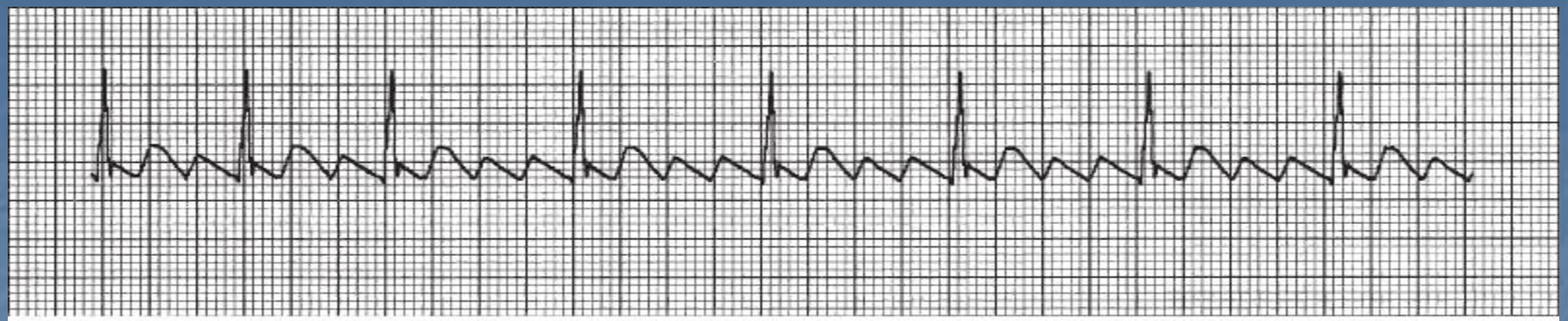
- Why?
  - Very Rapid Rate (150-250)
  - P wave may be buried in preceding T wave
  - PRI difficult to measure but may be between 0.12 and 0.20 secs.
- Common Causes?
  - Ischemic heart disease
  - Excessive catacholamines (e.g., epinephrine)
- Treatment?
  - Beta Blockers
  - Calcium Channel Blockers
  - Adenosine (AV blockade)

Atrial Fibrillation



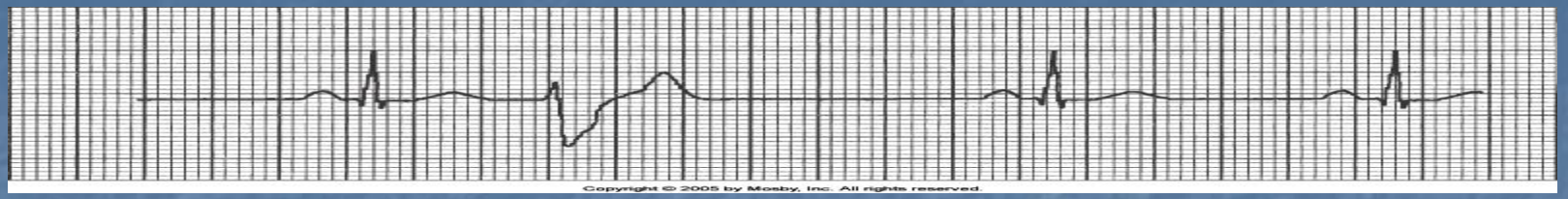
- Why?
  - No identifiable p-waves
  - Chaotic irregular baseline
  - QRS distinguishable but irregular & < .12 secs
- Common Cause
  - Enlarged atrium (due to CHF or mitral stenosis)
- Clinical significance:
  - Threat of emboli
  - Decreased cardiac output
    - If rapid rate = less ventricular filling
    - Loss of "Atrial kick"
- Treatment?
  - Beta Blockers (Lopressor)
  - Calcium Channel Blockers (Cardizem)
  - Digoxin
  - Cardioversion

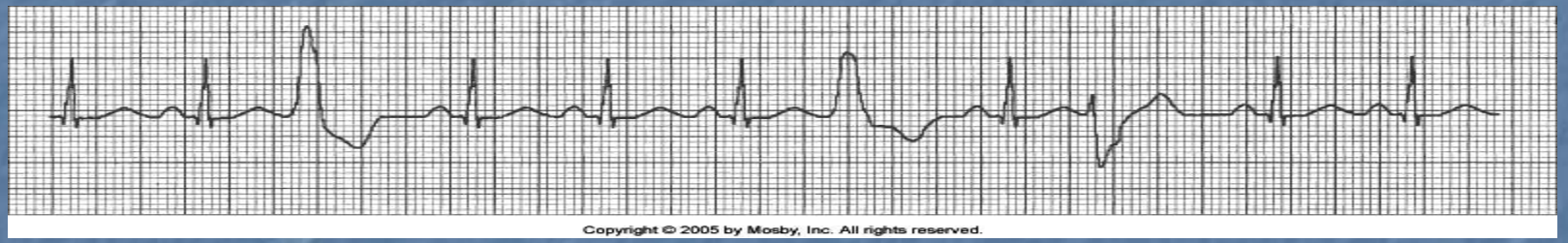
Atrial Flutter



- Why?
  - P waves not present with "*Sawtooth*" baseline
  - PRI not measurable
  - QRS less than 0.12 seconds
- Common causes?
  - Ischemic heart disease
  - Rheumatic heart disease
- Treatment?
  - Beta Blockers (Lopressor)
  - Calcium Channel Blockers (Cardizem)
  - Digoxin
  - Cardioversion

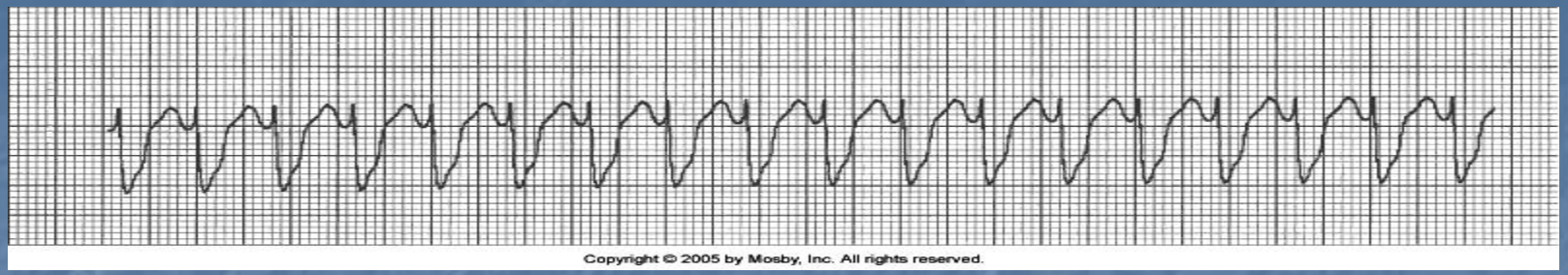
Premature Ventricular Contraction (PVC)





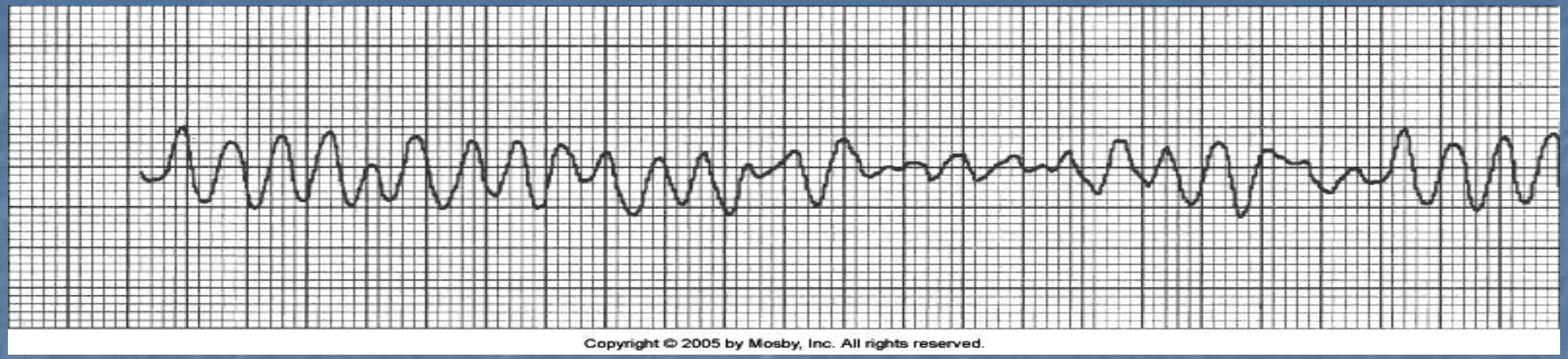
- Why?
  - Premature beat makes rhythm appear irregular
  - PVC is not preceded by a P-wave
  - PRI is not measurable
- Common Causes?
  - Hypokalemia
  - MI or ischemia
  - Hypoxemia
  - Hypovolemia
- Treatment?
  - Treat underlying cause
  - Beta blockers
  - Antiarrhythmic drugs (Amiodarone or Lidocaine)

Ventricular Tachycardia



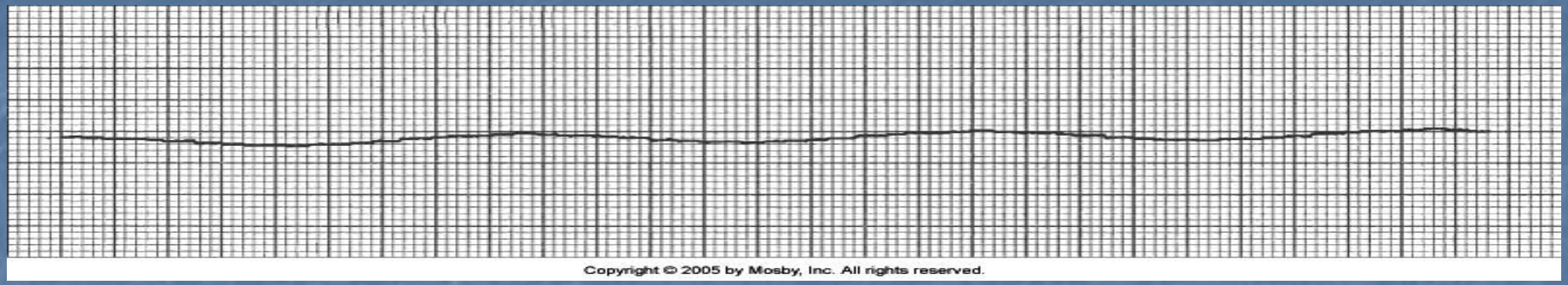
- Why?
  - Rate generally between 100 & 200
  - P-waves not present
  - PRI not measurable
  - QRS wide and bizarre, width > 0.12 seconds
- Common Causes?
  - Similar to PVCs
- Treatment?
  - If pulse & stable: Similar antiarrhythmic drugs as PVCs
  - If pulseless, then immediately begin CPR and rapid defibrillation

Ventricular Fibrillation



- Why?
  - Chaotic rhythm
  - HR can not be determined
  - P-waves, PRI and QRS not discernable
- Causes?
  - MI or ischemia
  - Acidosis
  - Hypothermia
  - Hypoxemia
- Treatment = ABCDs of ACLS, including immediate defibrillation

Asystole



- Causes:
  - Electrolyte disturbances
  - Pneumothorax
  - Drug overdose
  - Hypoxemia
  - Post MI
- Treatment =
  - Not shockable
  - Immediate CPR, unless a valid DNR
  - Identify and treat underlying cause
  - Pacing
  - Basic troubleshooting.

Pulseless Electrical Activity (PEA):

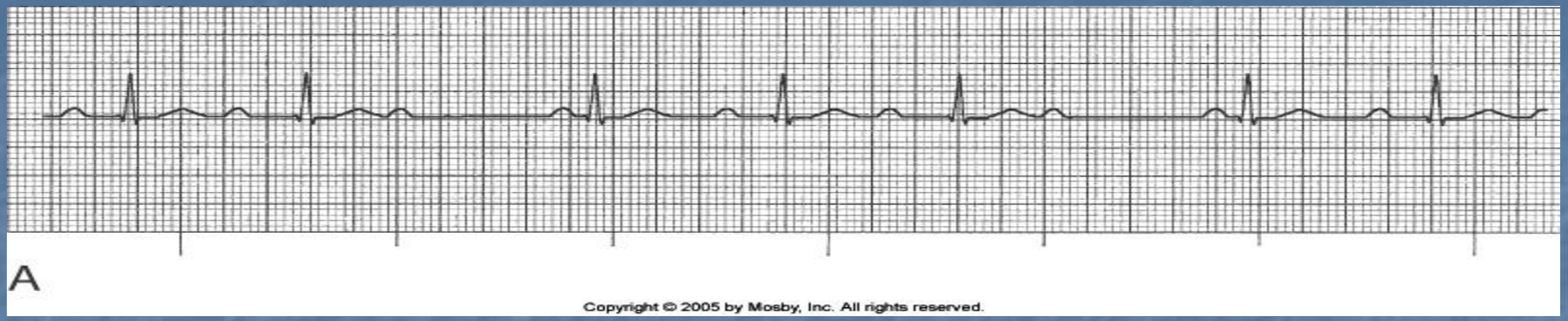
Electrical Conduction without Mechanical Activity of the Heart. Most common causes are as follows:

- **5 H's:**
  - Hypovolemia,
  - Hypoxia,
  - H+(acidosis),
  - Hyper/hypokalemia
  - Hypothermia
- **5 T's:**
  - Tamponade (cardiac),
  - Tension pneumo,
  - Thrombosis (coronary),
  - Thrombosis (pulmonary)
  - Tablets (OD)

First Degree Heart Block

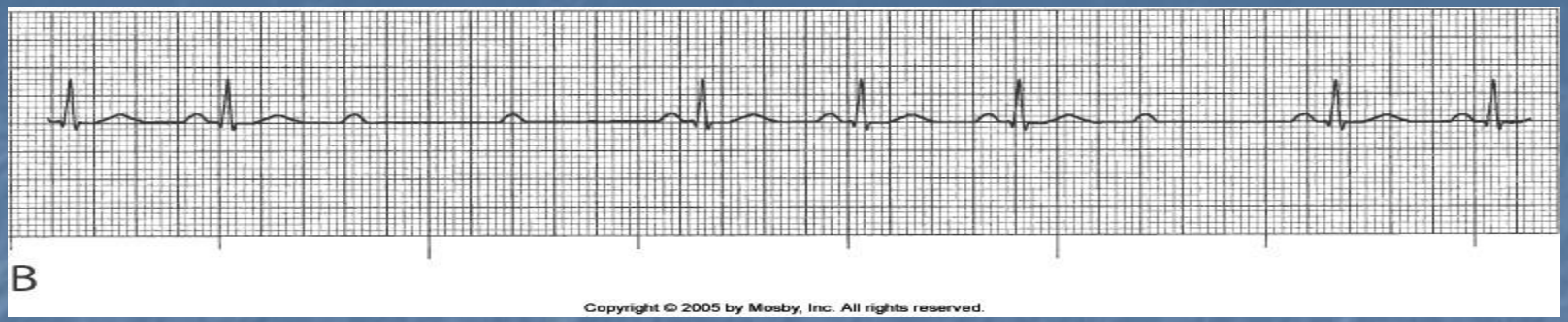
- Why?
  - Regular rhythm
  - Rate 60-100
  - QRS < 0.12 secs
  - **PRI Interval > 0.20 secs**
- Causes?
  - Physiologic interference with conduction pathway
  - Digoxin toxicity
- Treatment?
  - May be benign
  - Treat underlying cause
  - Stop digoxin, if levels are high

2nd Degree Heart Block-Type I
(Wenckebach)



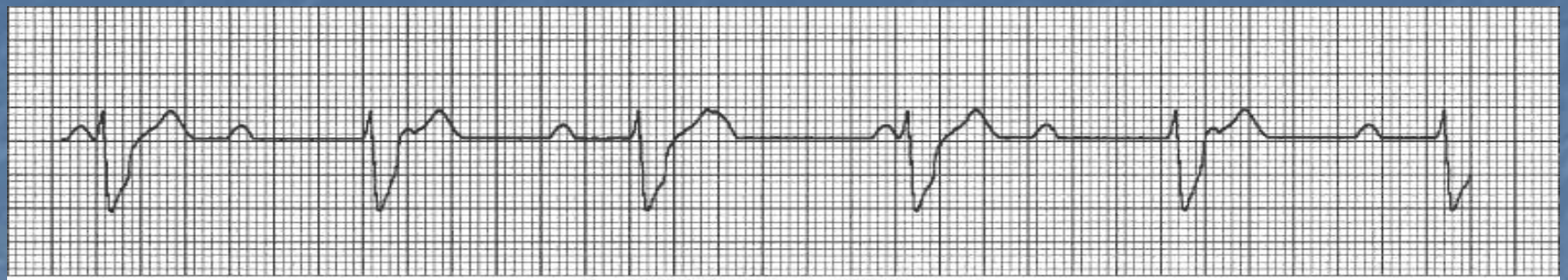
- Why?
  - Irregular rhythm
  - Ventricular rate < atrial rate
  - Progressive prolongation of PRI interval until a QRS is dropped
- Causes?
  - Mi or ischemia
  - Excessive beta blockers
  - Digoxin toxicity
- Treatment?
  - Atropine if symptomatic heart rate < 60
  - Monitor

Second Degree Heart Block-Type II



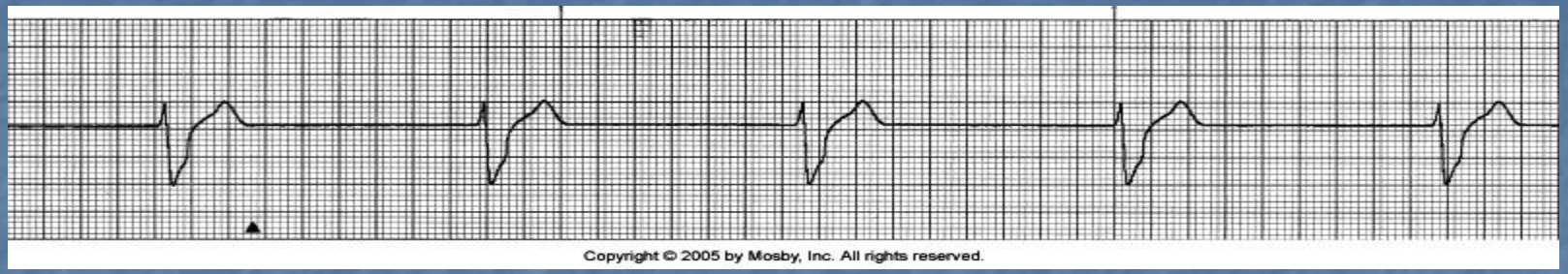
- Why?
  - Regular rhythm
  - Ventricular rate < atrial rate
  - QRS does not occur with every p-wave (some QRS's are dropped)
  - More p- waves than QRS
- Causes?
  - MI or ischemia
  - Excessive beta blockers
  - Digoxin toxicity
- Treatment?
  - Atropine if symptomatic heart rate < 60
  - Pacemaker

Third Degree Heart Block



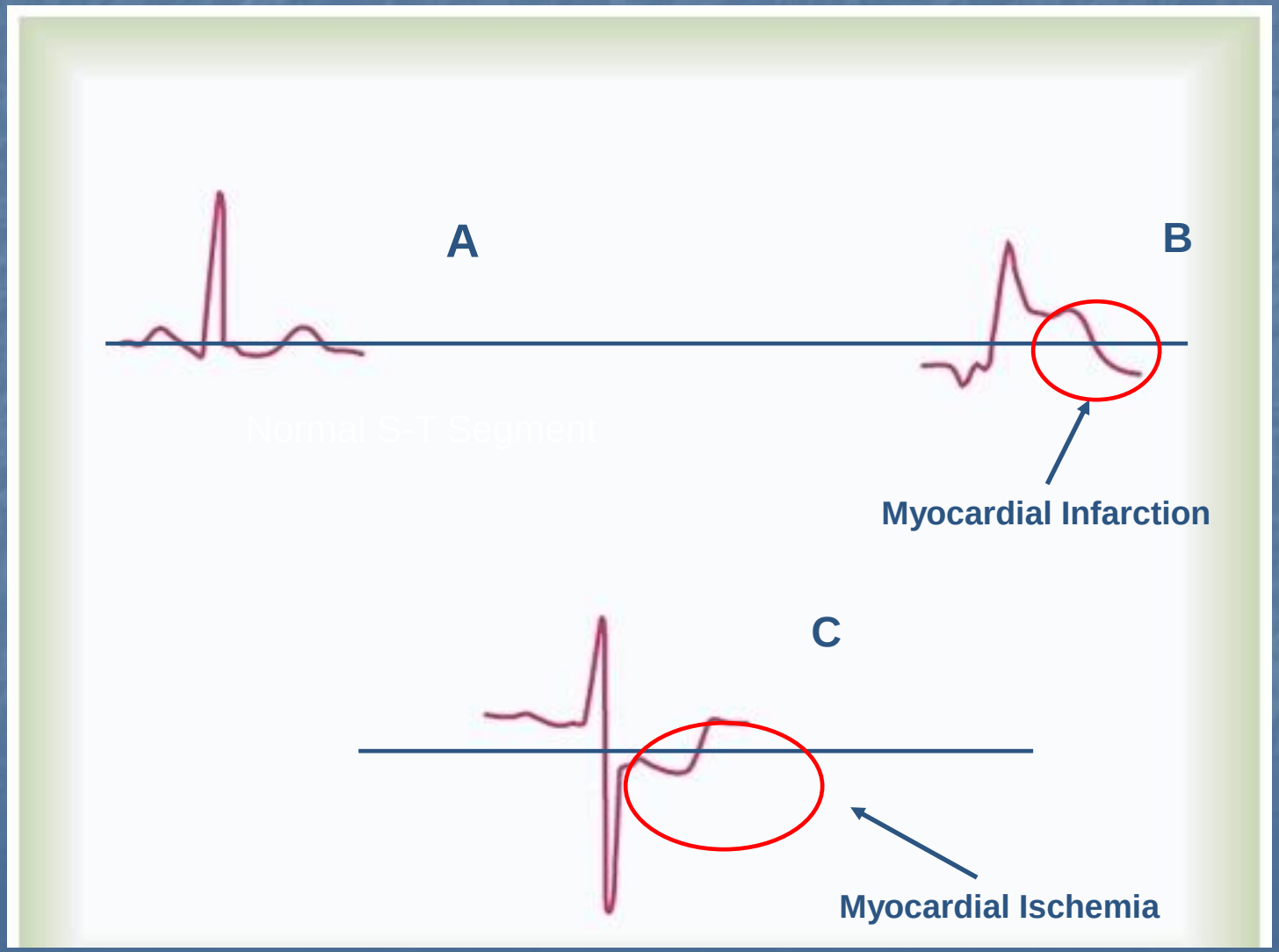
- Why?
  - Independent atrial (P wave) and ventricular activity.
  - The atrial rate is always faster than the ventricular rate.
  - HR often < 40
  - PRI not measurable
  - QRS may be > 0.12 seconds
- Causes?
  - MI or ischemia
  - Digoxin toxicity
- Treatment?
  - Atropine
  - Pacemaker

Idioventricular Rhythm

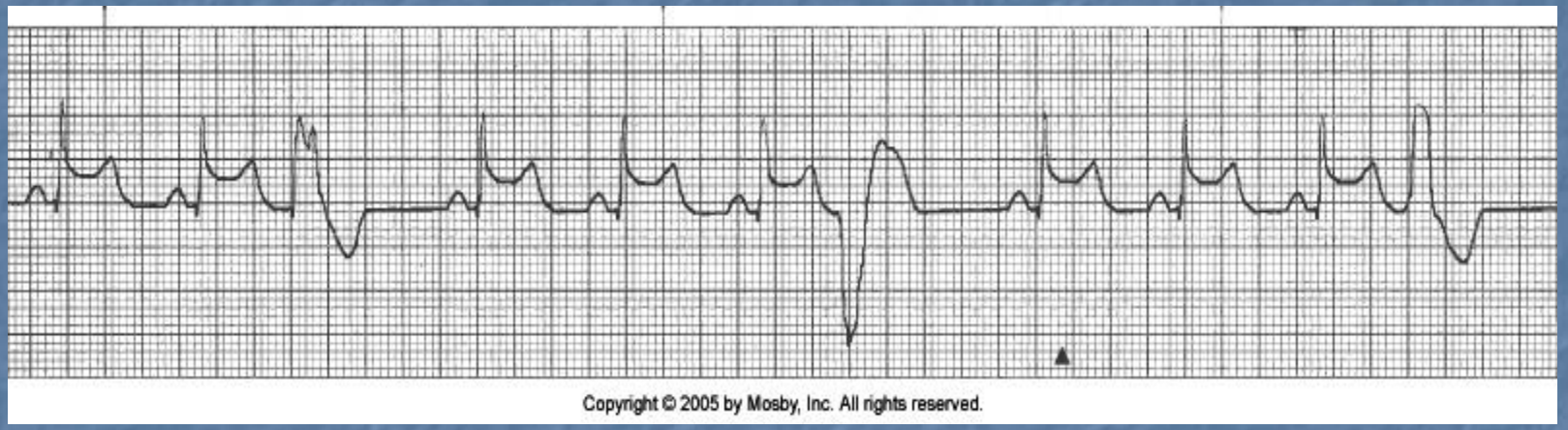


- Why?
  - Ectopic foci takes over as pace maker for ventricles
  - No "P" waves
  - Wide QRS (> 0.12 secs)
  - Rate 30-40, unless accelerated
- Common causes?
  - MI
- Treatment?
  - Pacing
  - Atropine

Other EKG Abnormalities: ST Segment Elevation & Depression



ST Elevation with a PVC

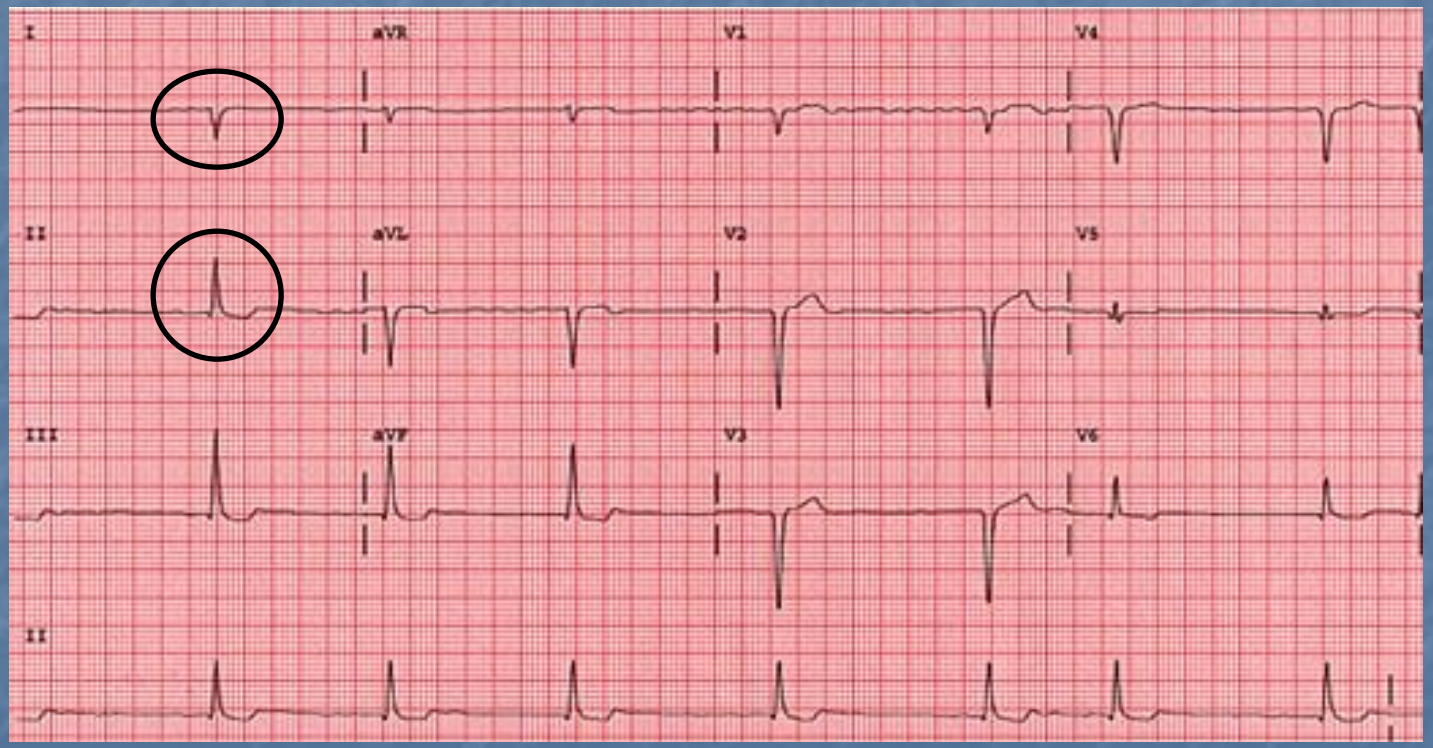


- Cause: Acute MI
- Treatment:
  - TPA ("clot busters")
  - Vasodilators
  - Revascularization

S-T Segment Depression

- Cause: Myocardial Ischemia
- Treatment:
  - Vasodilators
  - Oxygen
  - Revascularization

Right Axis Deviation



Identifying Axis Deviation

Quick Axis Determination	
Lead	Axis Interpretation
I is Positive II is Positive	Normal
I is Positive II is Negative	Left Axis deviation
I is Negative II is Positive	Right Axis Deviation
I is Negative II is Negative	Extreme Right axis Deviation

Also: With Right Axis Deviation, lead 3 will positive, but taller than lead II.

Causes of Axis Deviation:

Right Axis Deviation

- Right ventricular hypertrophy
- COPD
- Acute PE
- Infants (normal)
- Bi-ventricular hypertrophy

Left Axis Deviation

- Left ventricular hypertrophy
- Abdominal obesity
- Ascites or large abdominal tumors
- Third trimester pregnancy

Take Home Messages

- Decide What it is you ***Need/Want*** to know about EKGs/ECGs
- Identify resources
  - Texts
  - Manuals
  - Actual EKG strips
- Review and reinforce
- Obtain and maintain ACLS
- Know thy limitations

Additional Resources

- Aehlert B: *ECGs made easy*, ed. 3, Mosby 2005.
- American Heart Association: *Advanced cardiovascular life support*, AHA, 2008.
- Goldberger AL: *Clinical electrocardiography: a simplified approach*, ed. 7, Mosby 2006.
- Heuer A & Scanlan C: Clinical Assessment in Respiratory Care, ed 7, Elsevier, 2013
- Thaler MS: *The only ECG book that you'll ever need*, ed. 5, Lippincott-Raven, 2006.
- www.ecglibrary.com