Basic ECG Interpretation Workshop

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Objectives

- Analyze the basic ECG components required to assess pathology to include, heart rate, rhythm, axis, and intervals.
- Develop a simple method to enable consistent assessments of unknown ECGs for common pathologies.
- Identify the common variances within normal ECGs.

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Objectives

- Interpret normal ECGs, Bundle branch blocks, IVCDs and Fascicular Blocks.
- Interpret common rhythm abnormalities (PAT, atrial fibrillation, atrial flutter) using specific diagnostic criteria.

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Disclosure Statement

- No association or financial arrangement with any vendor or pharmaceutical company.

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Basic Assumption

- I assume that you do not know or remember much about ECGs.

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Basic Issues

- What is an ECG?
- When would you order one?
- What does it tell you?
- Art of Interpreting ECG!

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First Things First

- Coming from a Primary Care Perspective
- Evaluate an ECG the same way each time
- Develop a system to accomplish this process
- Force yourself to practice

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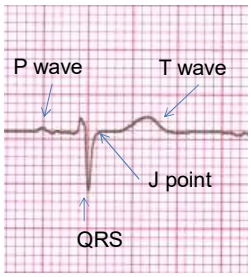
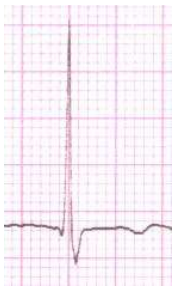
Waveforms





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One Method

- **Gestalt or general impression**
- Determine the Heart Rate
- Determine the Rhythm
- Measure the Longest Interval in the Limb Leads
- Determine the Axis
- Assess the R-Wave Progression

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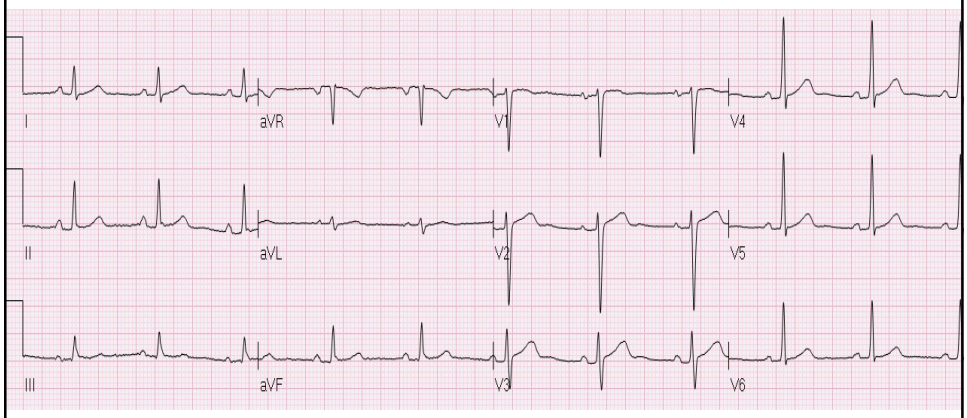
Gestalt: Normal



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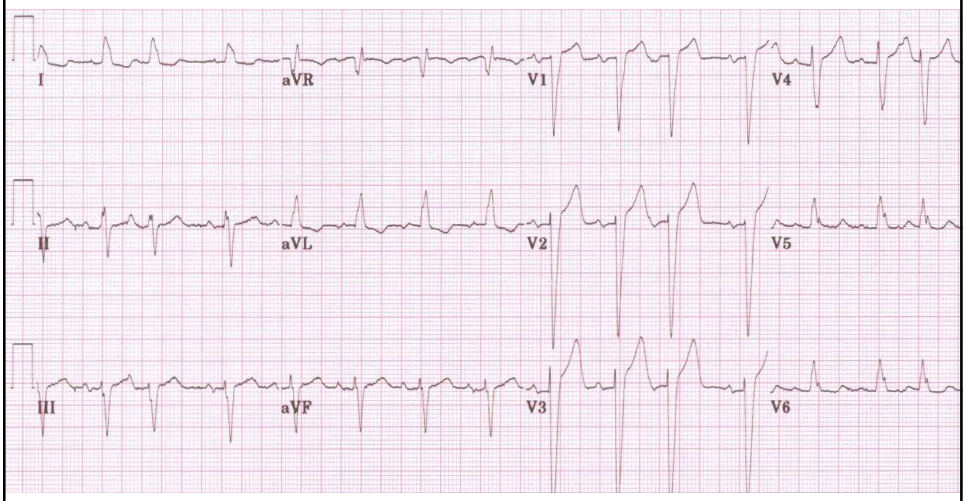
Gestalt: or Abnormal



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One Method

- Gestalt or general impression
- **Determine the Heart Rate**
- **Determine the Rhythm**
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- Assess the R-Wave Progression

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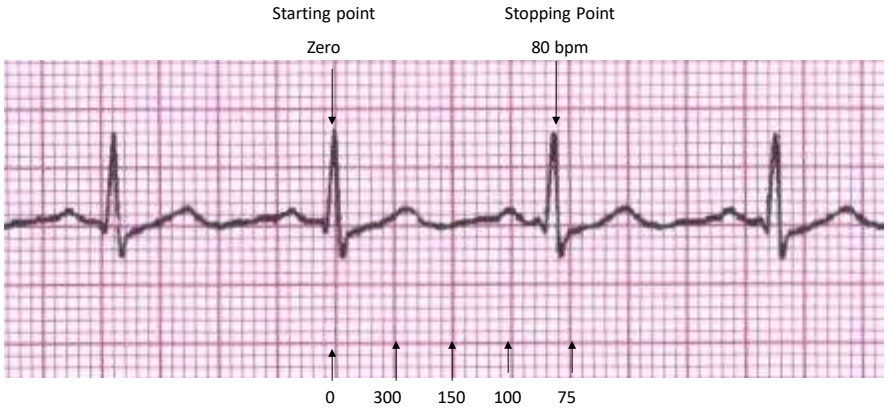
Heart Rate Determination



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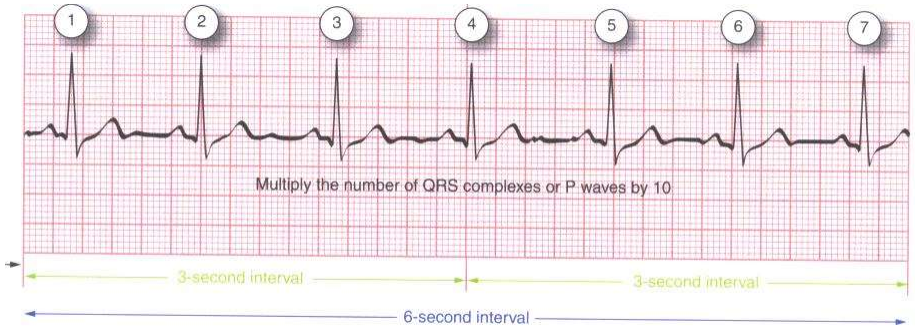
Heart Rate for Irregular Rhythms



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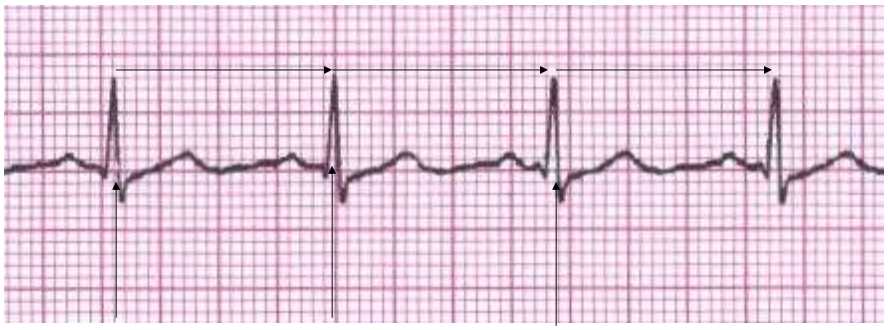
Rhythm Determination



Is the distance between one QRS complex the same as the others?

If yes, rhythm is considered Regular.

If no, rhythm is considered Irregular.

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One Method

- Gestalt or general impression
- Determine the Heart Rate
- Determine the Rhythm
- **Measure the Longest Interval in the Limb Leads**
- Determine the Axis
- Assess the R-Wave Progression

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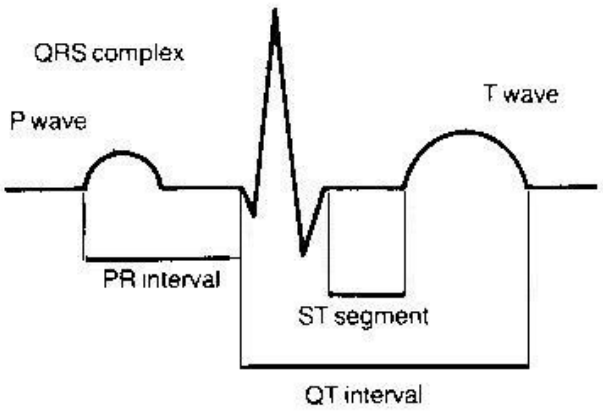
PR, QRS, QT Intervals



PR Normal: 120 – 200 ms

QRS Normal: < 120 ms

QT Normal: Heart rate dependent:

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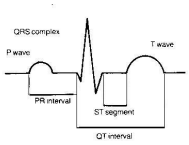
PR Interval

- Measure from start of P wave to start of QRS
- Best measured in limb lead II
- Conduction through the AV node
- Normal:
  - 120 ms to 200 ms
  - 3 to 5 boxes



- Short PR Interval
  - Preexcitation synd.
    - WPW, LGL
  - PACs
- Long PR Interval
- Lots of causes, don't really care about cause
- Refer to as: "First Degree AV Block"

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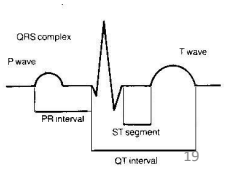
QRS Interval

- Beginning of QRS to the end (J-point)
- Normal: < 120 ms (less than 3 boxes)
- Use the Limb Lead with longest QRS to measure

- Causes of Prolonged QRS interval:
  - Bundle Branch Blocks, IVCD, WPW, LVH, RVH,
  - Rhythm: ventricular tach, PVCs, idoventricular rhythm



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QT Interval

- Measures a complete ventricular cycle
  - From beginning of ventricular depolarization to ventricular repolarization
- Measure from start of QRS to end of T-wave
- Normal is defined based on heart rate
  - HR of 60 = 400 ms; HR of 100 = 320 ms
- Simple rule:
  - The QT is probably prolonged if it exceeds more than HALF of the R-R interval.
  - Rule works well as long as HR is not excessive

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One Method

- Gestalt or general impression
- Determine the Heart Rate
- Determine the Rhythm
- Measure the Longest Interval in the Limb Leads
- **Determine the Axis**
- Assess the R-Wave Progression

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Axis Determination

- Based on the frontal plane (limb leads)
- Ballpark estimates are usually fine, rarely necessary to have specific degrees noted
- Utilize the Quadrant Method
  - Based on two limb leads: I and aVF
  - Normal is based on quadrant

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Quadrant Method

- From the ECG, looking at Limb Lead I, determine the net deflection of the QRS complex (Positive, Negative, equal)
- Plot this on your axis diagram
- Next, from the ECG, looking at Limb Lead aVF, determine the net deflection of the QRS complex (Positive, Negative, equal)
- Plot this on your axis diagram

- Where the areas cross over, this is the quadrant in which the axis lies.

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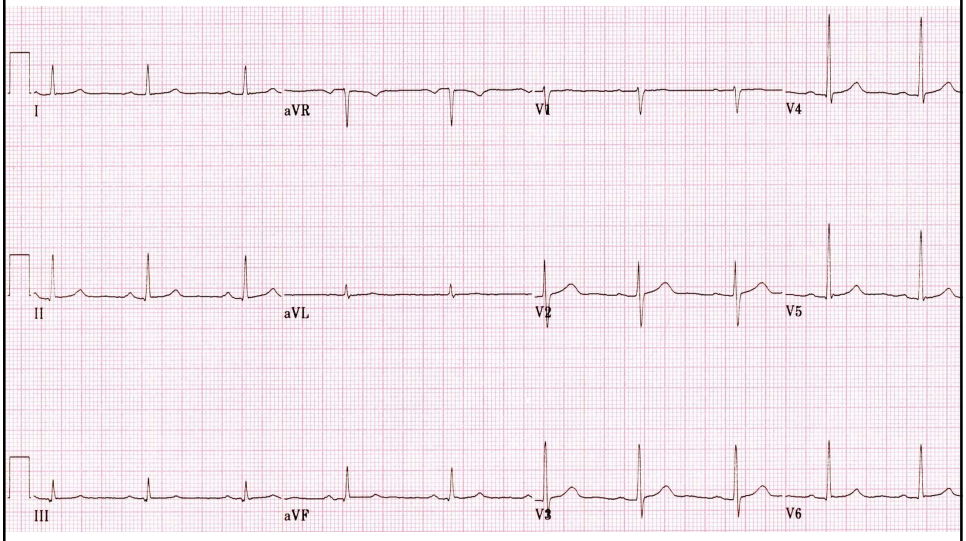
Example 1



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Axis Pathology

- Left Axis Deviation
  - Left Bundle Branch Block
  - Left Ventricular Hypertrophy
  - Inferior Wall MI
  - Left Anterior Fascicular Block
- Right Axis Deviation
  - Right Bundle Branch Block
  - Right Ventricular Hypertrophy
  - High Lateral Wall MI
  - Left Posterior Fascicular Block

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One Method

- Gestalt or general impression
- Determine the Heart Rate
- Determine the Rhythm
- Measure the Longest Interval in the Limb Leads
- Determine the Axis
- **Assess the R-Wave Progression**

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R-wave Progression

- Precordial Chest leads V1 – V6
- R wave progresses from V1 through V6
- Descriptive term only, does not imply pathology
- Terminology:
  - Normal, early transition, late transition
- Causes:
  - LVH, RVH, MI, Conduction defects, normal variants, lead misplacement….

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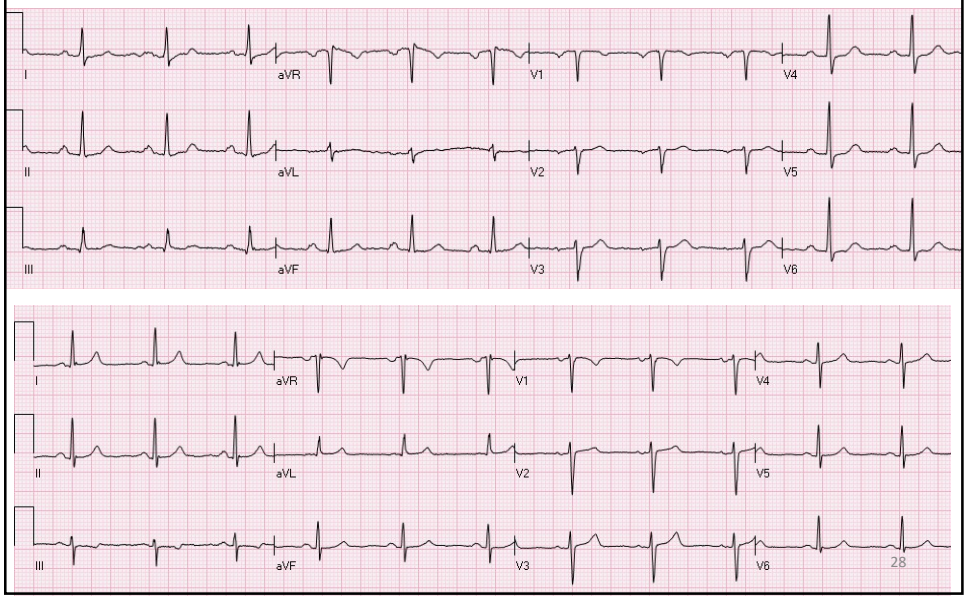
R-Wave Progression



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What Next

- For each ECG lead, note the following:
  - Location and morphology of P-waves
  - QRS pattern (presence of Q-waves)
  - ST Segment (elevation or depression)
  - T wave changes

  Review all leads except aVR.

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Normal ECG:
The 12-lead ECG morphology for a normal individual is not always uniform. A number of constitutional variables can substantially alter a normal ECG, including sex, age, height, race and anatomic position of the heart within the chest. Lead placement, variations in technique and different machines can also distort a normal ECG.

Helpful Criteria:
* P-waves upright in I, II, V2-V6
* T-waves upright in I, II, V3-V6, Inverted in aVR
  Variable in III, aVL, aVF, V4-V6

* Small Q-waves normal in I, aVL, V4-V6
* Deep Q-waves (QS) normal in aVR, and occasionally seen in leads III and V_1

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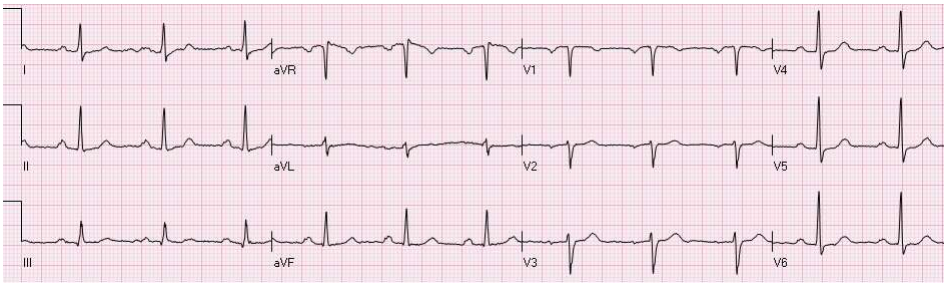

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* T-waves upright in I, II, V3-V6, Inverted in aVR
  Variable in III, aVL, aVF, V4-V6

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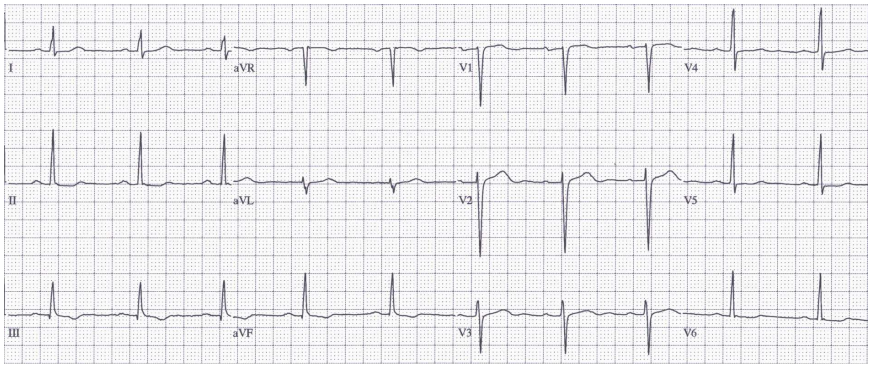
Let's Practice



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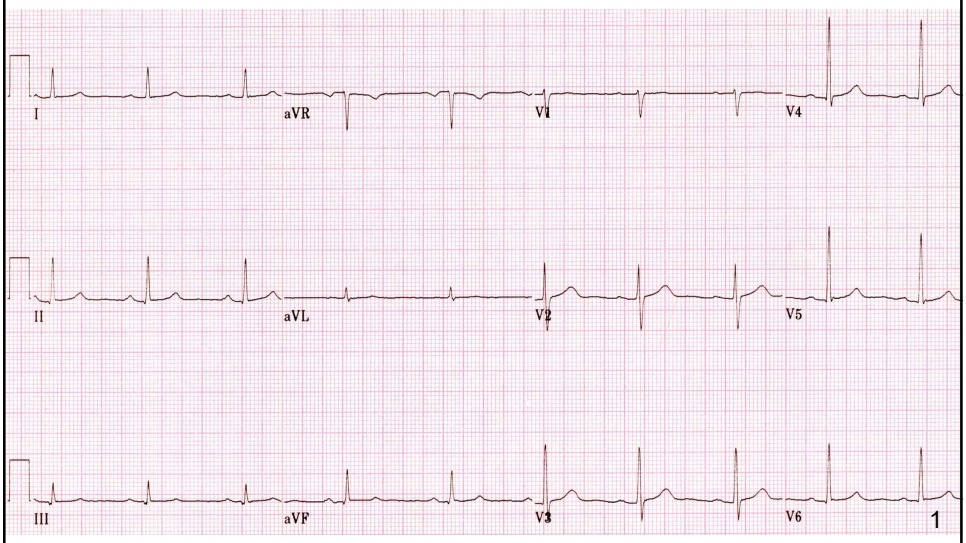
Example 2



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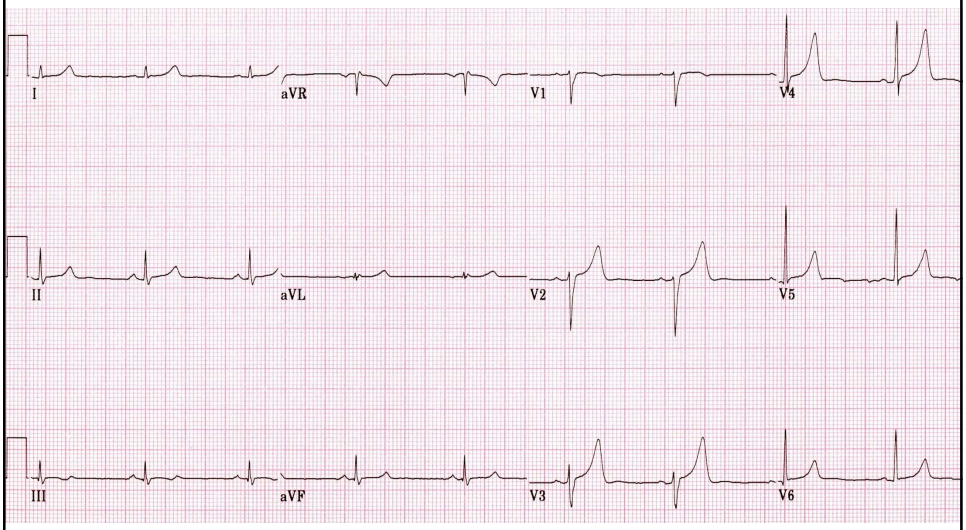
Example 3



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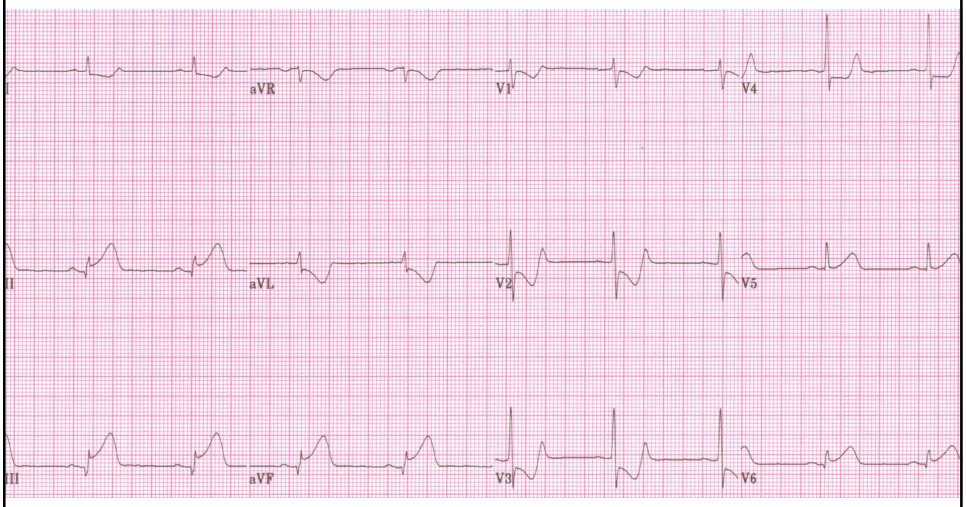
Example 4



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Bundle Branch Blocks

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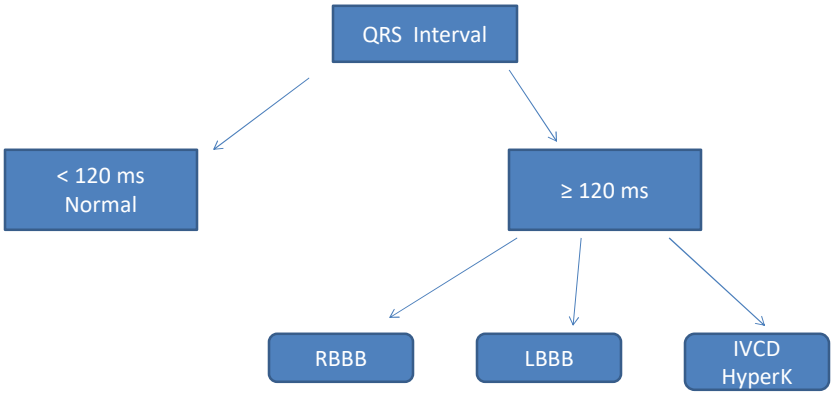
Simplified Diff. Wide-QRS Complex



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Differential for Wide-QRS Complex

- Hyperkalemia
- Ventricular tachycardia
- Idioventricular rhythm, including heart block
- Drug effects and overdose (esp. tricyclics)
- Wolff-Parkinson-White
- Bundle Branch Blocks and Idioventricular conduction delays (IVCD)
- Ventricular premature contractions
- Aberrantly conducted complexes
  - In order of descending mortality

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Do I have a Bundle Branch Block?

- Diagnostic criteria
  - Width of the QRS complex
    - ≥ 120 ms is Always abnormal
  - If QRS is < 120 ms, NOT a BBB

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Right Bundle Branch Block

- Diagnostic criteria:
  - QRS ≥ 120 ms
  - Axis is RAD or Normal (can be LAD with LAFB)
  - rSR' pattern V_1 - V_2
  - Slurred S-wave in I and V_6
  - NSSTT changes in V_1 & V_2

  (Non-specific ST-T wave changes)

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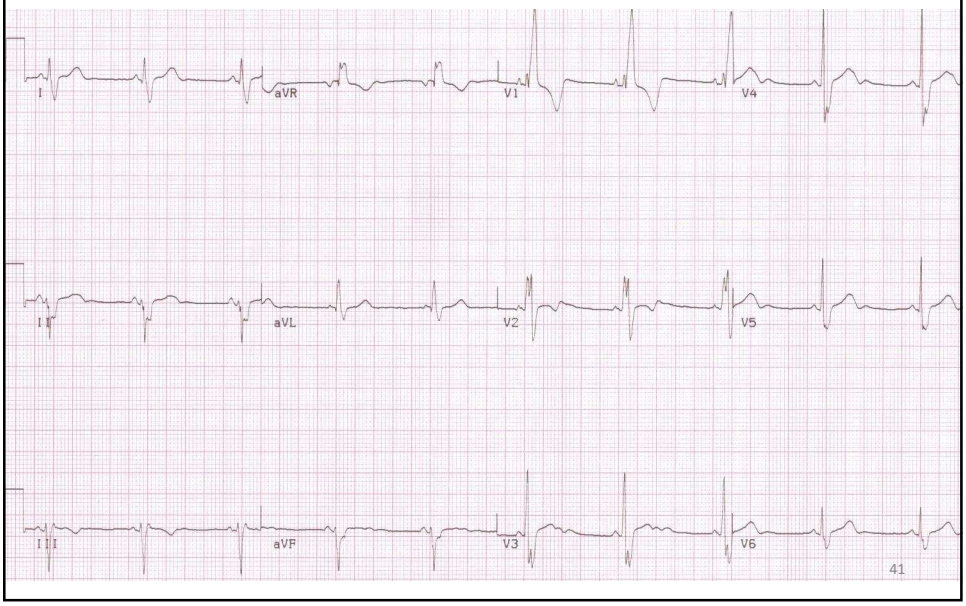
Example 5

RBBB



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Left Bundle Branch Block

- Diagnostic criteria:
  - QRS ≥ 120 ms
  - Axis is Normal or LAD
  - Wide monomorphic S-waves in V_1 – V_4
  - Wide monomorphic R-wave in I and V_6
  - NSSTT changes in most leads

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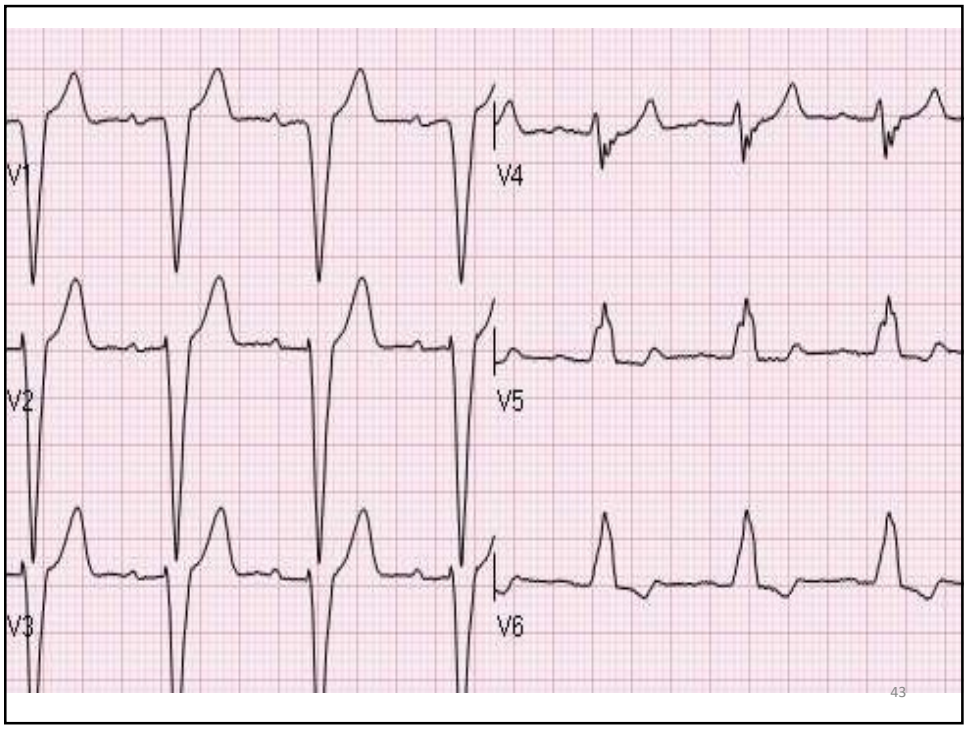

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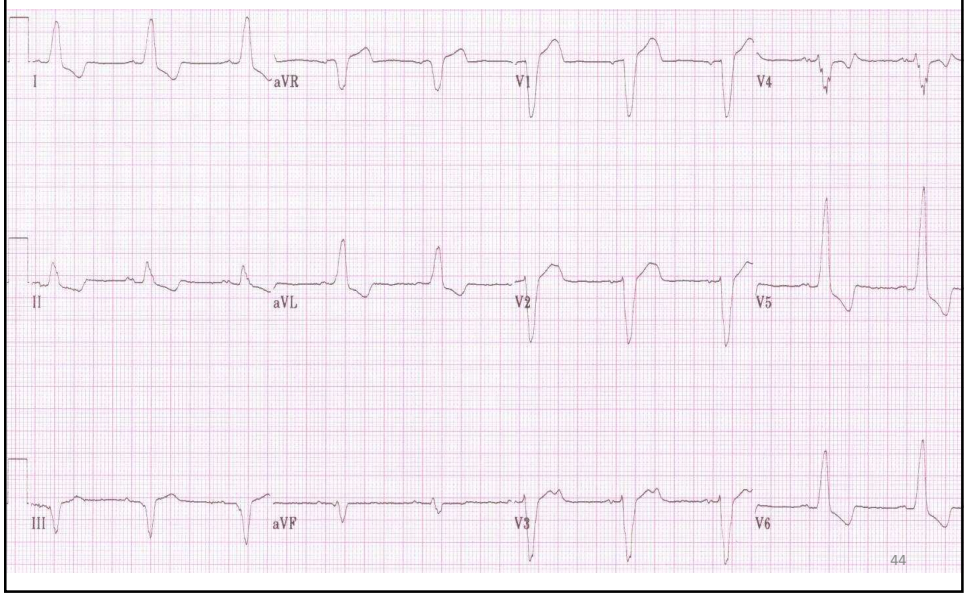
Example 6

LBBB



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How do I Differentiate between Left and Right BBB?

- RBBB
  - QRS ≥ 120 ms
  - Axis is RAD or Normal (can be LAD with LAFB)
  - rSR' pattern V_1 - V_2
  - Slurred S-wave in I and V_6
  - NSSTT changes in V_1 & V_2
- LBBB
  - QRS ≥ 120 ms
  - Axis is Normal or LAD
  - Wide monomorphic S-waves in V_1 – V_4
  - Wide monomorphic R-wave in I and V_6
  - NSSTT changes in most leads

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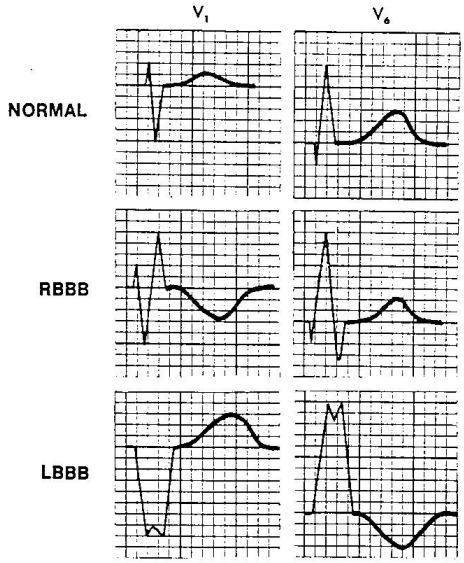
RBBB vs. LBBB



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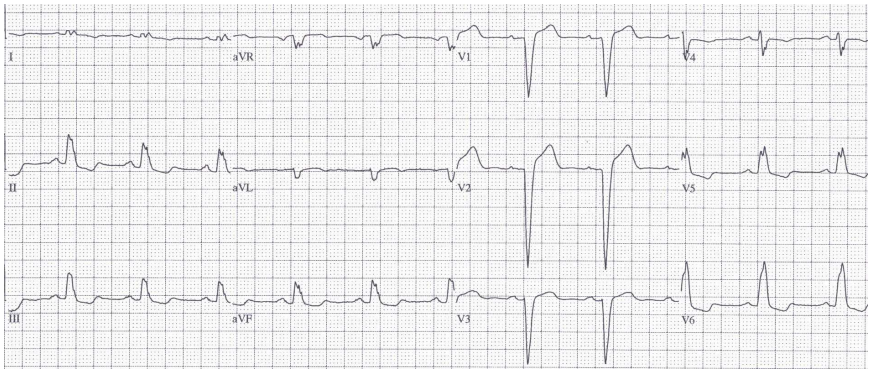
Let's Practice



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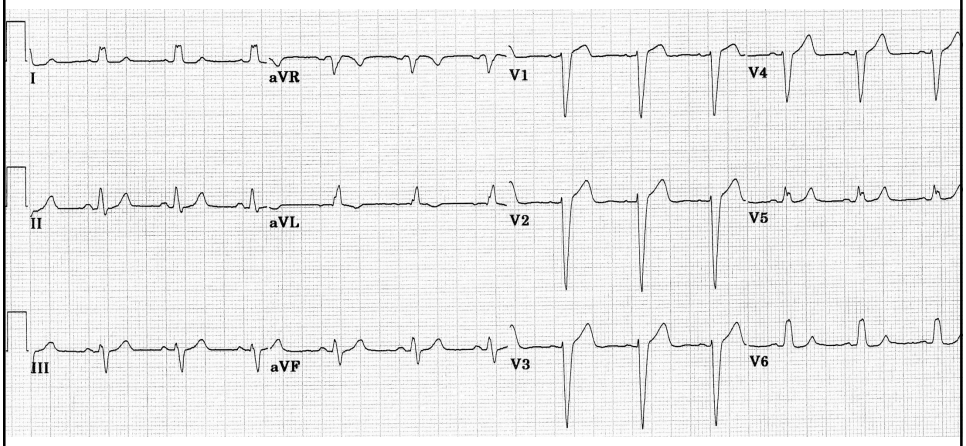
Example 7



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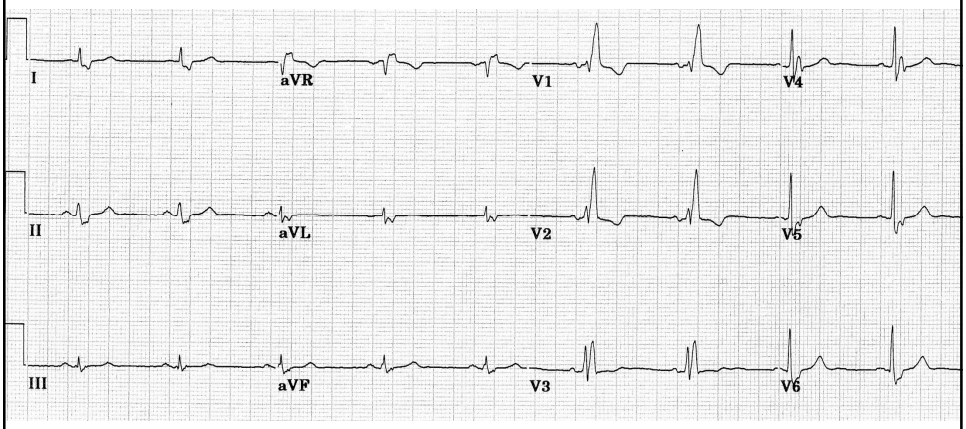
Example 8



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Intraventricular Conduction Delay

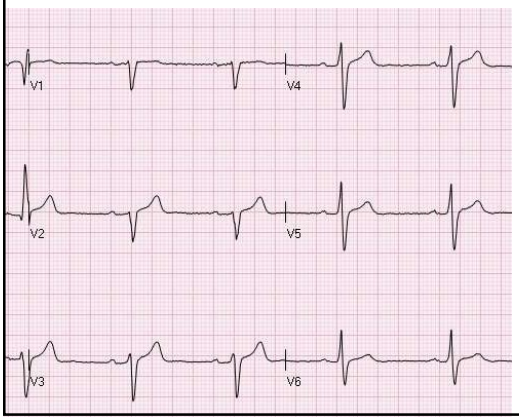
QRS Widening

Typical RBBB

Typical LBBB

Neither typical RBBB or LBBB

IVCD



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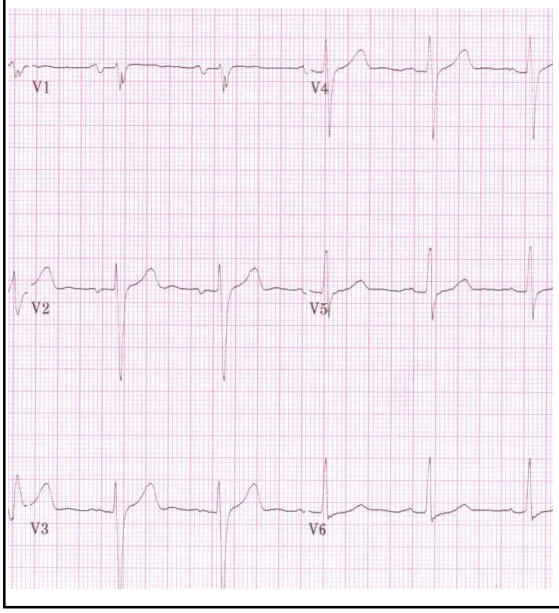

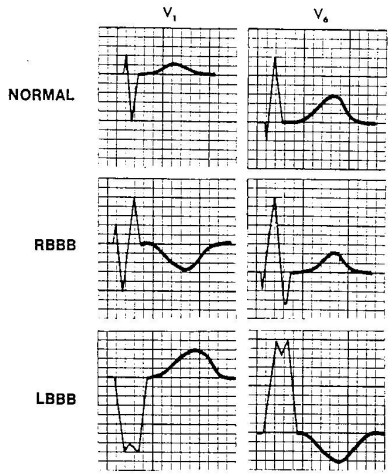

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Fascicular Blocks

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Pathology

- Disruption of the Left Ventricular conduction system, resulting in the ventricles being innervated asynchronously and abnormally. Results in altered vectors produced by the ventricle.

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Left Anterior Fascicular Block

- ECG Criteria:
  - Axis ≥ 45°
  - No other cause of axis deviation present
  - Normal QRS duration (100 – 110 ms)
  - Small Q in lead I, small R in lead III (q1r3 pattern)

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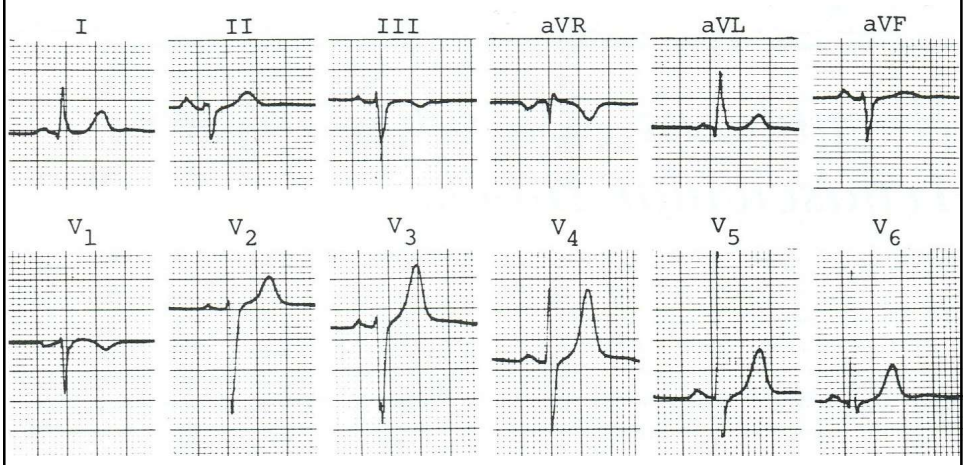
Left Anterior Fascicular Block



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Left Posterior Fascicular Block

- ECG Criteria:
  - Axis ≥ 100°
  - No other cause of axis deviation present
  - Normal QRS duration (100 – 110 ms)
  - Small R in lead I, small Q in lead III (r1q3 pattern)

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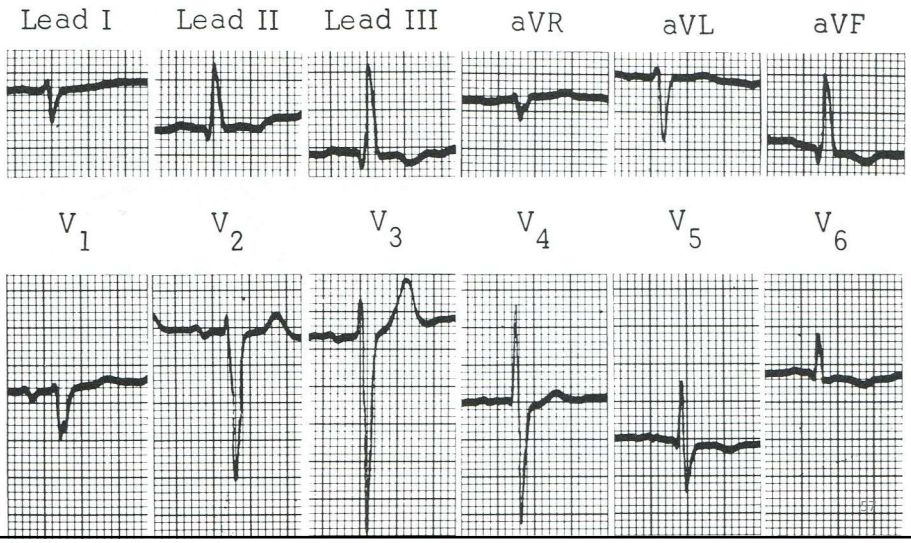
Left Posterior Fascicular Block



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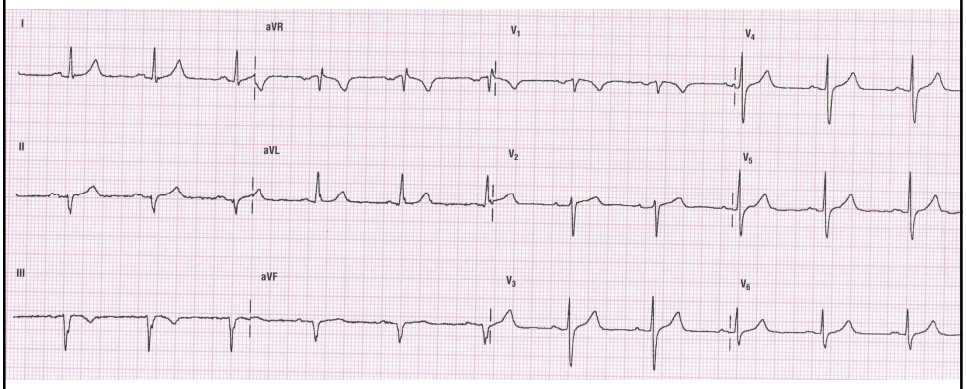
Let's Practice



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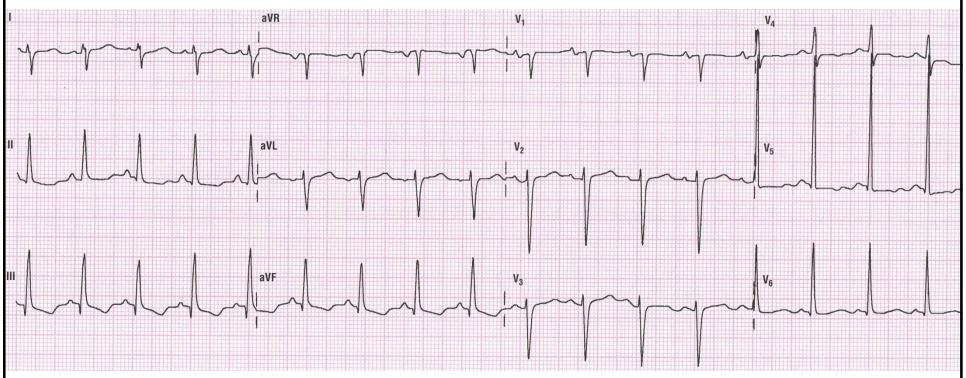
Example 9



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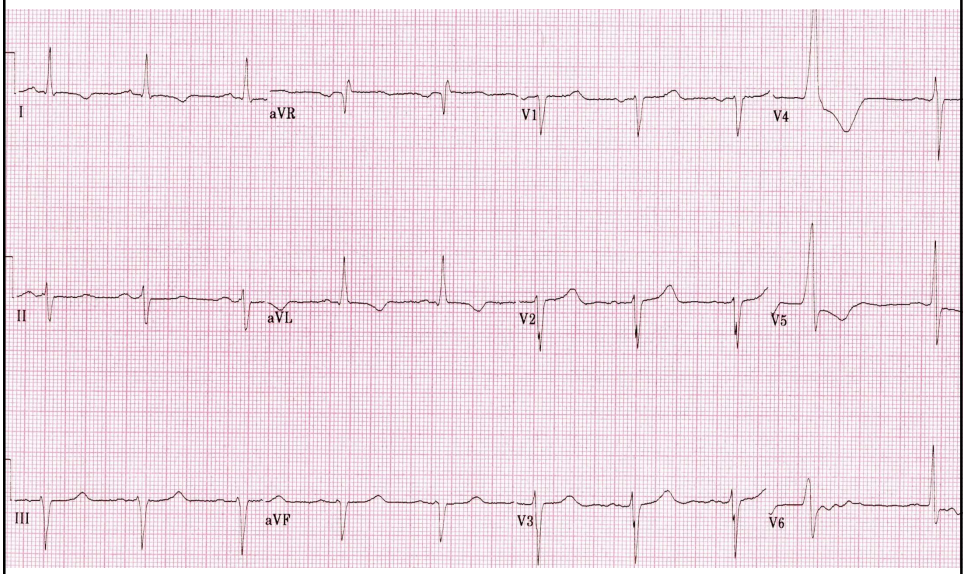
Example 10



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Bifascicular Blocks

- Involves RBBB with either LAFB or LPFB
- RBBB with LAFB is very common and stable
- RBBB with LPFB is also more common than LPFB by itself and is more unstable
- The RBBB is the dominant ECG finding, associated with a axis deviation

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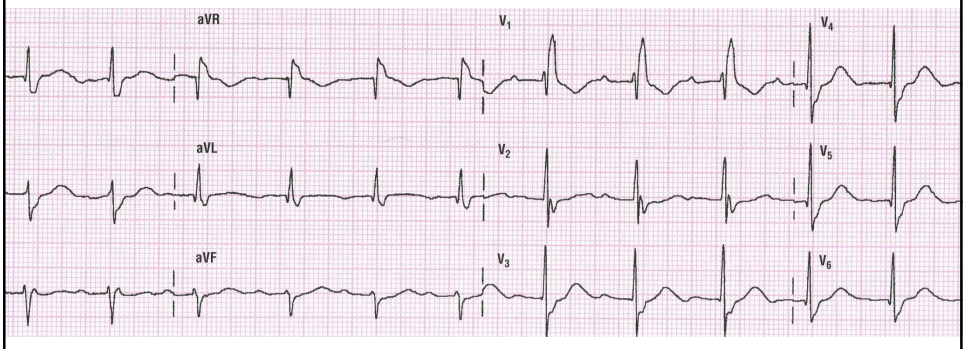
Example 11



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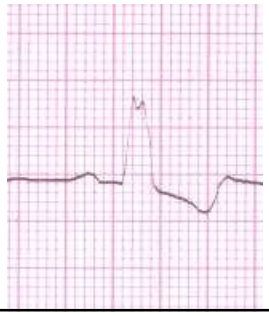
WPW Exception

- Diagnostic criteria for WPW
  - PR interval < 120 ms with a normal looking P-wave
  - Wide QRS complex: 110 ms or greater
  - Presence of “delta-wave” (initial slurring or QRS)
  - Secondary ST-T changes



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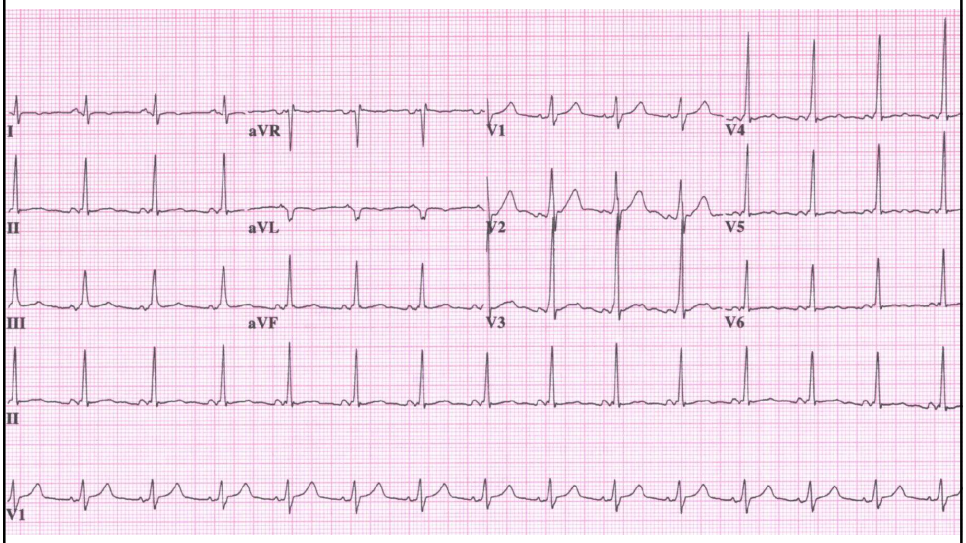
Example 12



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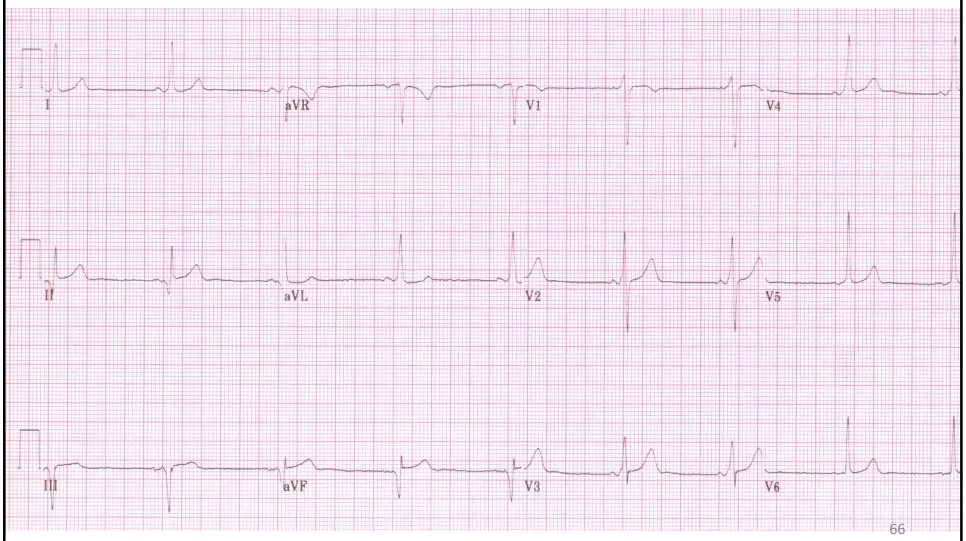
WPW



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ARRYTHMIA INTRODUCTION

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One Method

- ~~Gestalt or general impression~~
- ~~Determine the Heart Rate~~
- ~~Determine the Rhythm~~
- ~~Measure the Longest Interval in the Limb Leads~~
- ~~Determine the Axis~~
- ~~Assess the R-Wave Progression~~

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Method for Rhythm Strip Analysis

- For each rhythm strip, note the following:
  - Determine regularity (rhythm)
  - Calculate rate
  - Location and morphology of P-waves
  - Measure PR interval (fixed or variable)
  - Measure QRS interval

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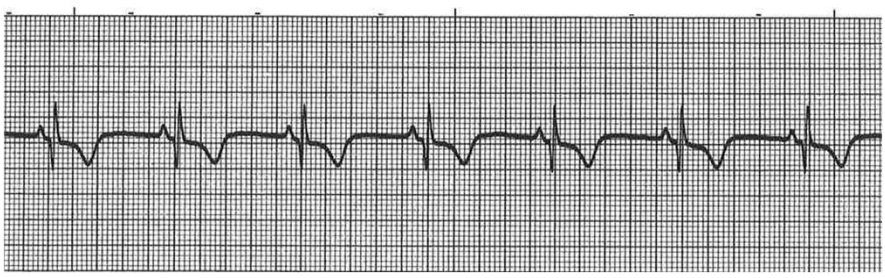

For each rhythm strip, note the following:

Determine regularity (rhythm)
Calculate rate
Location and morphology of P-waves
Measure PR interval (fixed or variable)
Measure QRS interval

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Atrial Arrhythmias

- Very common in clinical practice
- Usually easy to differentiate and diagnose
- Will cover A Fib, A Flutter, and PSVT

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Location and Morphology of "P" Waves

A single P-wave should proceed each QRS complex.

Should bear a family resemblance to all other P-waves.

Measure the PR interval.

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Paroxysmal Supraventricular Tachycardia (PSVT)

Rate: 140 - 250 bpm*
Rhy: Very Regular
P-wave: Lost in the T-wave, not typically observed on rhythm strip
PR: Not measurable
QRS: Normal (narrow, <0.12 sec)

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Paroxysmal Supraventricular Tachycardia (PSVT)

- Lots of names (AVNRT, AVRT, AT…)
- Typically a “reentry” process
- Often presents abruptly for a number of reasons.
- Symptoms can include: light-headedness, syncope, racing heart. Can worsen angina and heart failure.
- Signs: Rapid HR, low BP?
- Can manage most in office.

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Example 13

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Atrial Fibrillation

Rate: Variable, usually fast > 100 bpm
Rhy: Irregularly irregular (chaotic)
P-wave: Not consistently present or reproducible
PR: Not measurable
QRS: Normal (narrow, <0.12 sec), but can be wide

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Atrial Fibrillation

- Most common abnormal rhythm seen in practice.
- Can be acute or chronic.
- Symptoms can include: palpitations, SOB, fatigue, DOE, CP, edema and many more.
- Signs: Irregular pulse, variable BP, crackles, edema,
- Many causes including organic heart disease, valvular disease, thyroid, HTN….

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Atrial Fibrillation

- Management concerns:
  - Control the rate is first priority
  - Consider thrombus formation and Treat
  - Convert the rhythm when appropriate
- It is not always necessary to convert back to NSR.
- Many patients live with A-fib chronically.

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Example 14

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Atrial Flutter

Rate: Atrial rate 250 – 400
Ventricular rate Varies
Rhythm: Regular or Irregular
P-waves: Saw tooth deflection (F waves)
PR: Not measurable
QRS: Typically normal

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Atrial Flutter

- Management concerns:
  - Less common overall
  - Conversion more difficult
  - Consider anticoagulation if A Flutter > 48 hours
- Options
  - Electricity works well (90% conversion)
  - Same agents as used in A Fib.

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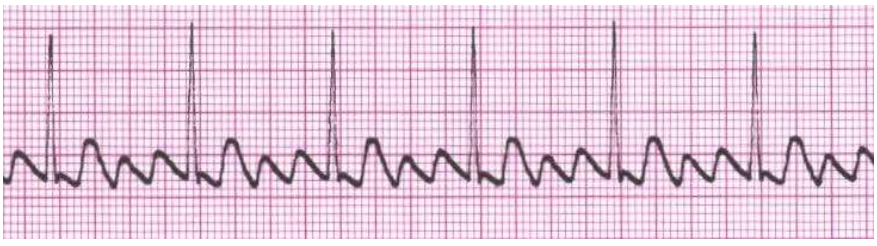
Example 14



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How to Differentiate

- Is the Rhythm Regular?
  - If yes, think PSVT or Atrial Flutter
  - If no, Atrial Fibrillation or Atrial Flutter
- Are P-waves (F-waves) present?
  - If F-waves present, Atrial Flutter
  - If no, PSVT or Atrial Fibrillation

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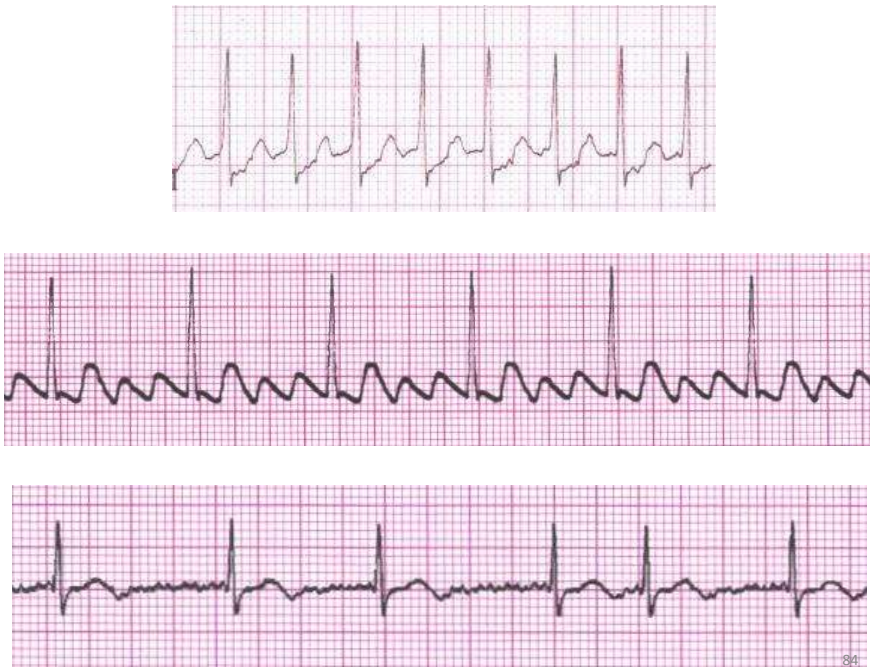

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Summary

- Three important Take Home points!

- Develop a “system” to evaluate ECGs
- Practice does Improve Interpretative abilities
- Work with a good reference to improve skills

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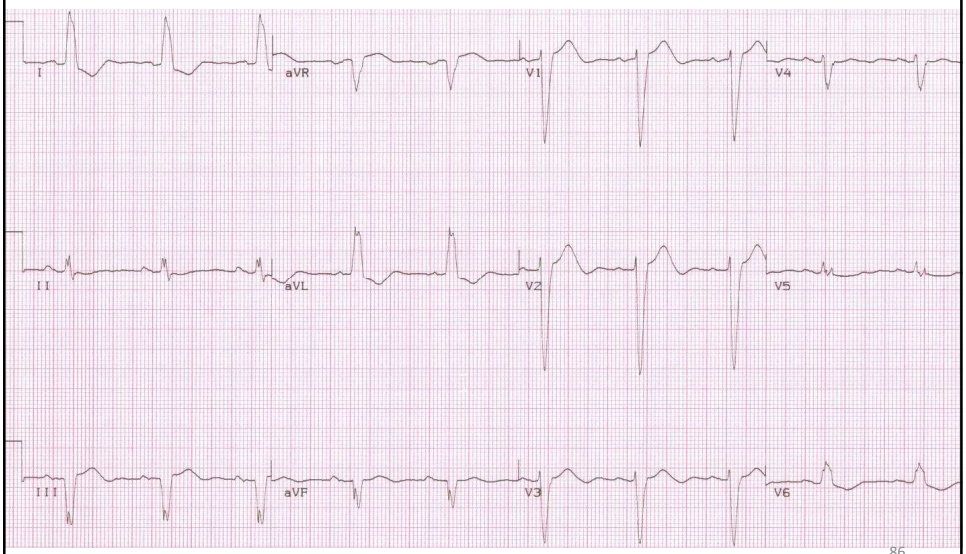

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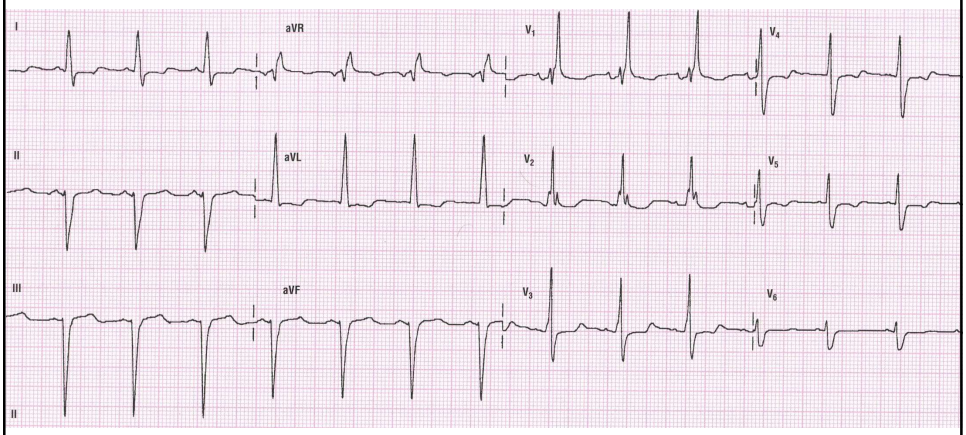

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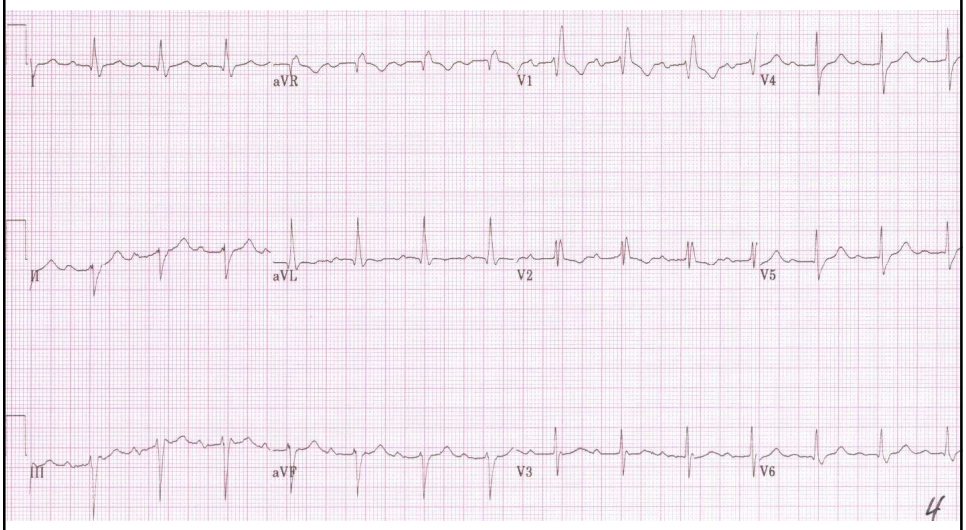

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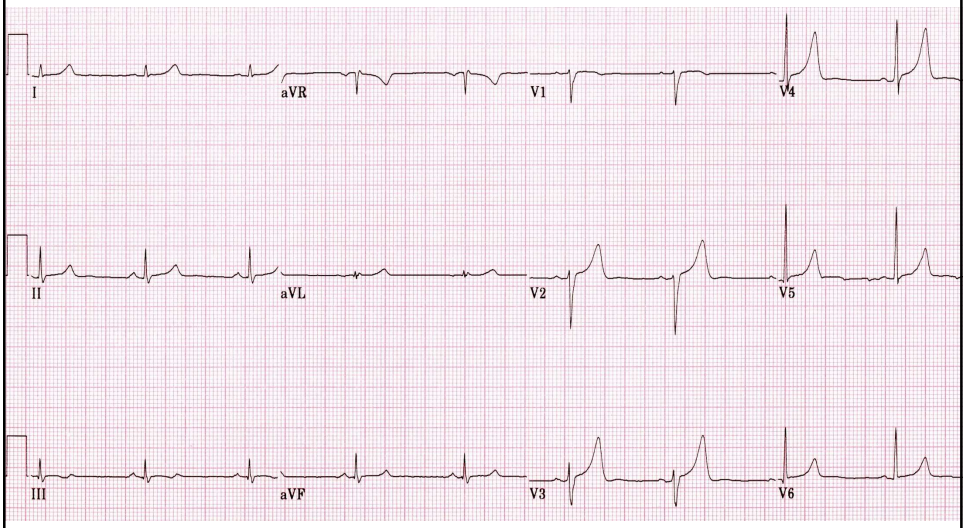

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Heart Rate Clues to Diagnosis

- 40-60 bpm: Sinus bradycardia
- 60-100 bpm: NSR
- 100-150 bpm: Sinus tach
- 150-250 & regular: PSVT
- Variable, but usually fast: A-fib, A-flutter
- > 110 with wide QRS: V-tach

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Rhythm Clues

- Regular Rhythms
  - NSR, Sinus tach
  - Sinus brady
  - PSVT
  - 1st AV Block
  - Ventricular Tach
- Irregular Rhythms
  - Atrial Fib
  - Atrial Flutter*
  - No rhythm
    - Ventricular Fib
    - Asystole

* Can be a Regular rhythm

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