



HARVARD MEDICAL SCHOOL  
TEACHING HOSPITAL

# Evaluation of Chest Pain

17 April 2023

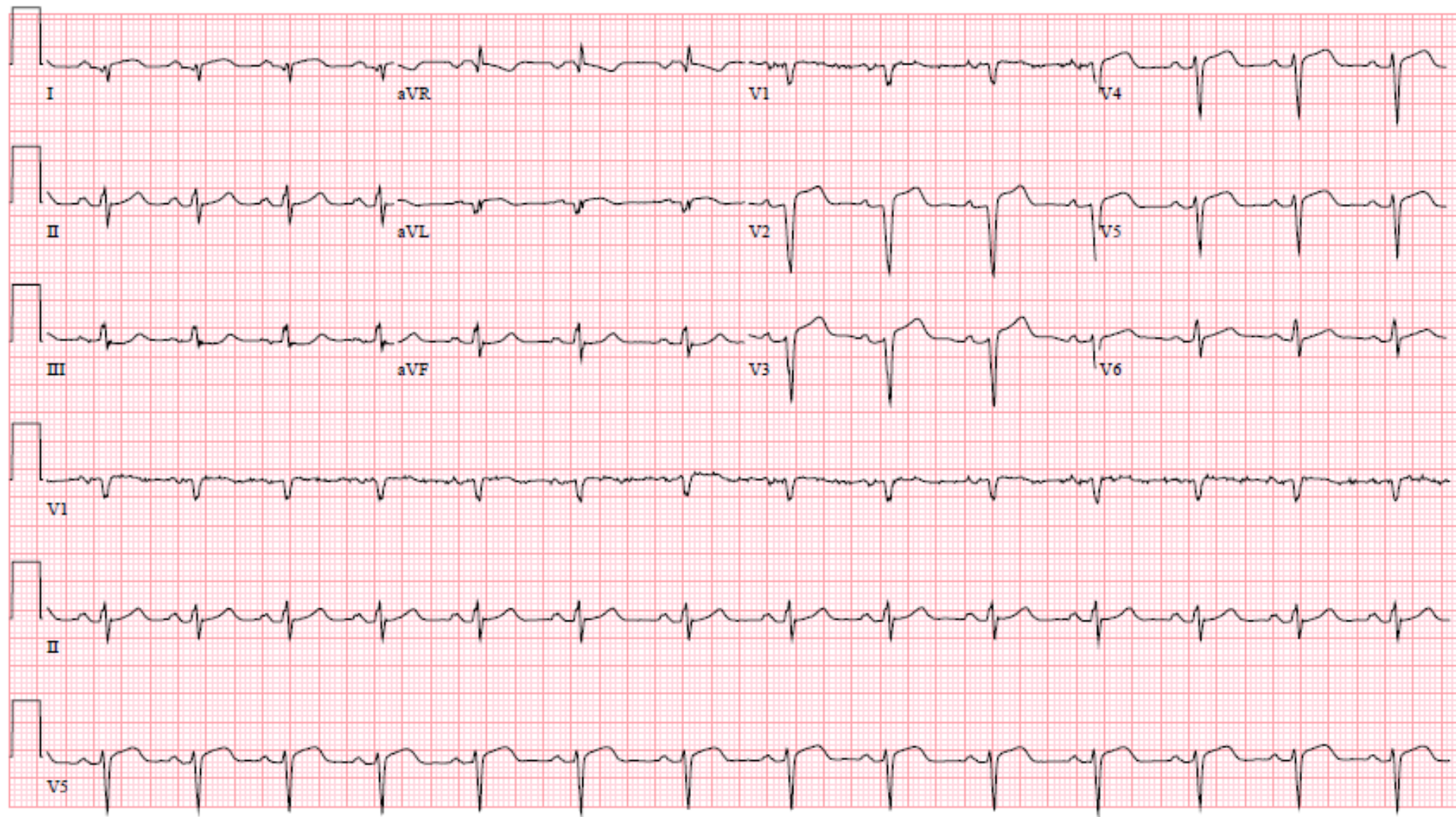
Leon Ptaszek, MD, PhD, FACC, FHRS  
MGH Cardiac Arrhythmia Service



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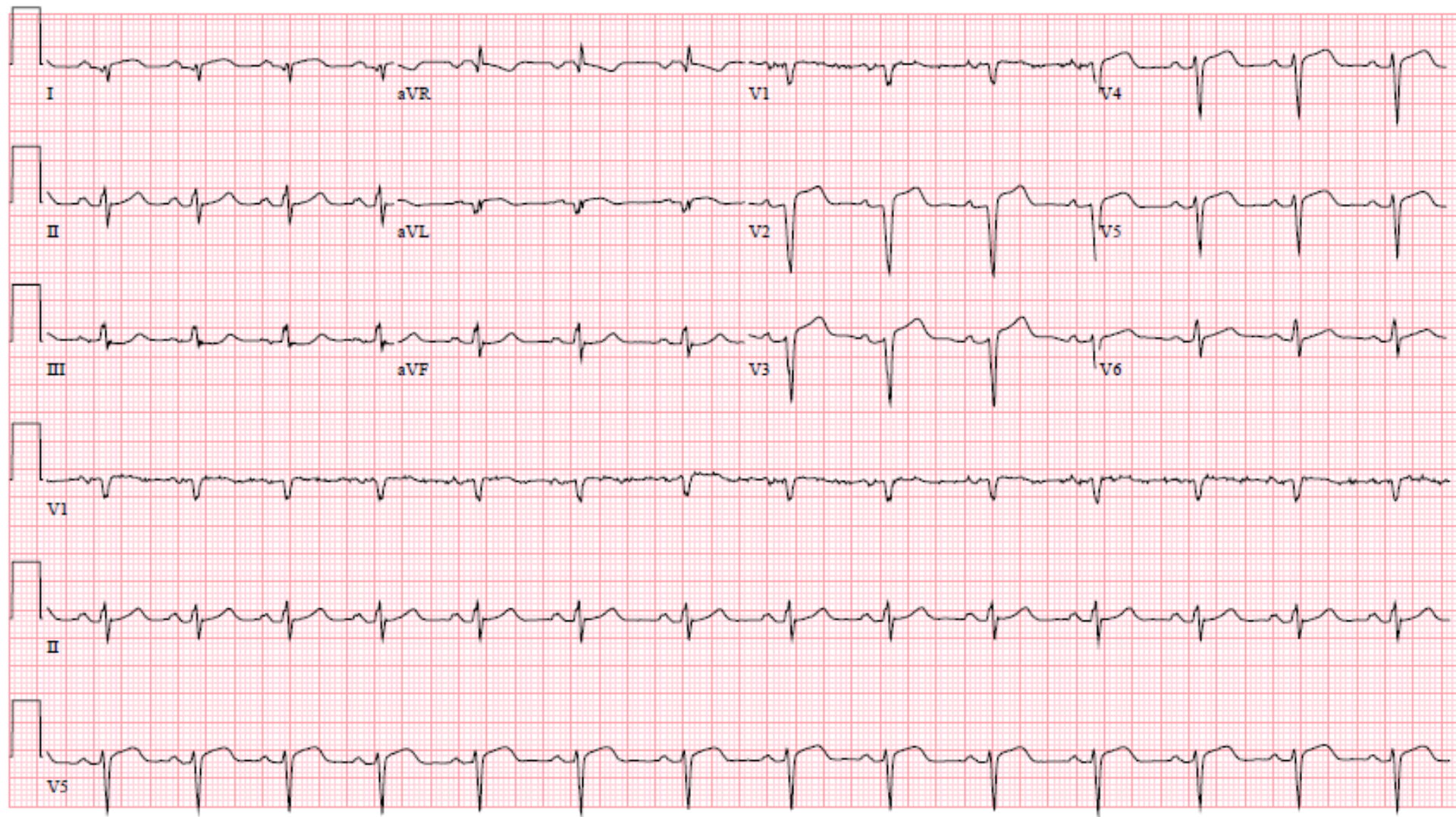
# ECG Review



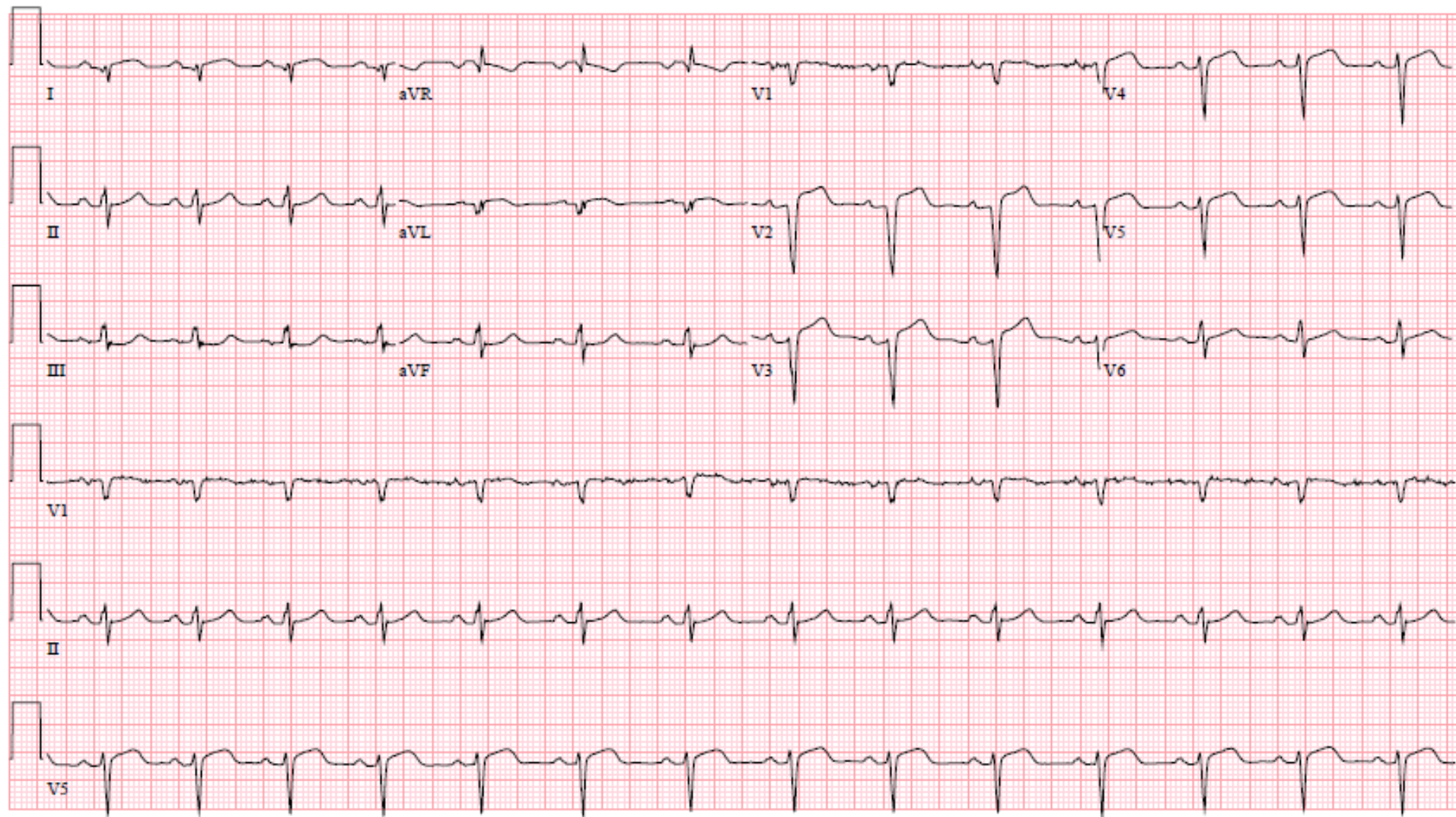
# Systematic Method for ECG Interpretation

- Rate
- Rhythm
- Axis
- Intervals
- QRS morphology
- P wave morphology
- ST segments and T waves

# ECG: Rate Calculation



# ECG: Rate Calculation



↑↑↑↑↑↑↑↑↑↑  
Start 300 150 100 75 60 50 43 38 30

Rate in bpm =  $300 / \# \text{ large squares}$

Rate in msec =  $60,000 / \text{bpm}$

# ECG: Rate Calculation

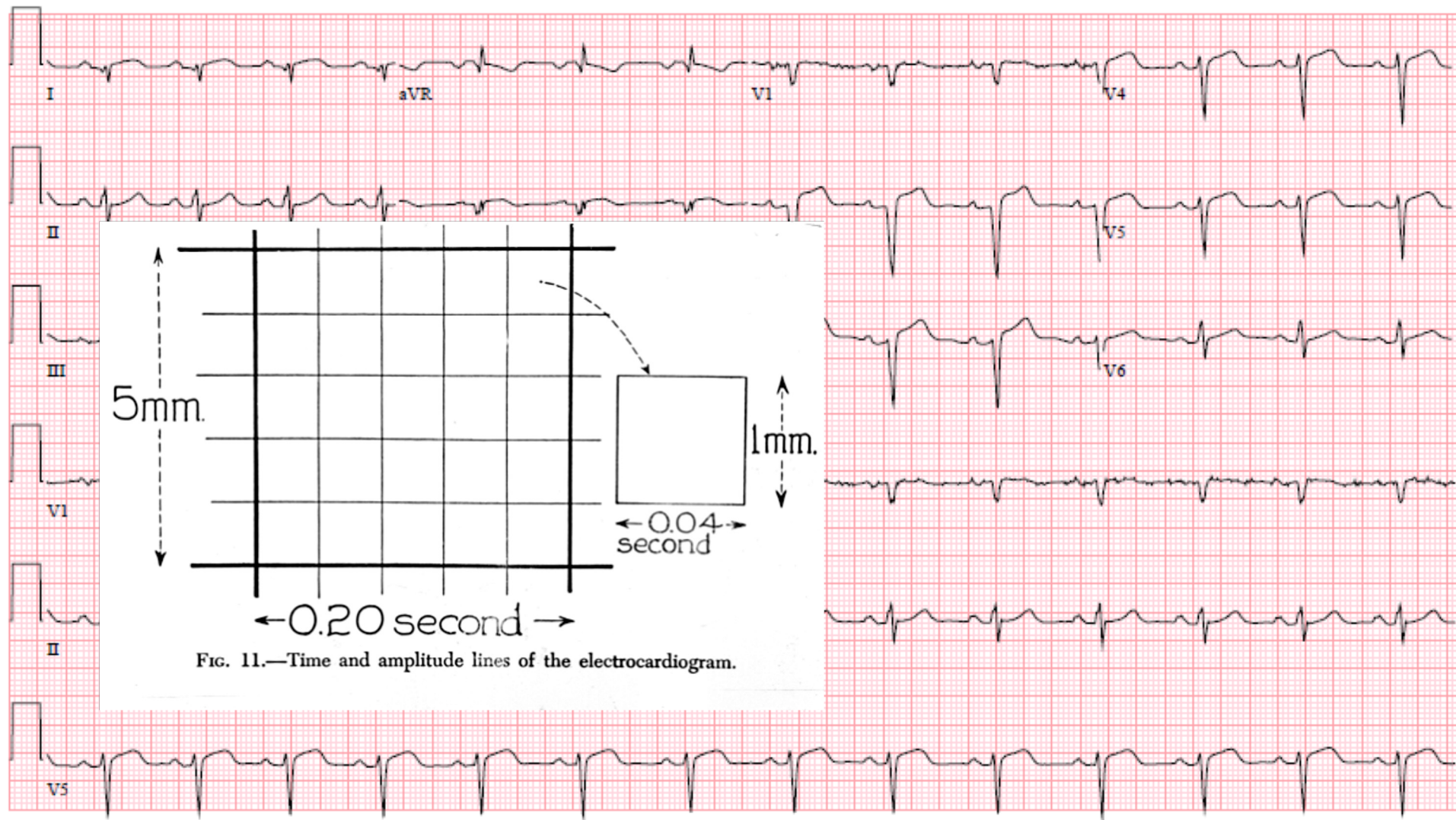
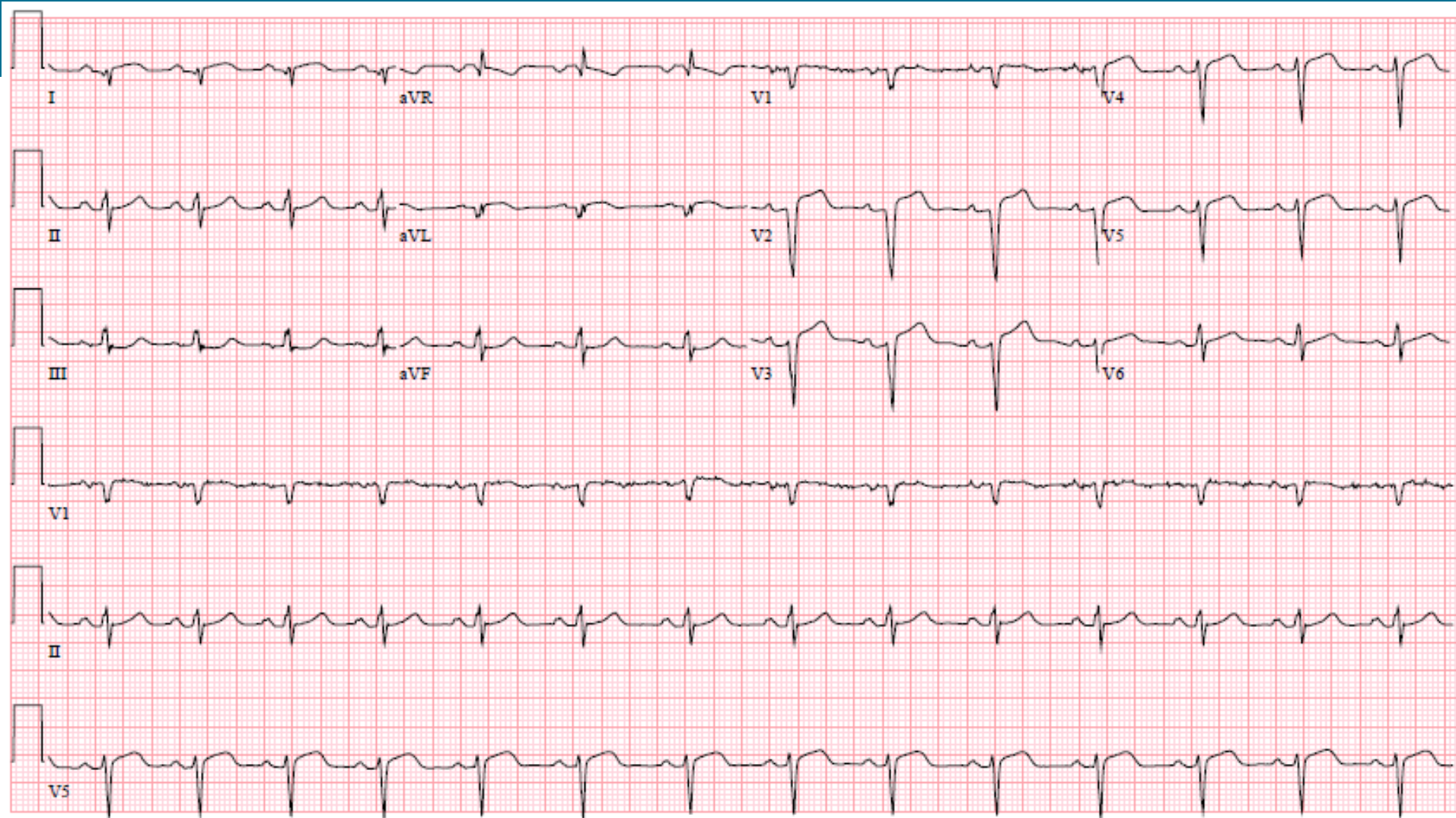


FIG. 11.—Time and amplitude lines of the electrocardiogram.

↑↑↑↑↑↑↑↑↑↑  
 Start 300 150 100 75 60 50 43 38 30

Rate in bpm =  $300 / \# \text{ large squares}$   
 Rate in msec =  $60,000 / \text{bpm}$

# ECG: Rhythm Assessment



**Is normal sinus rhythm present or not?**

Do you see a P wave?

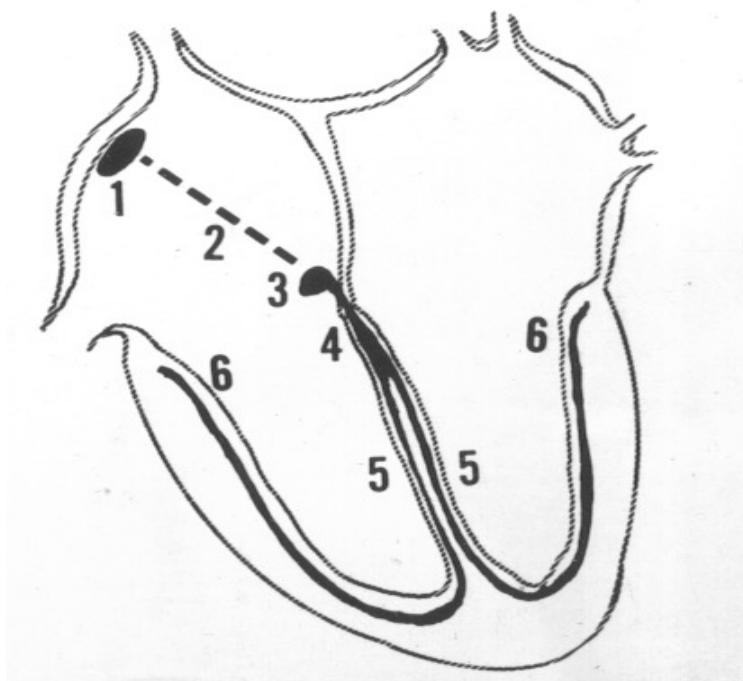
Does every P have a QRS and does every QRS have a P?



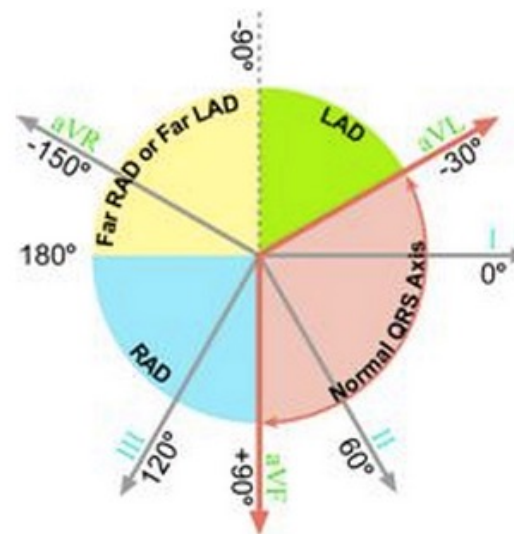
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# ECG: Axis Assessment



PM Yurchak

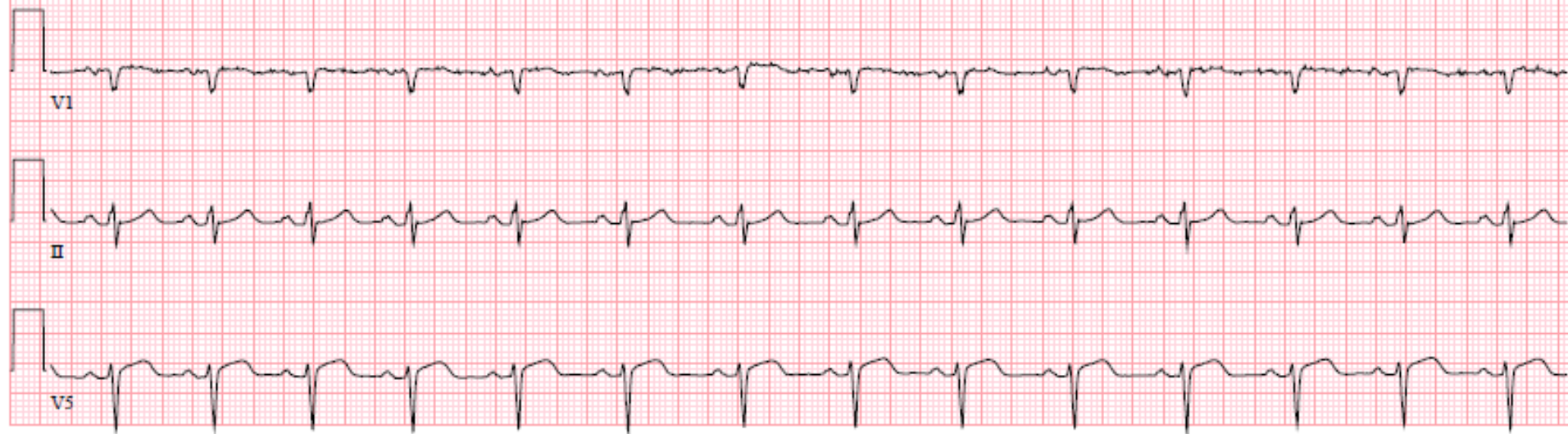
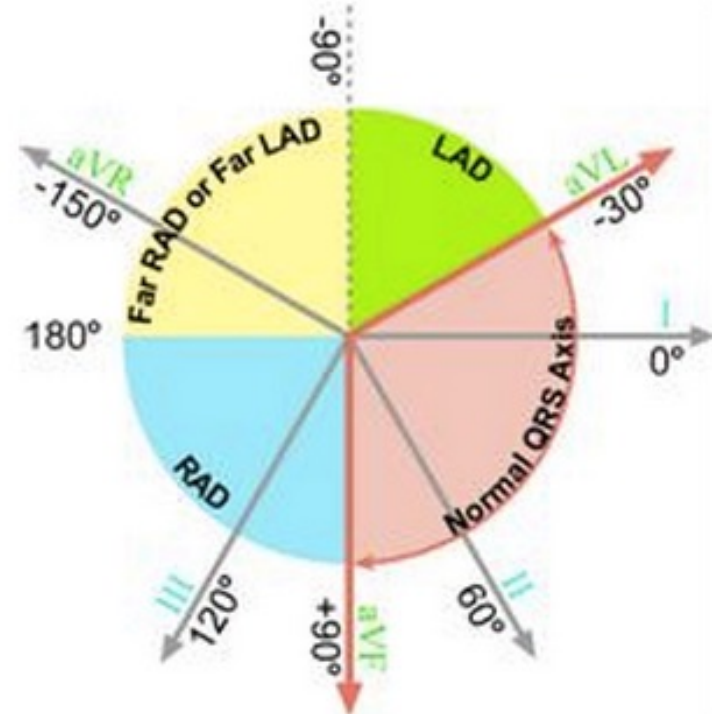
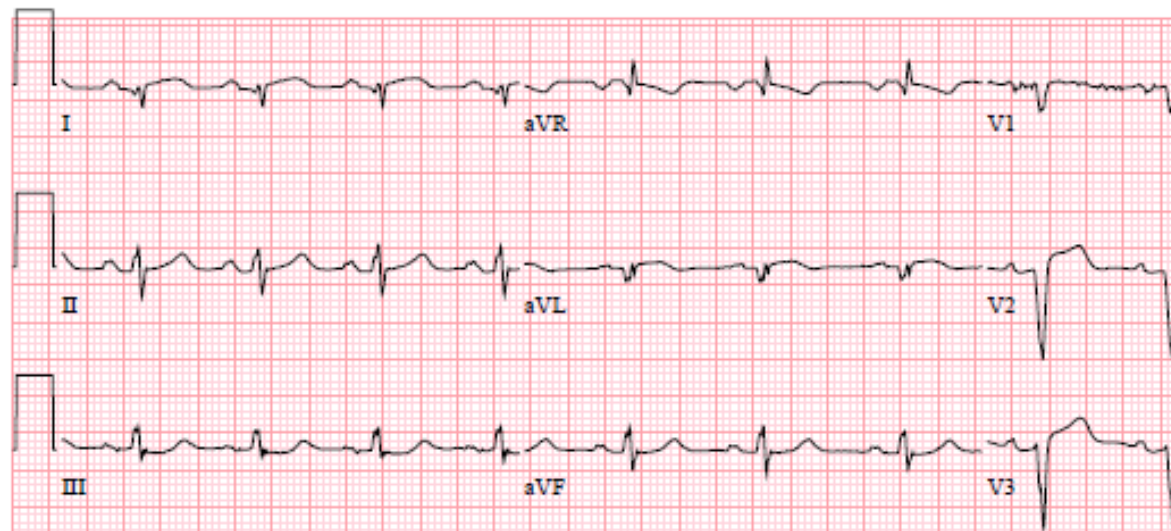


## Look at I and II:

- *If both (+):* normal axis
- *If (-) in I:* right axis deviation
- *If (-) in II:* left axis deviation

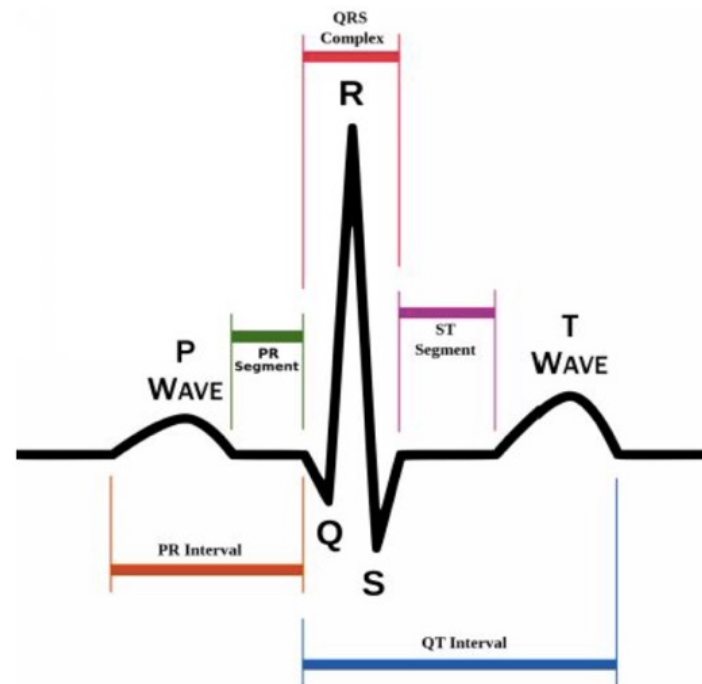


# ECG: Axis Assessment

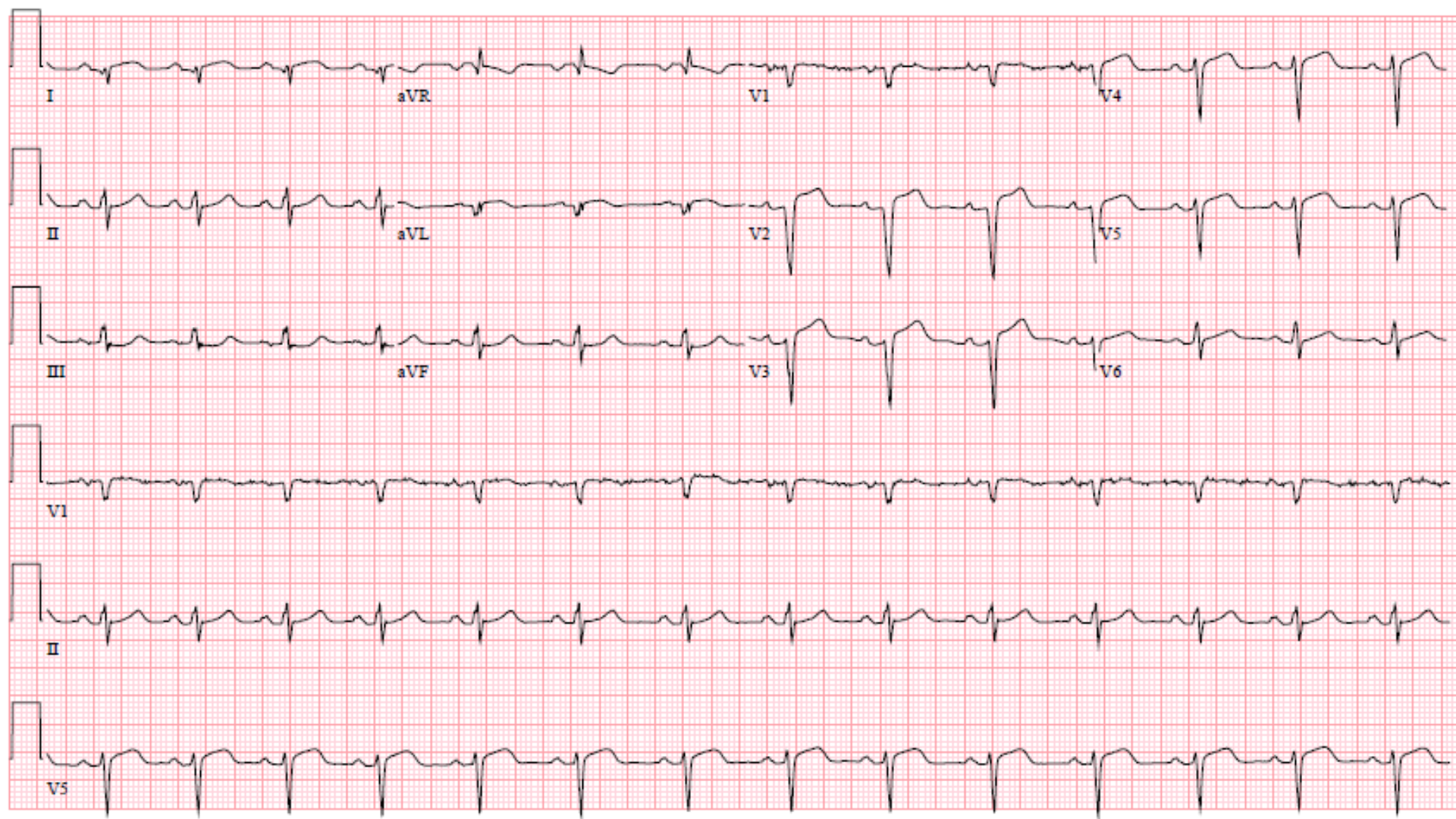


# ECG: Interval Measurement

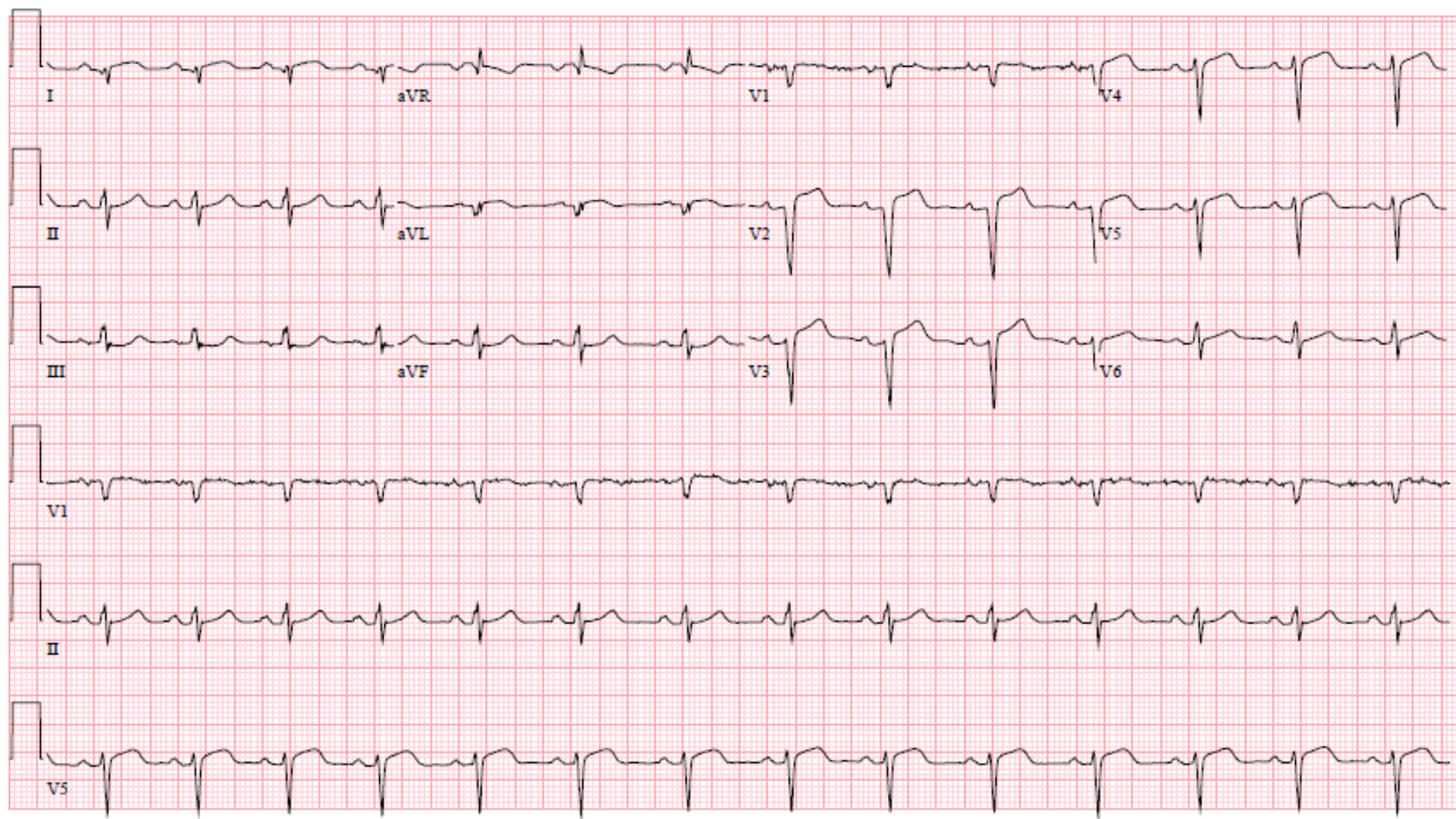
- **PR**
  - 0.12 to 0.2 seconds
  - $> 0.2$  = “1<sup>st</sup> degree AV Block”
- **QRS**
  - $< 0.12$  = normal
  - $> 0.12$  = “wide”
- **QT**
  - Ideally  $< 400 - 450$ msec
  - Shorter at faster HR



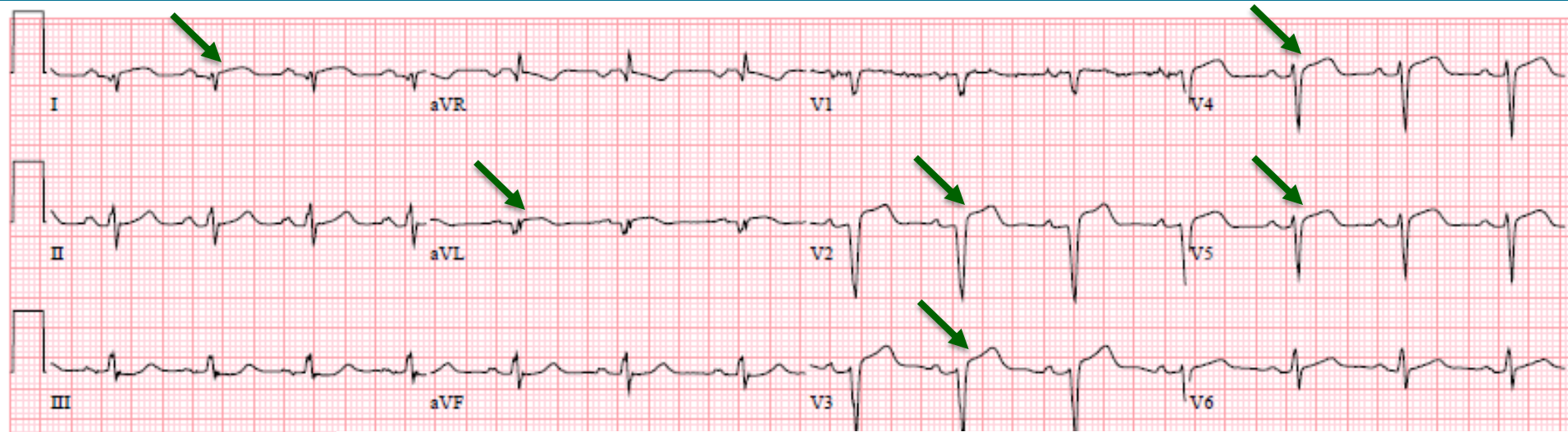
# ECG: Interval Measurement



# ECG: QRS/ST/T Wave Analysis



# ECG: QRS/ST/T Wave Analysis



## ESC/ACC/AHA/WHF Criteria:

ST Elevation:  $\geq 0.1\text{mV}$  (1mm) in two adjoining leads,

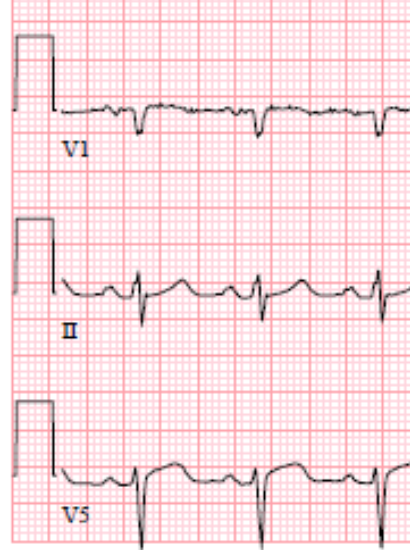
except V2, V3

In V2, V3:

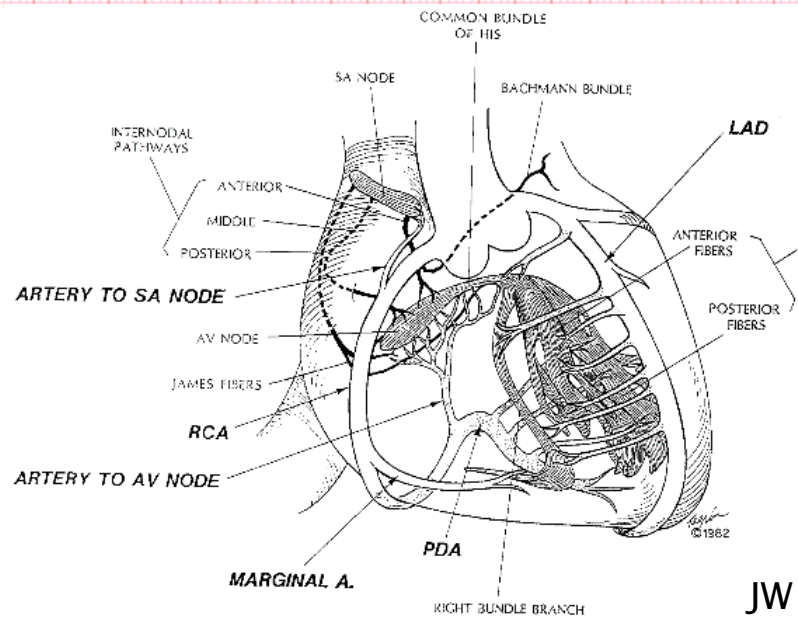
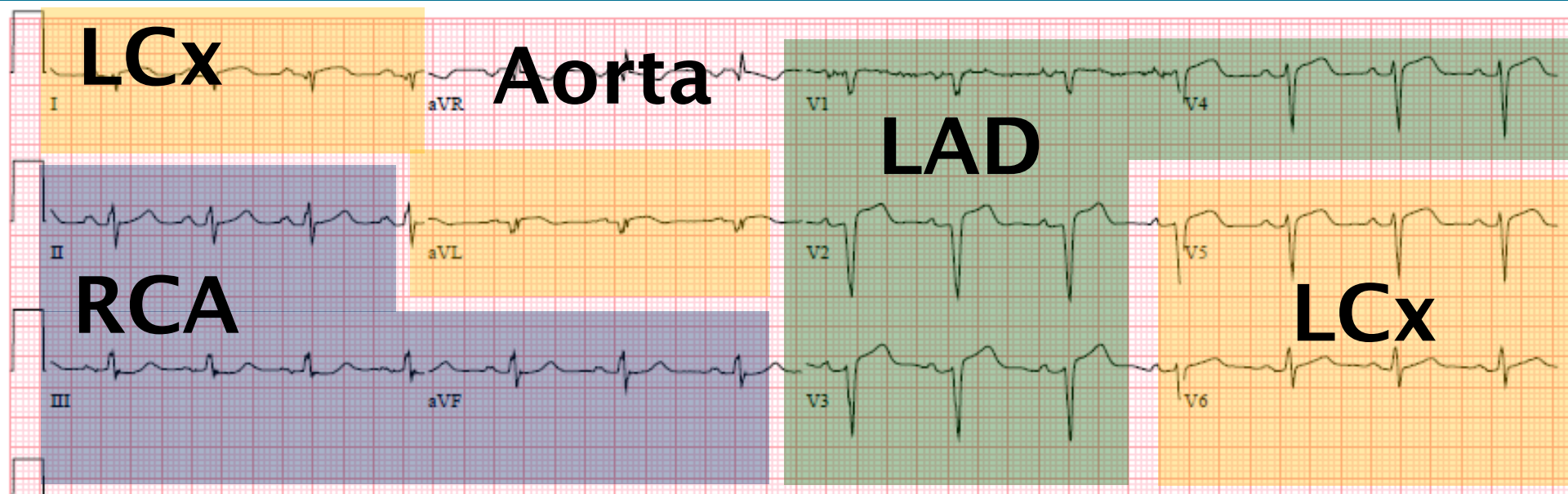
$\geq 1.5\text{mm}$  in women

$\geq 2\text{mm}$  in men  $\geq 40$  years

$\geq 2.5\text{mm}$  in men  $< 40$  years

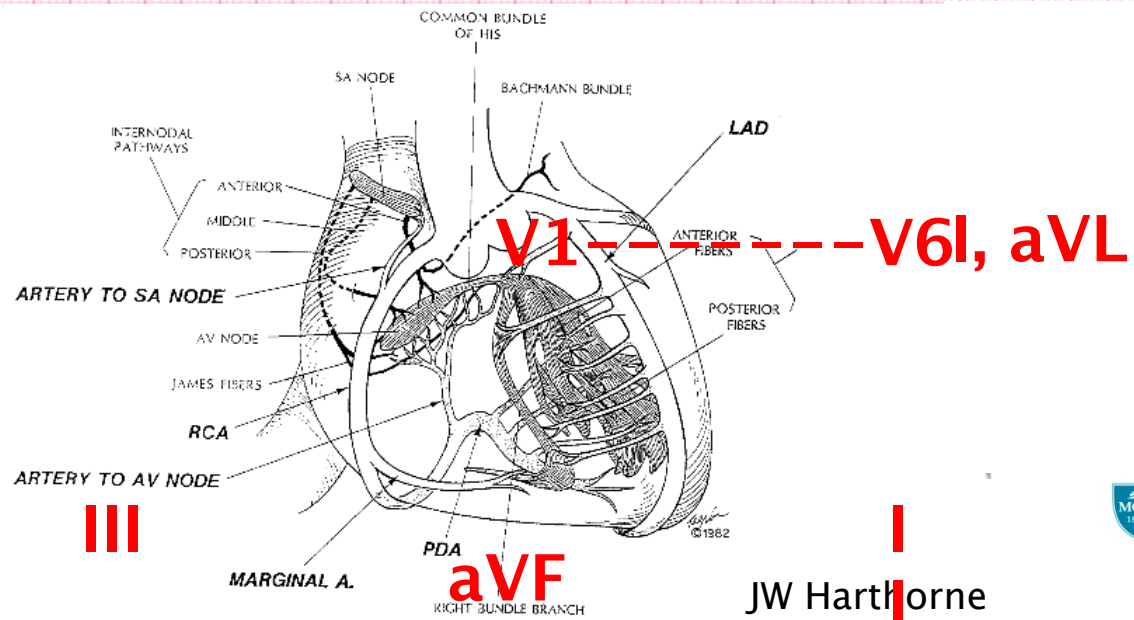
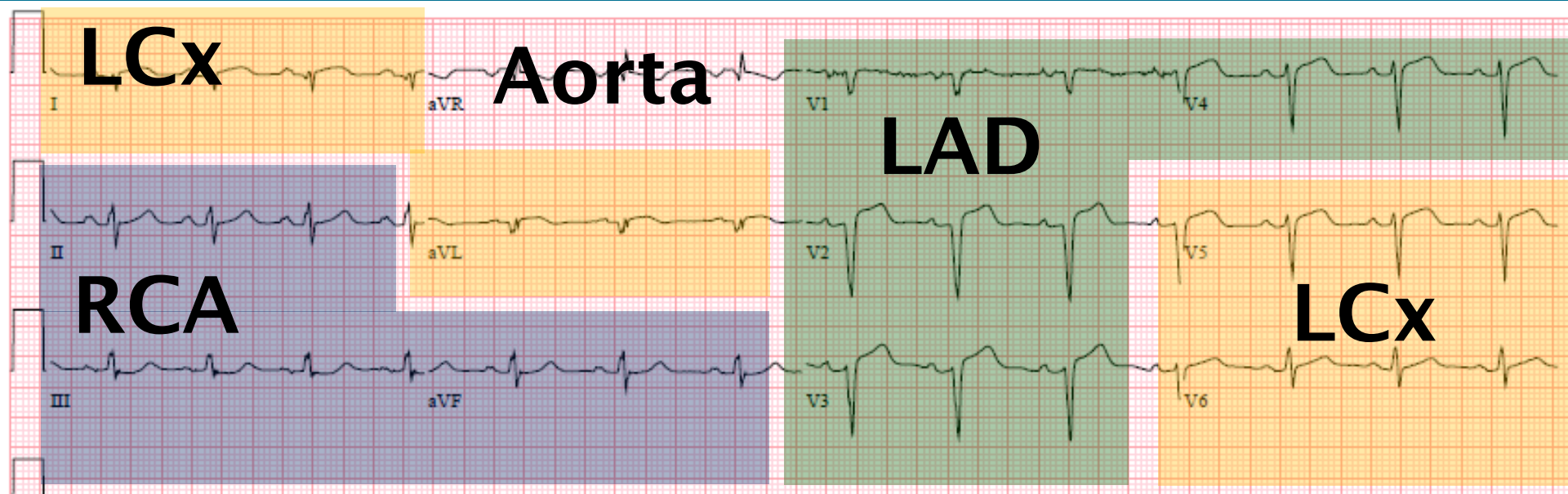


# ECG: QRS/ST/T Wave Analysis



JW Harthorne

# ECG: QRS/ST/T Wave Analysis



# All of the following are correct except:

- 1) In a 56-year-old woman presenting with progressive angina, ST elevation of 1.5mm in leads V2 and V3 meets criteria for ST elevation MI per ESC/AHA/ACC/WHF.
- 2) ST elevations of 1mm in leads II, III, and aVF in the appropriate clinical context are consistent with MI involving the right coronary artery.
- 3) In a 39-year-old man presenting with progressive angina, ST elevation of 2mm in leads V2 and V3 meets criteria for ST elevation MI per ESC/AHA/ACC/WHF.
- 4) ST elevations of 2.5mm in leads V2-V4 are consistent with MI involving the left anterior descending artery.



# All of the following are correct except:

- 1) In a 56-year-old woman presenting with progressive angina, ST elevation of 1.5mm in leads V2 and V3 meets criteria for ST elevation MI per ESC/AHA/ACC/WHF.
- 2) ST elevations of 1mm in leads II, III, and aVF in the appropriate clinical context are consistent with MI involving the right coronary artery.
- 3) In a 39-year-old man presenting with progressive angina, ST elevation of 2mm in leads V2 and V3 meets criteria for ST elevation MI per ESC/AHA/ACC/WHF.
- 4) ST elevations of 2.5mm in leads V2-V4 are consistent with MI involving the left anterior descending artery.



# ECG Learning Resources

**ECG Wave Maven:** <https://ecg.bidmc.harvard.edu>

**Excaliper:** <https://excaliper.com>

# Case Presentations: Objectives

- 1. Recognize the causes for chest pain*
- 2. Utilize a risk factor-based strategy to evaluate chest pain*
- 3. Identify patients who require tertiary care*

# Case Presentations: Objectives

- 1. Recognize the causes for chest pain***
- 2. Utilize a risk factor-based strategy to evaluate chest pain***
- 3. Identify patients who require tertiary care***

# Objective 1: Causes of Chest Pain

*Chest pain is the reason for 1% of primary care visits*

*Differential diagnosis for chest pain is very broad*

*Distinguishing between cardiac and non-cardiac pain is critical and time-sensitive*

# Objective 1: Causes of Chest Pain

*Differential diagnosis for chest pain is very broad*

<b>Musculoskeletal/chest wall</b>	<b>up to 50%</b>
<b>Esophageal/GI</b>	<b>up to 20%</b>
<b>Psychiatric</b>	<b>up to 10%</b>
<b>Angina</b>	<b>&lt;5%</b>

# Objective 1: Causes of Chest Pain

*Distinguishing between cardiac and non-cardiac pain is critical and time-sensitive*

**Finding the “needle in a haystack”**

**Evaluation needs to be rapid and efficient**

# Objective 1: Causes of Chest Pain

*Focus on high-yield items to quickly differentiate between cardiac and non-cardiac chest pain*

## **History:**

Presence of CAD/heart disease or risk factors

## **Physical:**

Evidence of heart failure or hypoxemia

## **Studies:**

Abnormal ECG or positive cardiac biomarkers



# Objectives

- 1. Recognize the causes for chest pain*
- 2. Utilize a risk factor-based strategy to evaluate chest pain*
- 3. Identify patients who require tertiary care*

# Objective 2: Use of Risk Factors

## *Case 1: 24-year-old man with chest pain*

HPI: Constant chest discomfort for two days. Not related to exertion.

PMH: Anxiety/depression

Exam: T 98 BP 110/70 HR 90 RR 12

JVP normal

Lungs clear

Heart sounds normal

Abdomen benign

No lower extremity edema

# Objective 2: Use of Risk Factors

## *Case 1: 24-year-old man with chest pain*

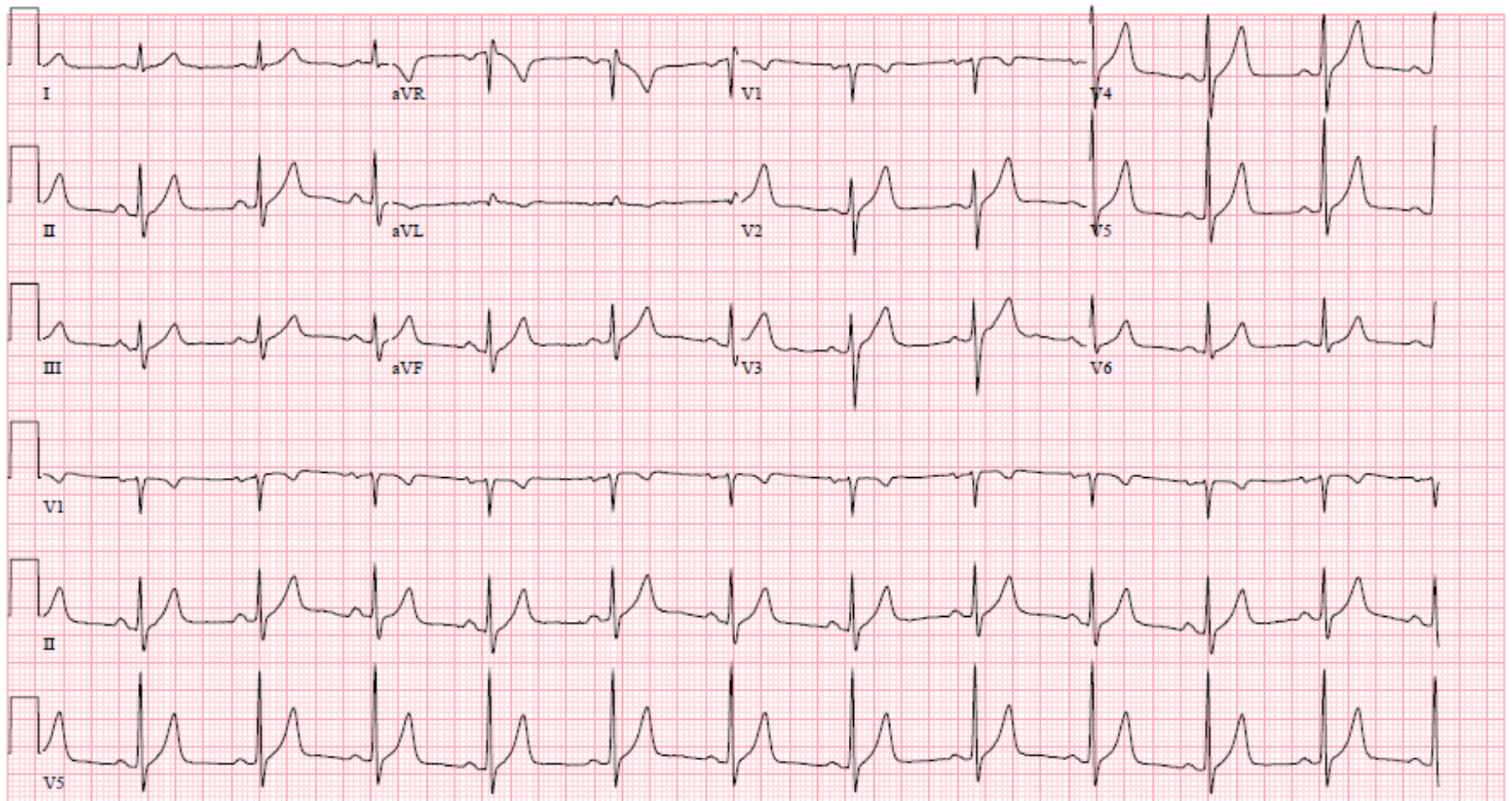
What findings are consistent with a cardiac etiology?

What findings are consistent with a non-cardiac etiology?

What tests do I need to perform in order to confirm?

# Objective 2: Use of Risk Factors

## *Case 1: 24-year-old man with chest pain*



# Objective 2: Use of Risk Factors

## *Case 1: 24-year-old man with chest pain*

History, exam, and ECG are reassuring.

What further evaluations could I perform in order to confirm my suspicion that this patient's chest pain is non-cardiac?

Physical exam / Labs / Other studies

# Objective 2: Use of Risk Factors

## *Case 1: 24-year-old man with chest pain*

What further evaluations could I perform in order to confirm my suspicion that this patient's chest pain is non-cardiac?

Physical exam / Labs / Other studies

Palpate chest wall to determine if point tenderness is present

# Objective 2: Use of Risk Factors

## ***Case 2: 44-year-old man with chest pain***

HPI: Intermittent exertional chest discomfort that is palliated by rest. Symptoms present for 2 days, progressive.

PMH: HTN, pre-diabetes

FamH: Early-onset CAD in father

Exam: T 98 BP 110/70 HR 90 RR 12

JVP elevated

Lungs clear

Heart sounds normal

Abdomen benign

No lower extremity edema



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# Objective 2: Use of Risk Factors

## *Case 2: 44-year-old man with chest pain*

What findings are consistent with a cardiac etiology?

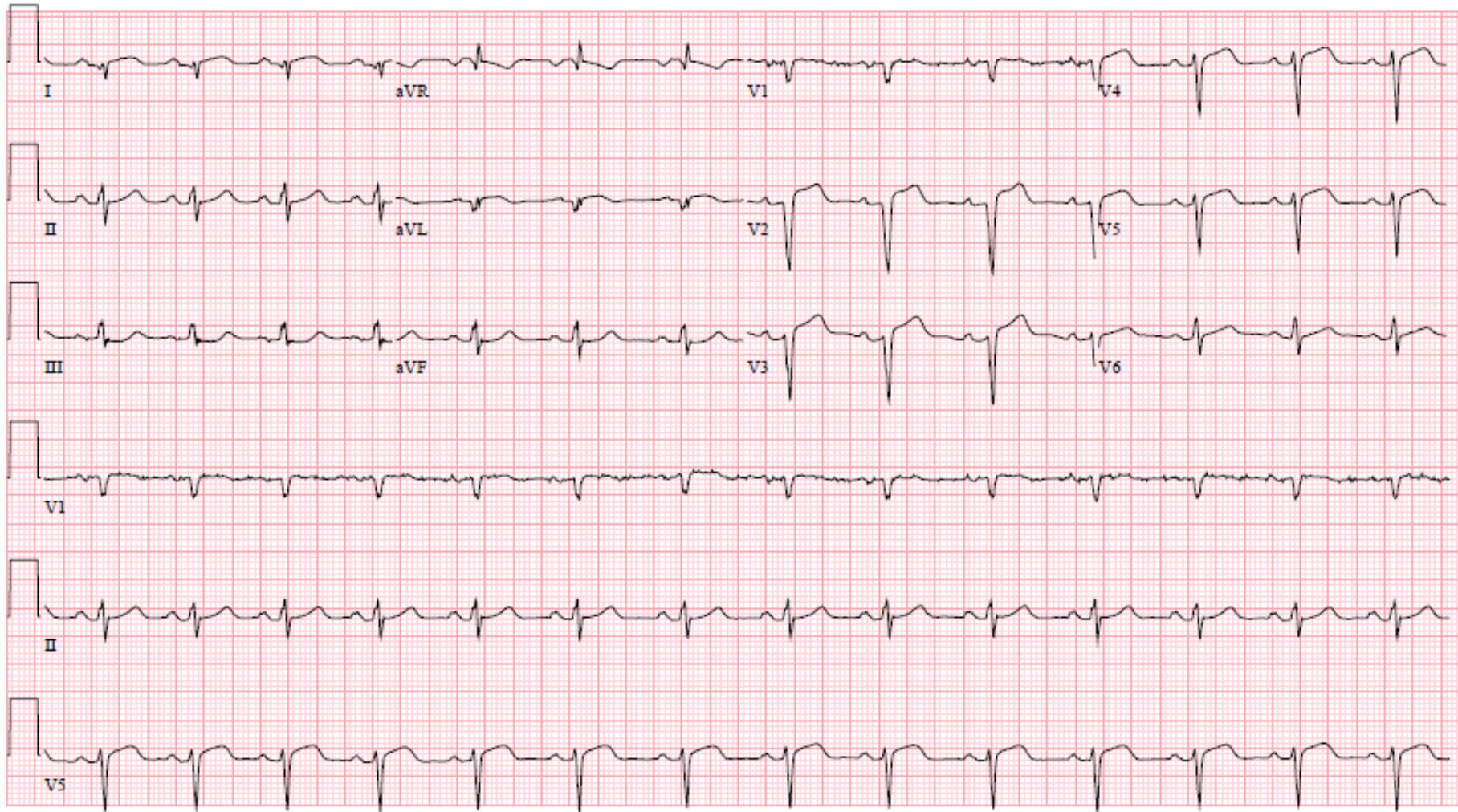
What findings are consistent with a non-cardiac etiology?

What tests do I need to perform in order to confirm?



# Objective 2: Use of Risk Factors

## *Case 2: 44-year-old man with chest pain*



# Objective 2: Use of Risk Factors

## *Case 2: 44-year-old man with chest pain*

Presentation consistent with STEMI – now what?

- Arrange for immediate transport to tertiary care center
- Oxygen
- Aspirin 325mg
- Sublingual NTG (depending on BP)
- Blood draw for cardiac biomarkers

# Objective 2: Use of Risk Factors

## *Case 3: 62-year-old woman with chest pain*

HPI: Progressive chest heaviness for 5 days, not sure if it is worse with exertion.

PMH: Known CAD with prior MI, HTN, DM, Obesity

Exam: T 98 BP 110/70 HR 90 RR 18

JVP not elevated

Lungs clear

Heart sounds normal

Abdomen benign

No lower extremity edema



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# Objective 2: Use of Risk Factors

## *Case 3: 62-year-old woman with chest pain*

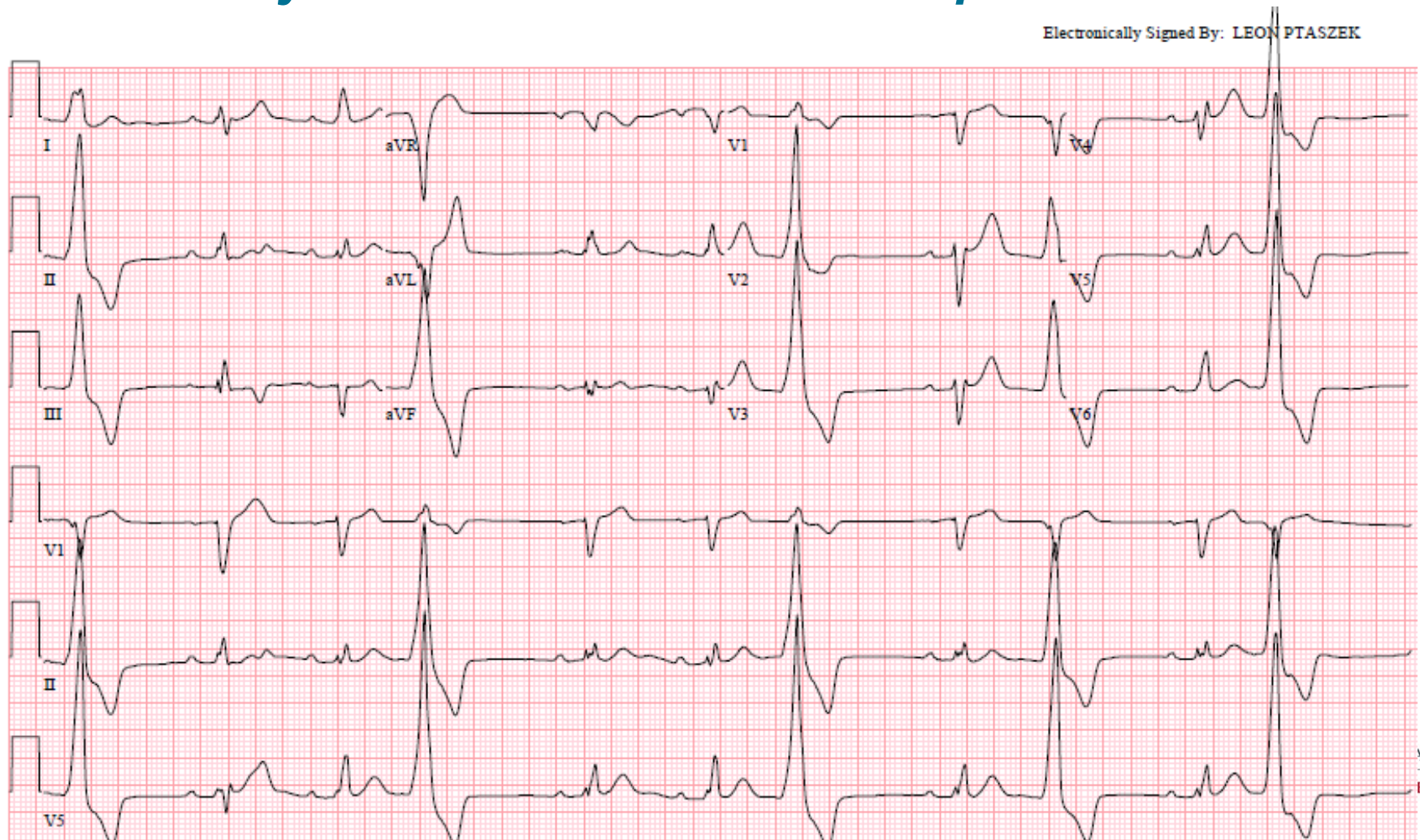
What findings are consistent with a cardiac etiology?

What findings are consistent with a non-cardiac etiology?

What tests do I need to perform in order to confirm?

# Objective 2: Use of Risk Factors

## Case 3: 62-year-old woman with chest pain



# Objective 2: Use of Risk Factors

## *Case 3: 62-year-old woman with chest pain*

What further evaluations could I perform in order to confirm my suspicion that this patient's chest pain is non-cardiac?

Physical exam / Labs / Other studies

# Objective 2: Use of Risk Factors

## *Case 3: 62-year-old woman with chest pain*

HPI: Progressive chest heaviness for 5 days, not sure if it is worse with exertion. **Sprained ankle, sedentary for 2 weeks.**

PMH: Known CAD with prior MI, HTN, DM, Obesity

Exam: T 98 BP 110/70 HR 90 RR 18 **O2 sat: 88% on RA**

JVP not elevated

Lungs clear

Heart sounds normal

Abdomen benign

No lower extremity edema **but pain and palpable cord in left calf**



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# Objective 2: Use of Risk Factors

## *Case 3: 62-year-old woman with chest pain*

Presentation possibly consistent with PE – now what?

- Arrange for immediate transport to ED
- Oxygen
- Consideration for heparin IV



# Objectives

- 1. Recognize the causes for chest pain*
- 2. Utilize a risk factor-based strategy to evaluate chest pain*
- 3. Identify patients who require tertiary care*

# Objective 3: Tertiary Care Referral

*Tertiary care needs to be considered for any patient with chest pain in whom a cardiac and/or pulmonary etiology is suspected*

- **History**
- **Physical**
- **Diagnostic Studies**

# Objective 3: Tertiary Care Referral

*Tertiary care needs to be considered for any patient with chest pain in whom a cardiac and/or pulmonary etiology is suspected*

## **History:**

- Strong family history of heart disease
- Known history of CAD in patient
- Risk factors (e.g., HTN, DM) in patient
- Substance abuse

# Objective 3: Tertiary Care Referral

*Tertiary care needs to be considered for any patient with chest pain in whom a cardiac and/or pulmonary etiology is suspected*

## History:

- Strong family history of heart disease
- Known history of CAD in patient
- Risk factors (e.g., HTN, DM) in patient
- Substance abuse

**Be mindful of undertreatment of heart disease in women!**

# Objective 3: Tertiary Care Referral

*Tertiary care needs to be considered for any patient with chest pain in whom a cardiac and/or pulmonary etiology is suspected*

## Physical:

- Hypoxemia
- Hypotension
- Tachycardia
- Exam consistent with decompensated heart failure
- Unremitting chest discomfort

# Objective 3: Tertiary Care Referral

*Tertiary care needs to be considered for any patient with chest pain in whom a cardiac and/or pulmonary etiology is suspected*

## Diagnostic studies:

- 12-lead ECG
- Bedside Ultrasound
- Blood work (cardiac biomarkers)

# Objectives

- 1. Recognize the causes for chest pain*
- 2. Utilize a risk factor-based strategy to evaluate chest pain*
- 3. Identify patients who require tertiary care*

# Thank you

Dena Thomas

David Stephens

Ashley Day

Nicholas Cushman

Matt Tobey



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