Brigham and Women's Hospital
Founding Member, Mass General Brigham

Can't-Miss ECG Cases for Hospitalists

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Division of Cardiovascular Medicine
Brigham and Women's Hospital

Assistant Professor of Medicine
Harvard Medical School

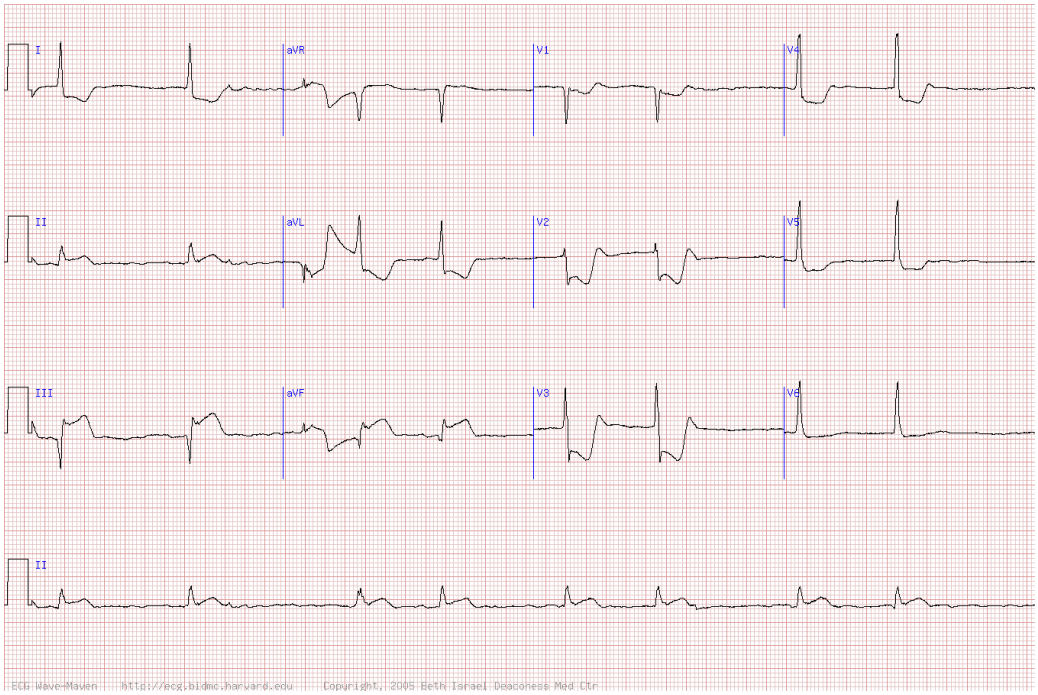
Disclosures

- None

Case 1

A 67-year-old woman with a history of CAD s/p CABG presents after the development of acute chest pressure and lightheadedness. On presentation to the emergency room, her HR is 50 bpm and her blood pressure is 84/57 mmHg. Her extremities are cool. An ECG is obtained. What is the most important finding?

1. Anterior Non-ST-elevation MI
2. Anterior ST-elevation MI
3. Inferior ST-elevation MI
4. Inferior-Posterior ST-elevation MI



Nathanson LA et al. http://ecg.bidmc.harvard.edu.

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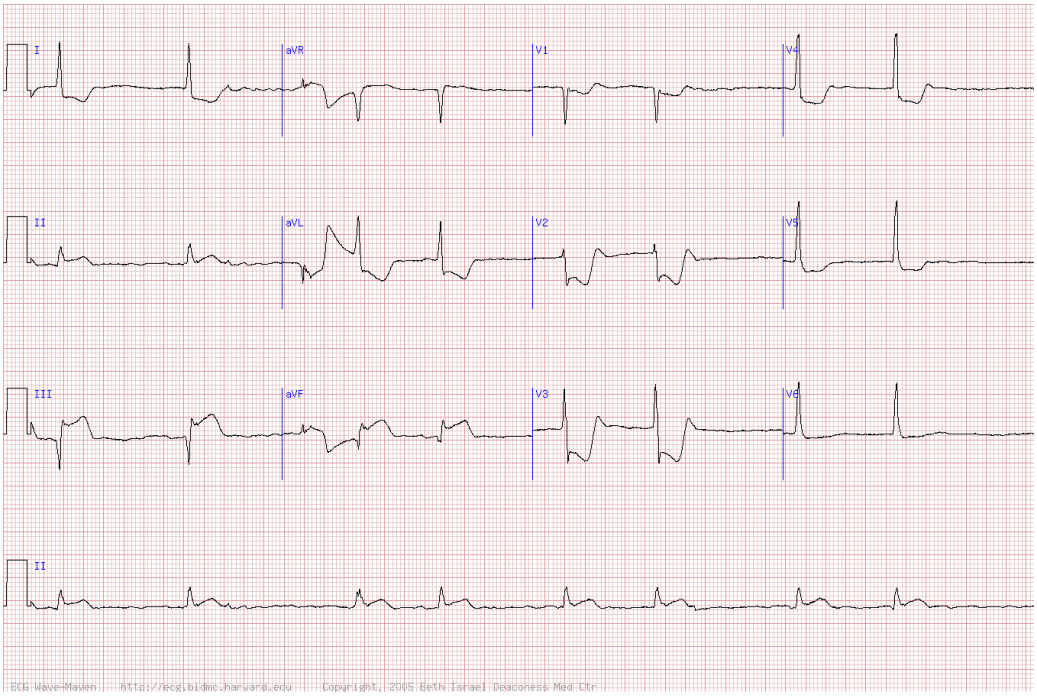
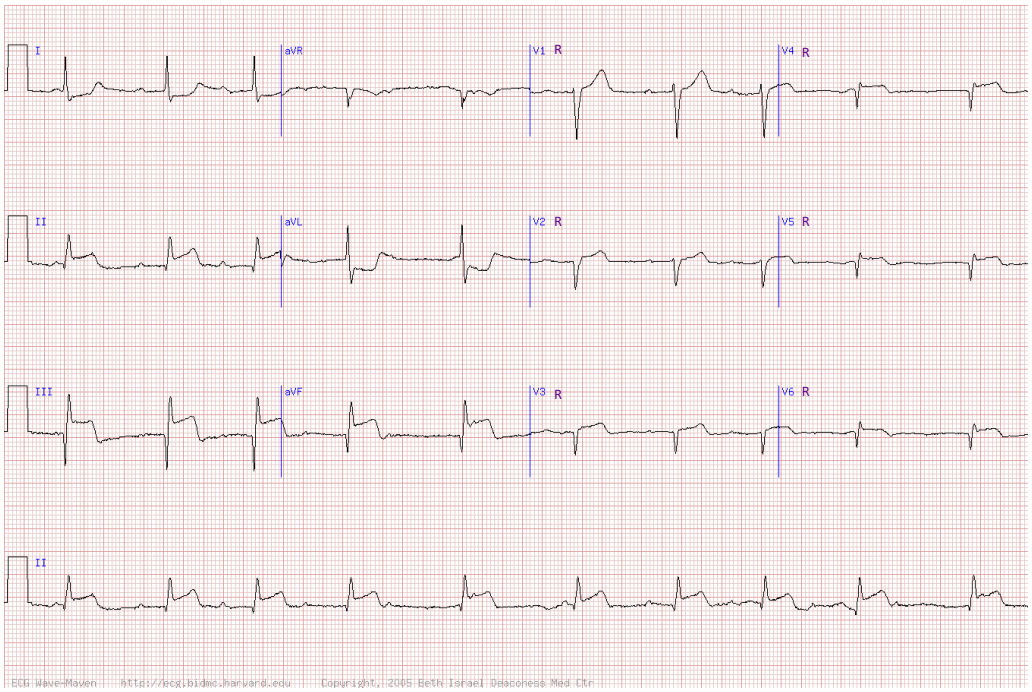


Nathanson LA et al. http://ecg.bidmc.harvard.edu.

Case 2

A 60-year-old female presents with nausea, epigastric discomfort, and chest pressure that started about 45 minutes ago. An ECG is obtained. Administering which of the following medications should be avoided in the emergency room?

1. Aspirin
2. Heparin
3. Morphine
4. Nitroglycerin



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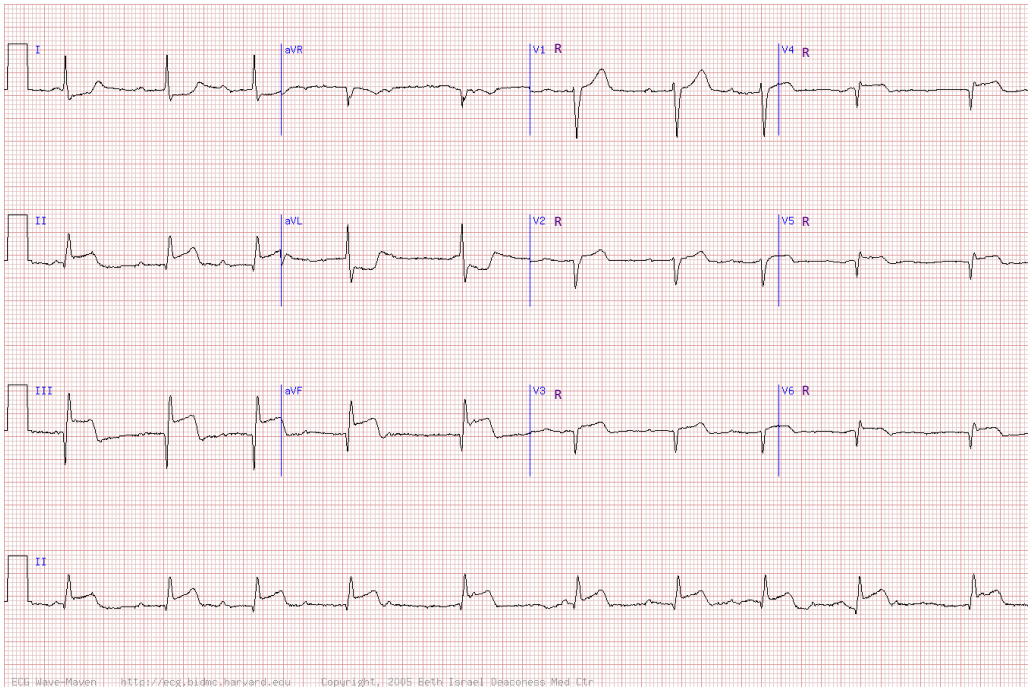


Nathanson LA et al. http://ecg.bidmc.harvard.edu.

TABLE I Association Between Location of Culprit Lesion and Presence of ST-Segment Ratio in Leads III and II of >1 and ST-Segment Elevation in V_1

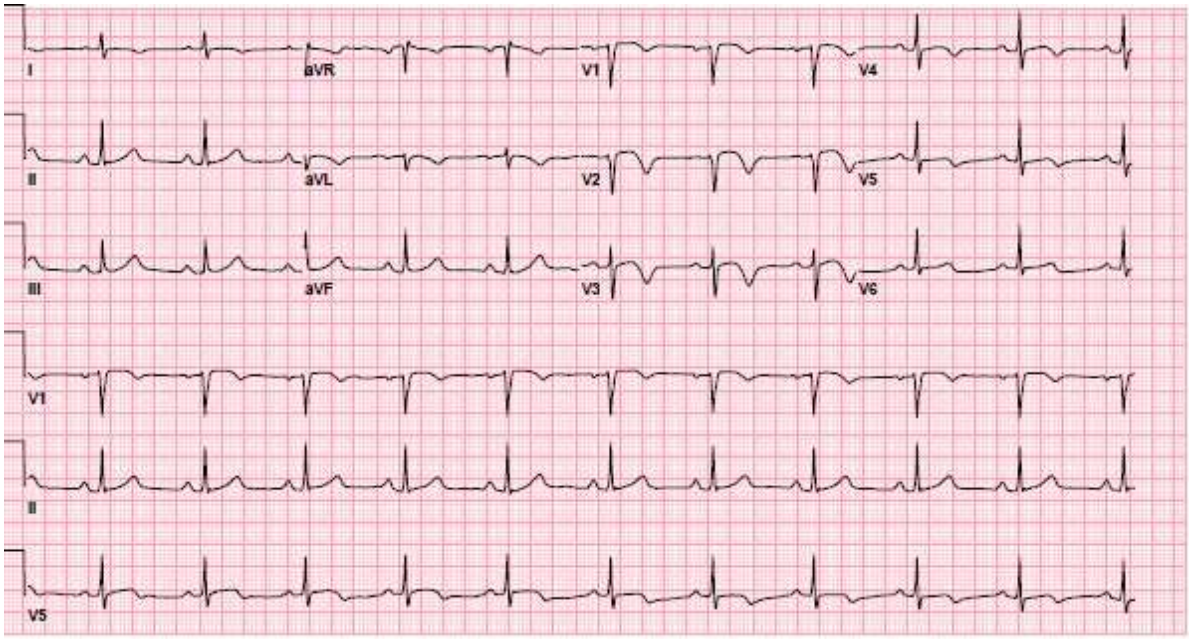
Culprit Lesion (n)	ST III >II (n) (%)	ST Elevated in V_1 + ST III >II	RV AMI
Proximal RCA (19)	17 (89%)	5	6
Mid RCA (25)	20 (80%)	0	4
Distal RCA (8)	1 (12.5%)	0	0
Left circumflex (17)	0	0	0

Zimetbaum PJ et al. Am J Cardiol. 1998 Apr 1;81(7):918-9

Case 3

A 71-year-old man with a history of hypertension, dyslipidemia, and former tobacco use presents to the emergency department with two weeks of chest pressure associated with exertion. He has never had these symptoms before. He currently has no chest pressure. An ECG is obtained. His exam is unremarkable and high-sensitivity troponin (hs-Tn) is < 6 ng/dL. After evaluation, a decision is made to perform coronary angiography. Which of the following would you expect to see?

1. Non-obstructive coronary artery disease
2. Proximal right coronary artery stenosis
3. Proximal left anterior descending artery stenosis
4. Proximal left circumflex coronary artery stenosis



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Regan E. StatPearls Publishing LLC. 2019.

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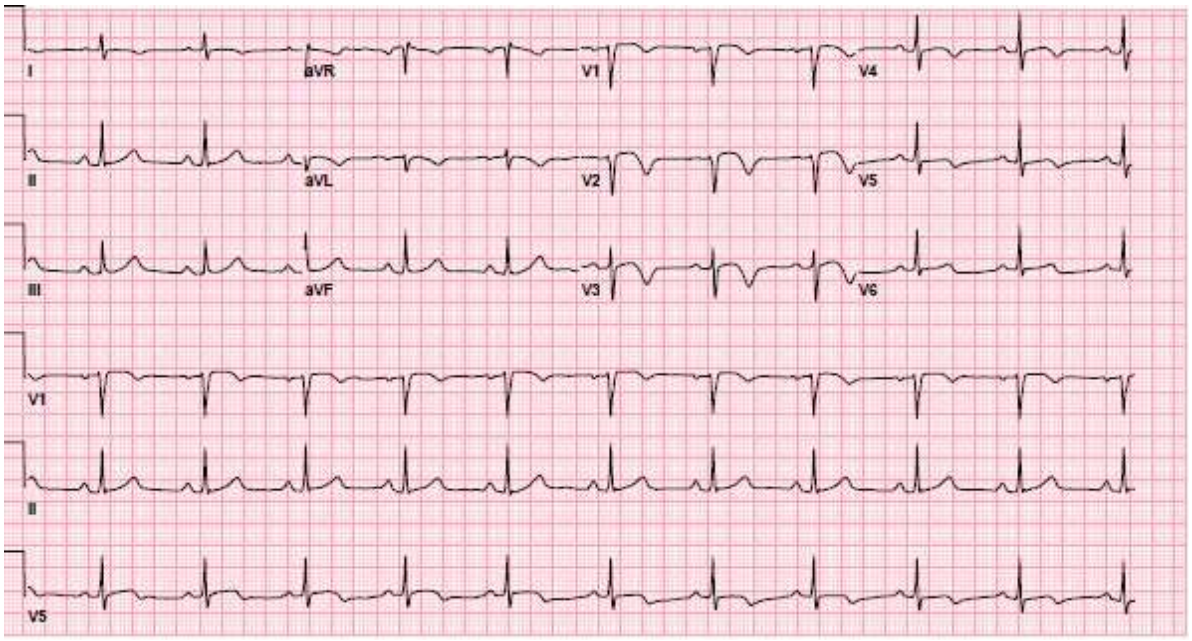
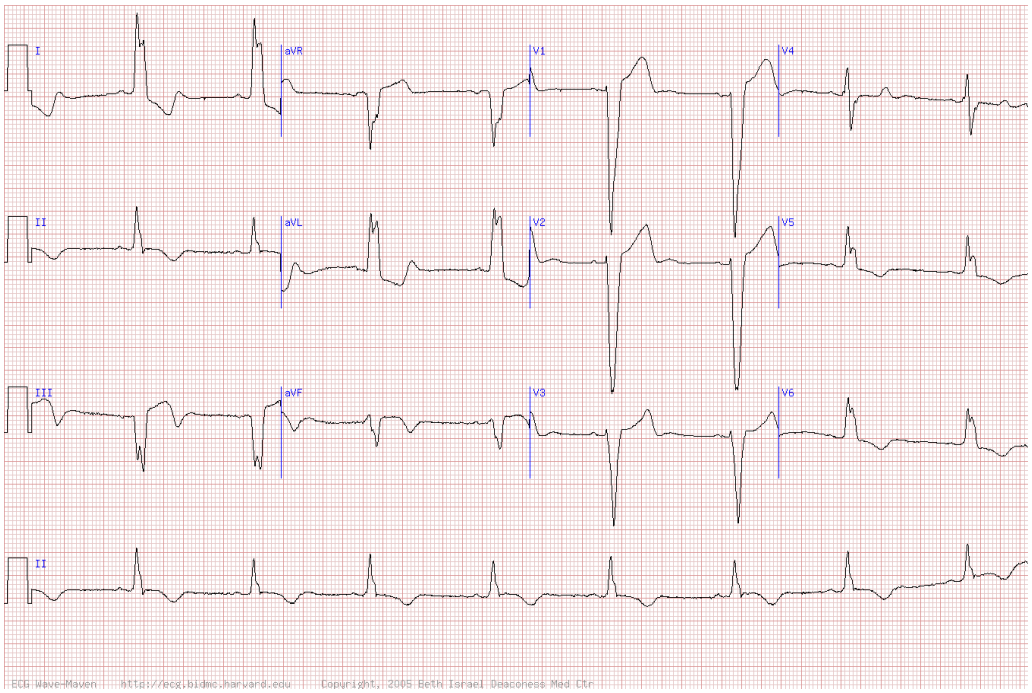


Case 4

An 82-year-old female with hypertension, diabetes, and known left bundle branch block is brought into the emergency room by her daughter due shortness of breath at rest. An ECG is obtained. Which myocardial territory is abnormal on this ECG?

1. Anterior
2. Posterior
3. Inferior
4. Lateral



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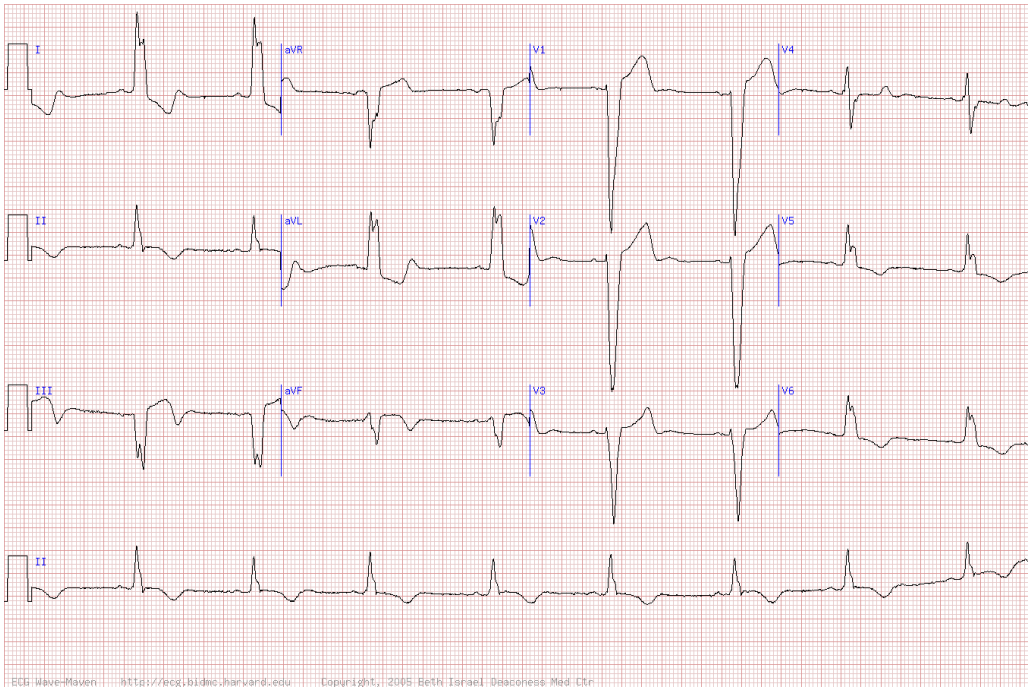

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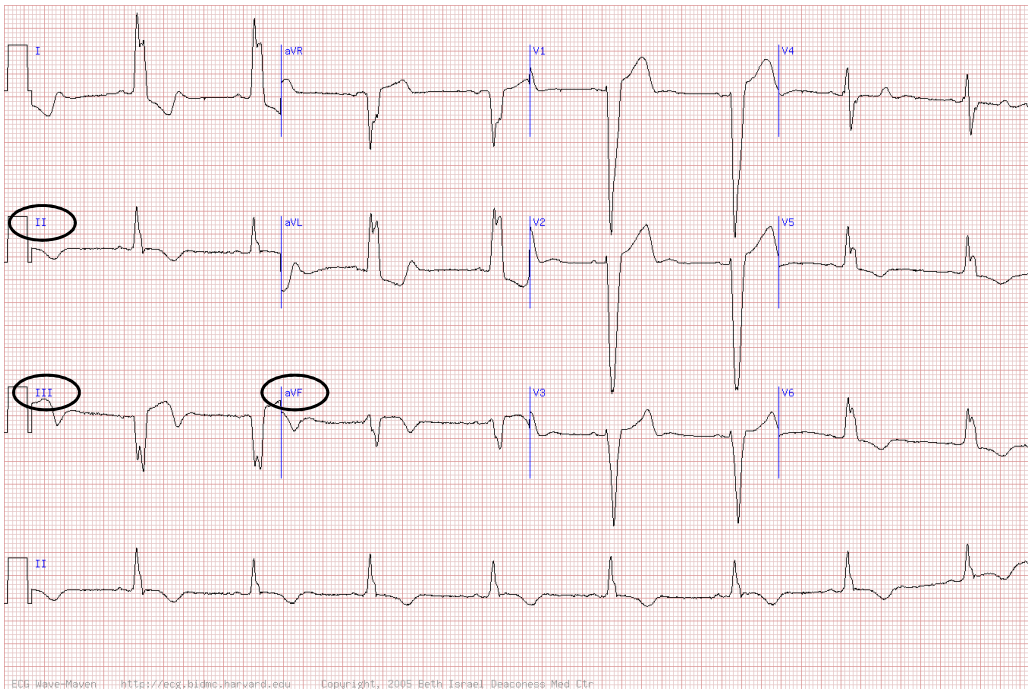

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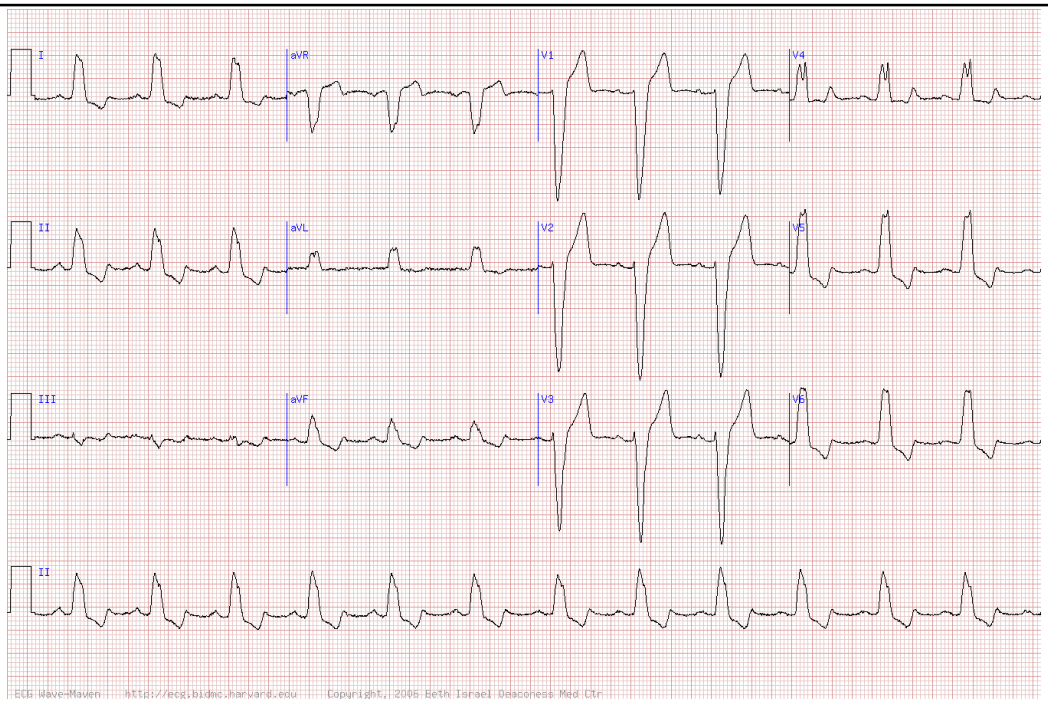

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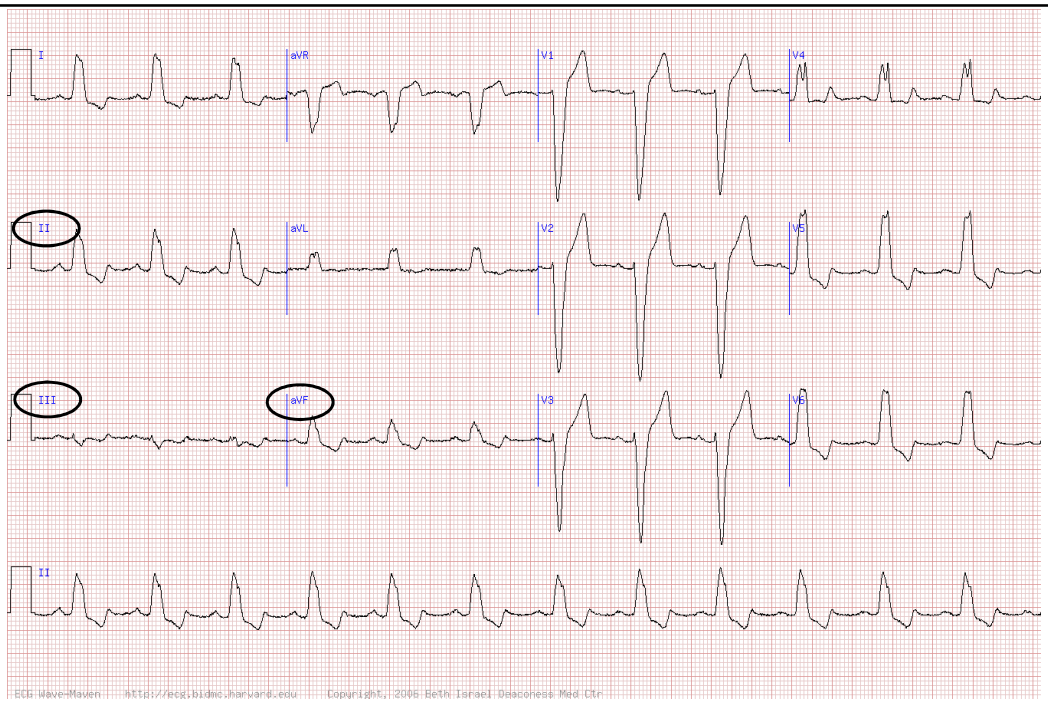

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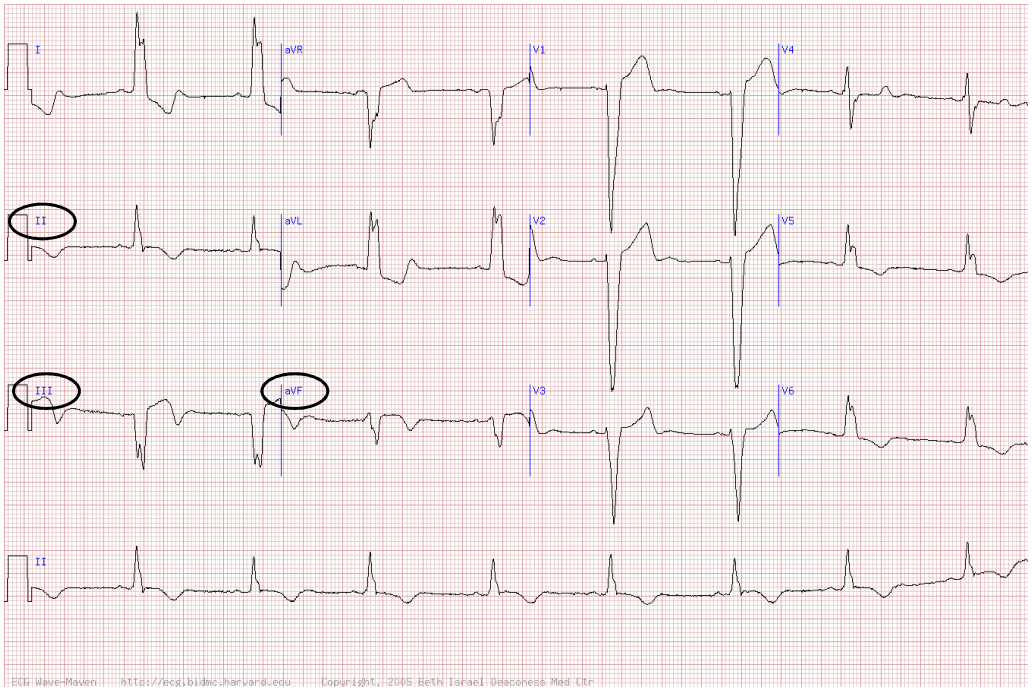

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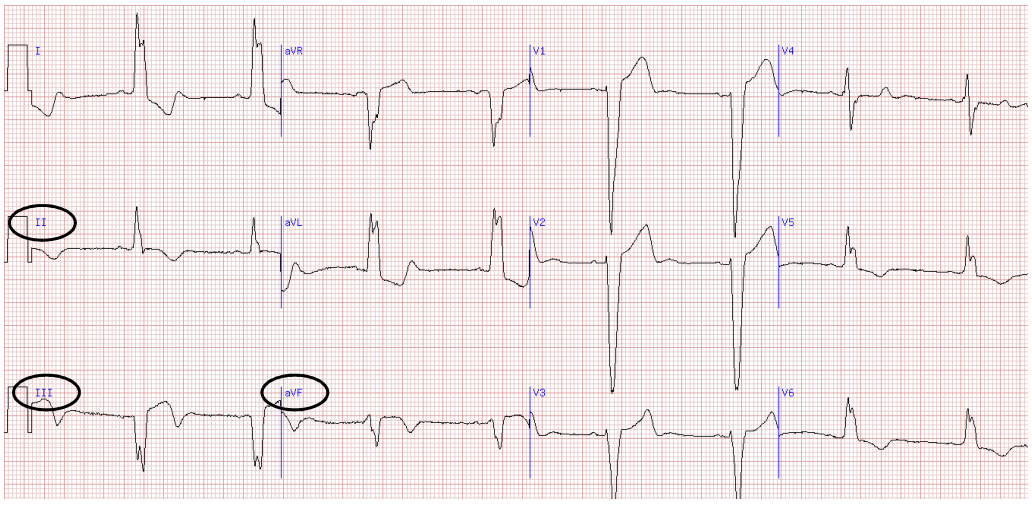
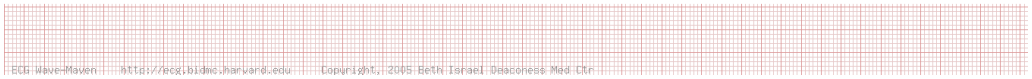


ST-T waves are typically opposite in direction to the major vector of the QRS in uncomplicated bundle branch blocks



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Case 5

An 80-year-old female with a history of pacemaker placement due to sick sinus syndrome and Mobitz Type II secondary degree heart block presents with dizziness, lightheadedness, and nausea approximately 90 minutes in duration. An ECG is obtained. What is the most likely cause of her symptoms?

1. Myocardial infarction
2. Atrial lead malfunction
3. Ventricular lead malfunction
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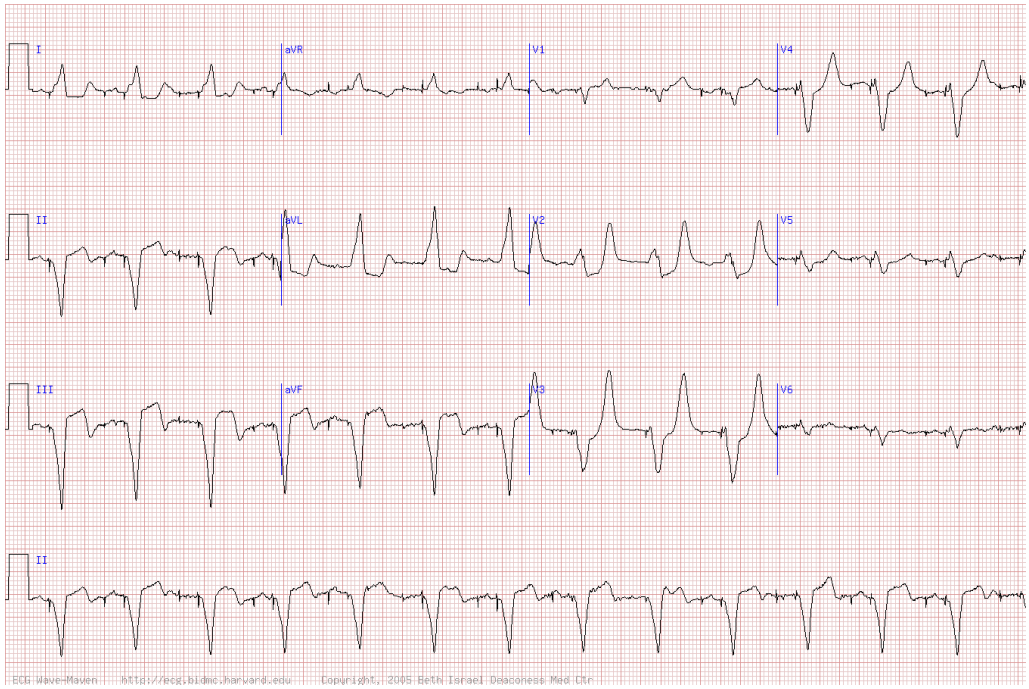

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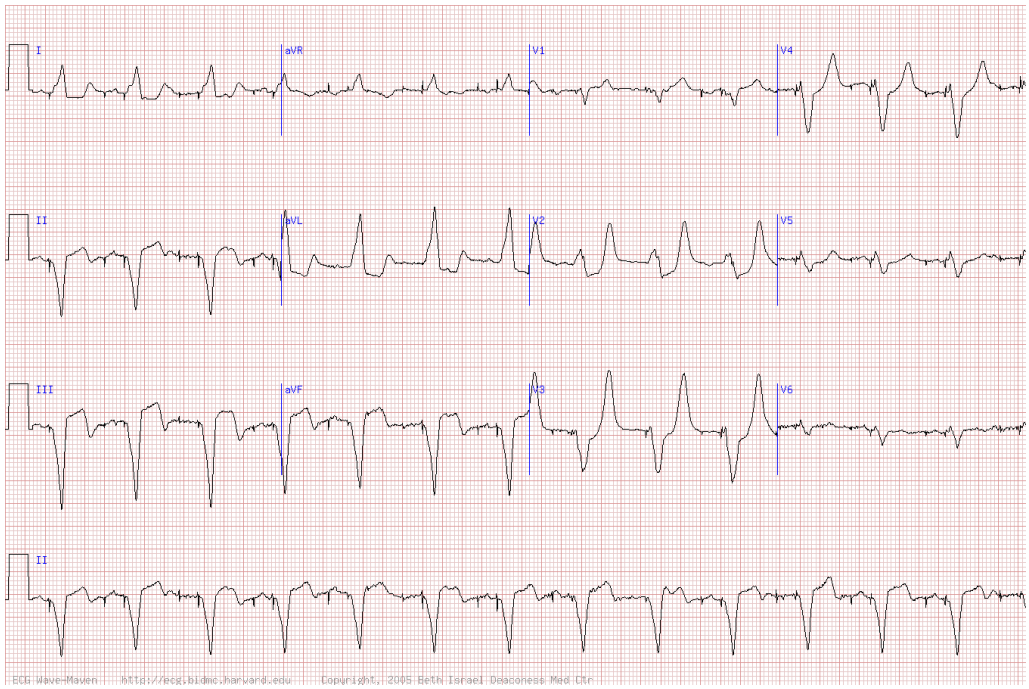

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3 ECG criteria with independent value in diagnosis of acute MI in the presence of LBBB

- ST segment elevation of 1mm or more that is in the same direction (concordant) as the QRS complex in any lead
- ST segment depression of 1 mm or more in any lead from V1 to V3
- ST segment elevation of 5 mm or more that is discordant with the QRS complex

Early Electrocardiographic Diagnosis of Acute Myocardial Infarction in the Presence of Ventricular Paced Rhythm

Elena B. Sgarbossa, MD, Sergio L. Pinski, MD, Kathy B. Gates, and Galen S. Wagner, MD, for the GUSTO-I Investigators

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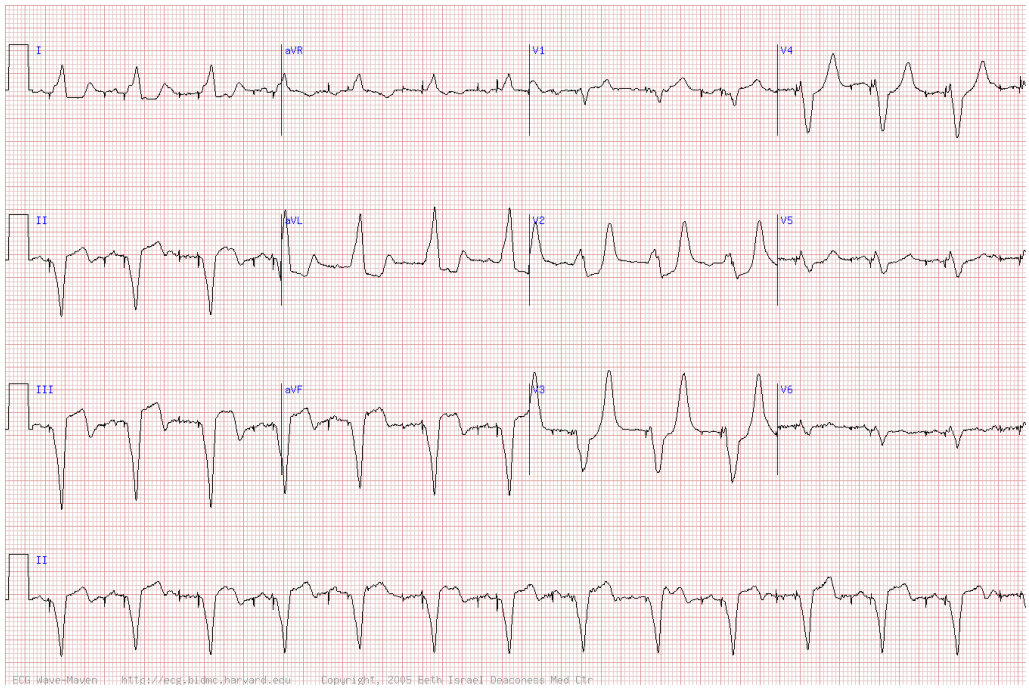
Sgarbossa EB et al. Am J Cardiol. 1996 Feb 15;77(5):423-4.



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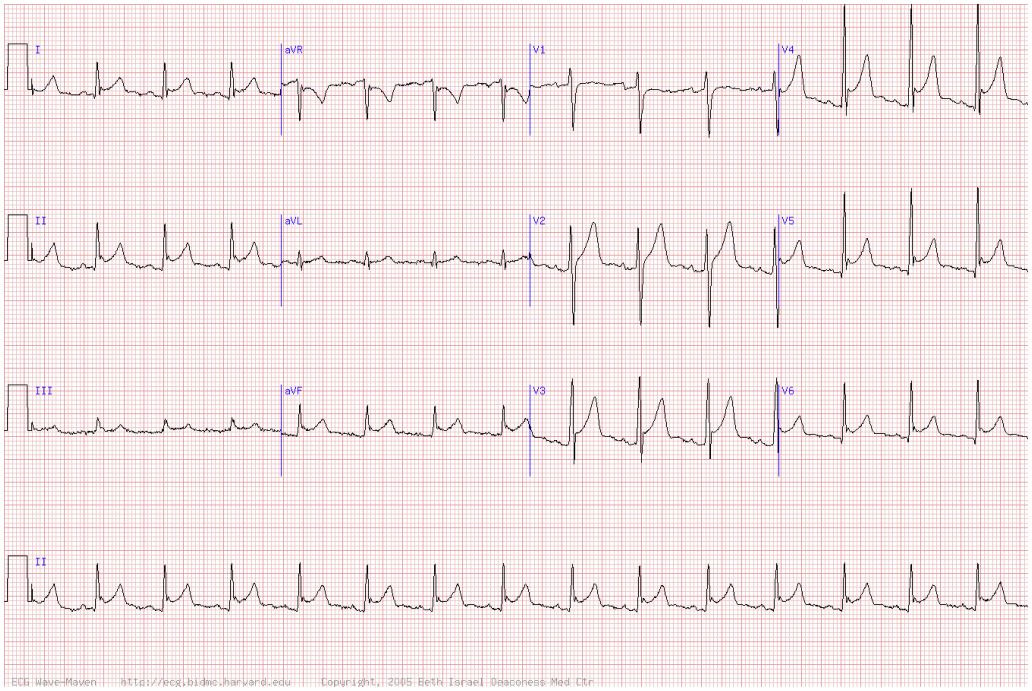
This ECG is most consistent with which of the following clinical scenarios?

1. A 54-year-old man with a history of diabetes with crushing, central chest pressure acute in onset
2. A 72-year-old woman with a history of hypertension and dyslipidemia with acute onset epigastric pain and diaphoresis
3. A 32-year-old man with a history of morbid obesity with asymmetric leg swelling and shortness of breath two days after abdominal surgery
4. A 44-year-old woman with a history of hypertension with positional, pleuritic chest discomfort



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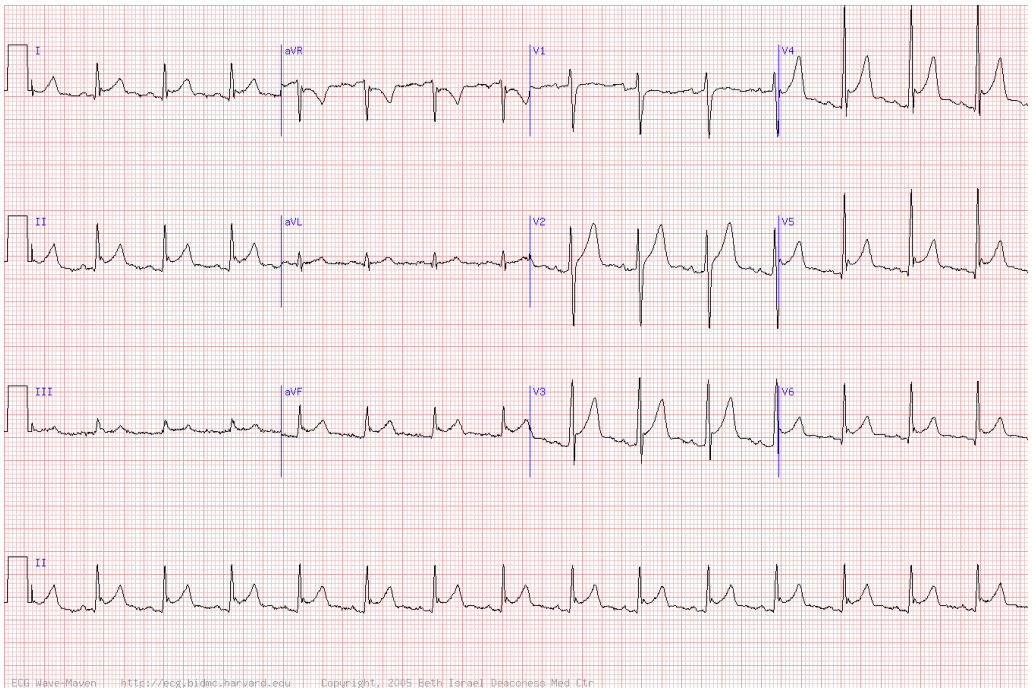

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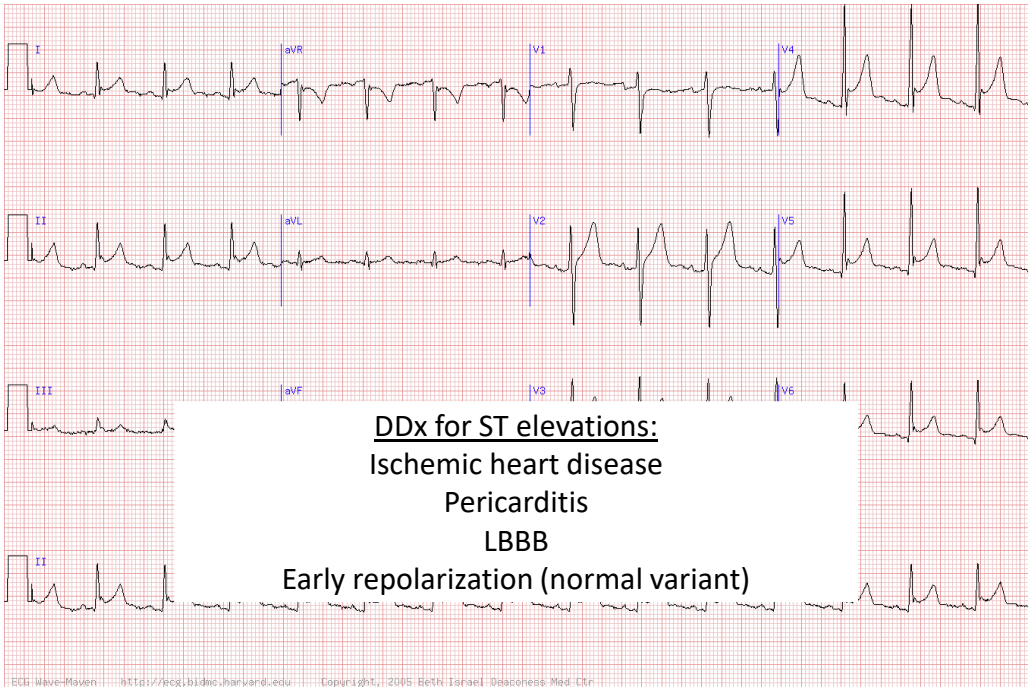

DDx for ST elevations:
Ischemic heart disease
Pericarditis
LBBB
Early repolarization (normal variant)

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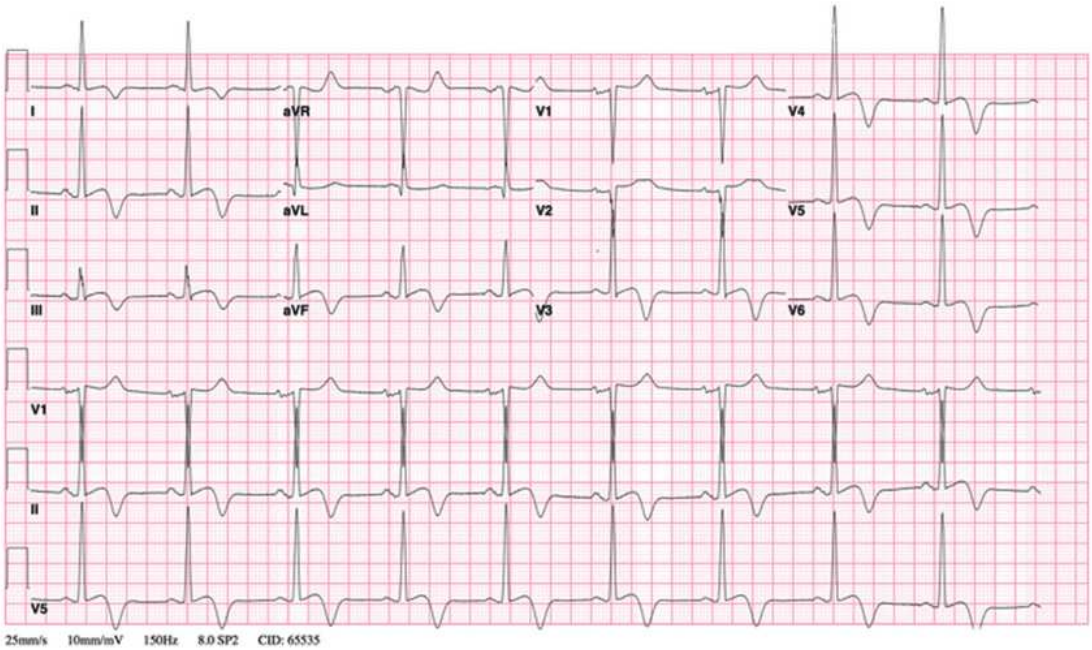
Nathanson LA et al. http://ecg.bidmc.harvard.edu.

Case 7

A 58-year-old female with a history of hypertension presents to her primary care physician's office for peri-operative risk assessment before a total knee replacement. She has no cardiovascular symptoms. An ECG is obtained. Which of the following is the most likely cause of this patient's ECG abnormalities?

1. Prior myocardial infarction
2. Current ischemia
3. Hypertrophic cardiomyopathy
4. Prior myocarditis



Abugroun A et al. Cardiol Res. 2017;8(5):265-268.

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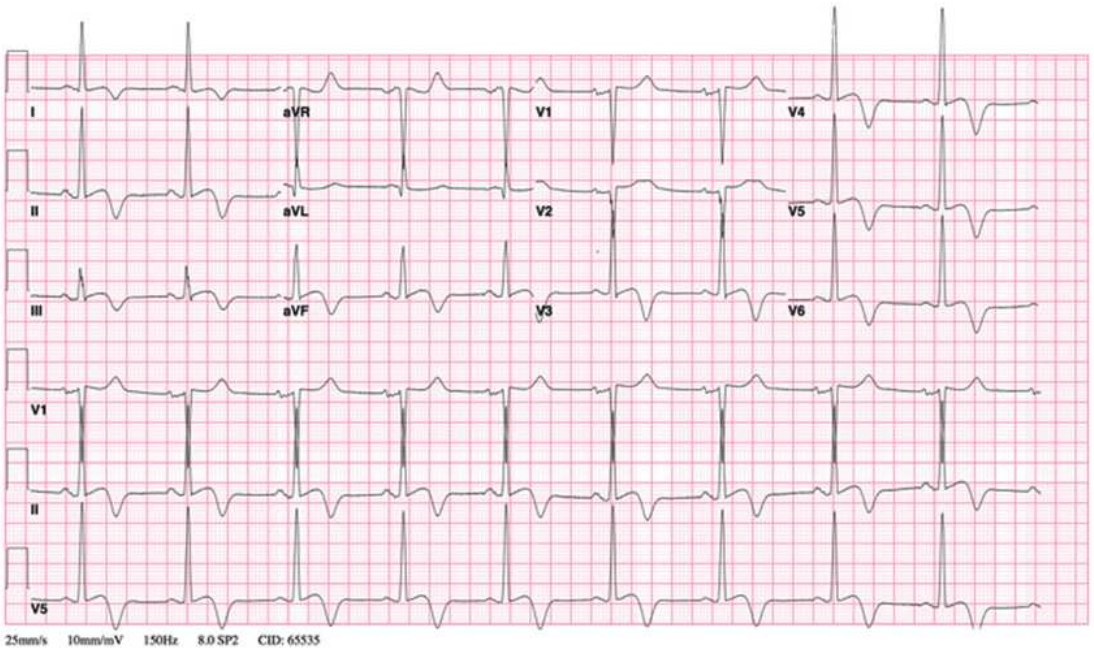

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Abugroun A et al. Cardiol Res. 2017;8(5):265-268.

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Finocchiaro G et al. Heart Rhythm. 2019 August 10.

Nomenclature	Sigmoidal HCM	Reverse curve HCM	Apical HCM	Neutral HCM
Prevalence	40-50%	30-40%	10%	10%
Age group	> 50-60 years	< 50-60 years	< 50-60 years	< 50-60 years

Canepa M et al. Heart. 2016 Jul 15;102(14):1087-94.

Case 8

A 39-year-old male presents to the emergency department with two weeks of intermittent chest discomfort while jogging. An ECG is obtained. Troponin-T was elevated at 0.07 ng/mL. Due to concern for a non-ST-elevation myocardial infarction, he underwent coronary angiography which revealed no obstructive coronary artery disease. Which of the following is the most likely cause of the ECG abnormalities?

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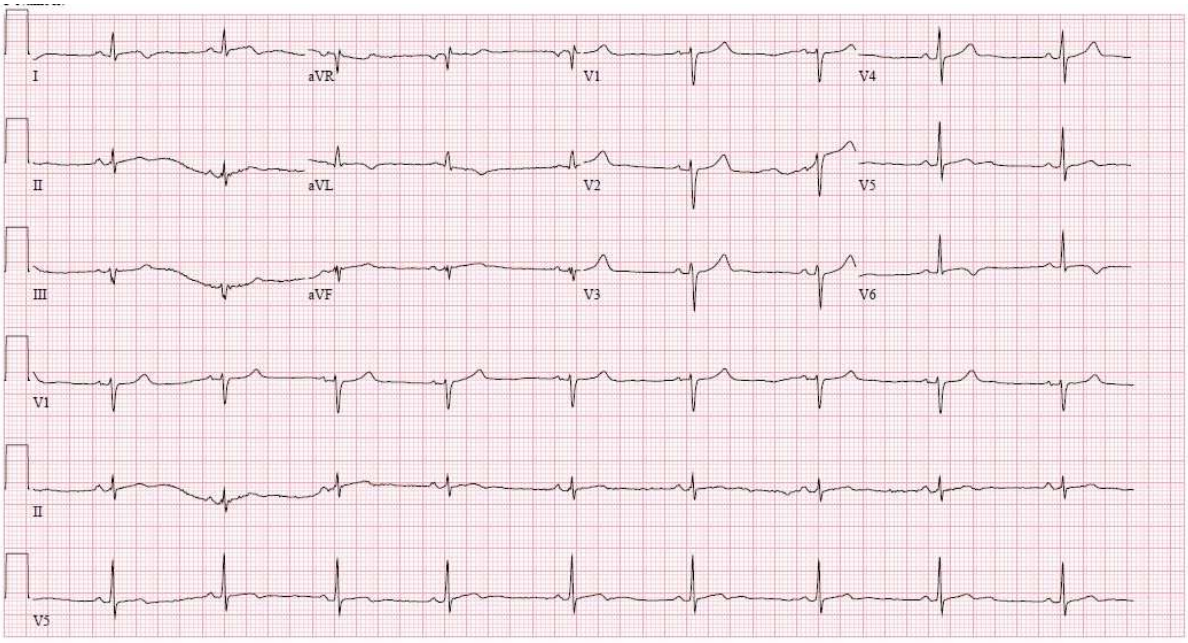
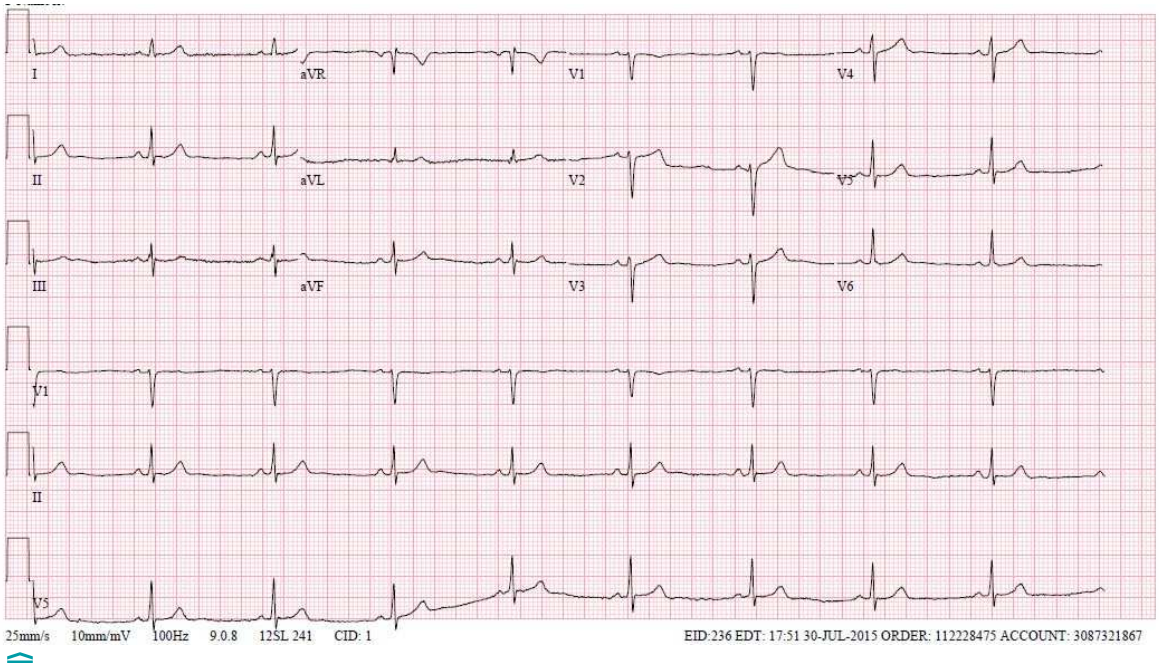
2. Pulmonary embolism
3. Pericarditis
4. Left ventricular hypertrophy and associated strain pattern


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5

51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V4
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V3
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V5
25mm/s 10mm/mV 100Hz 9.0.8 12SL 241 CID: 1
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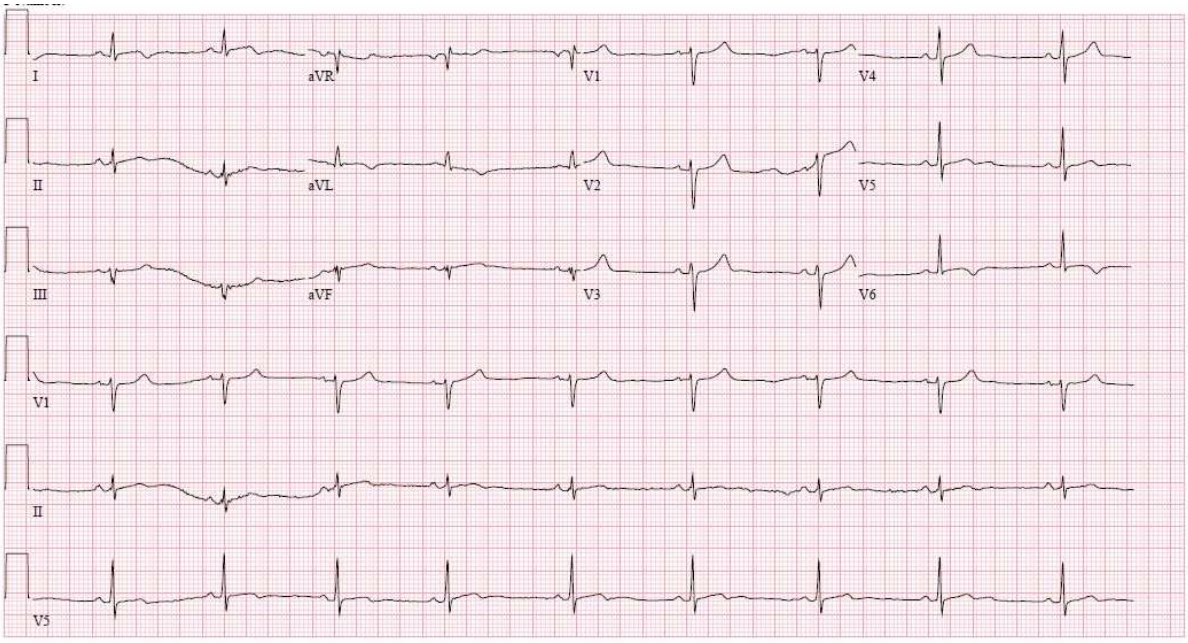

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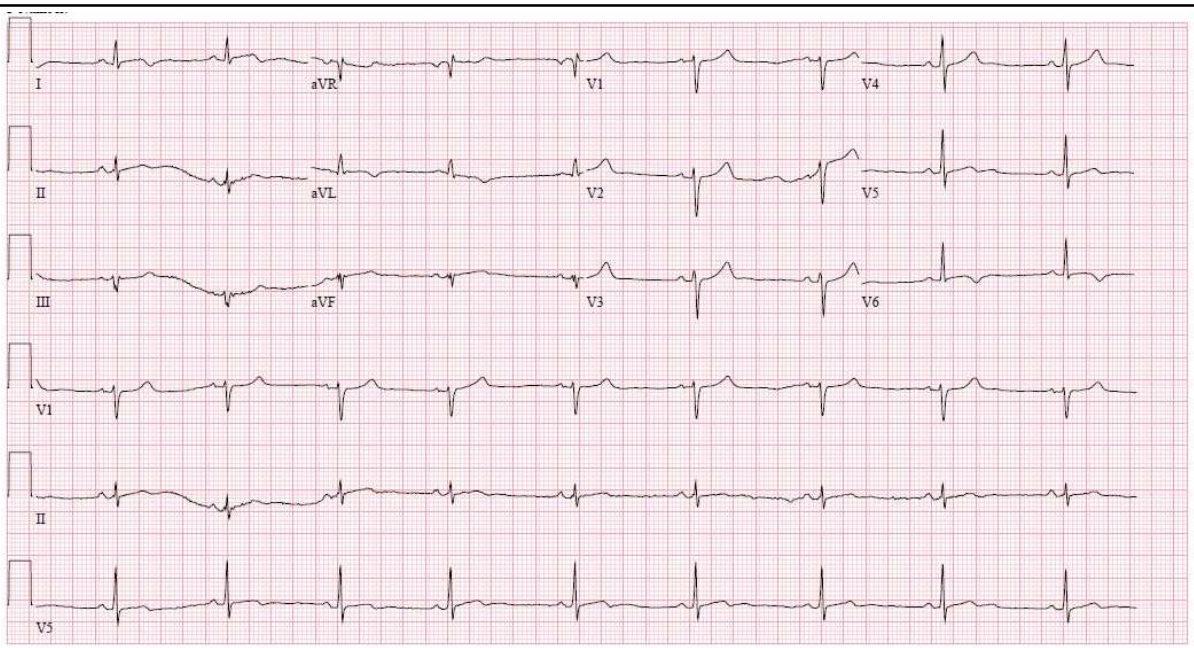

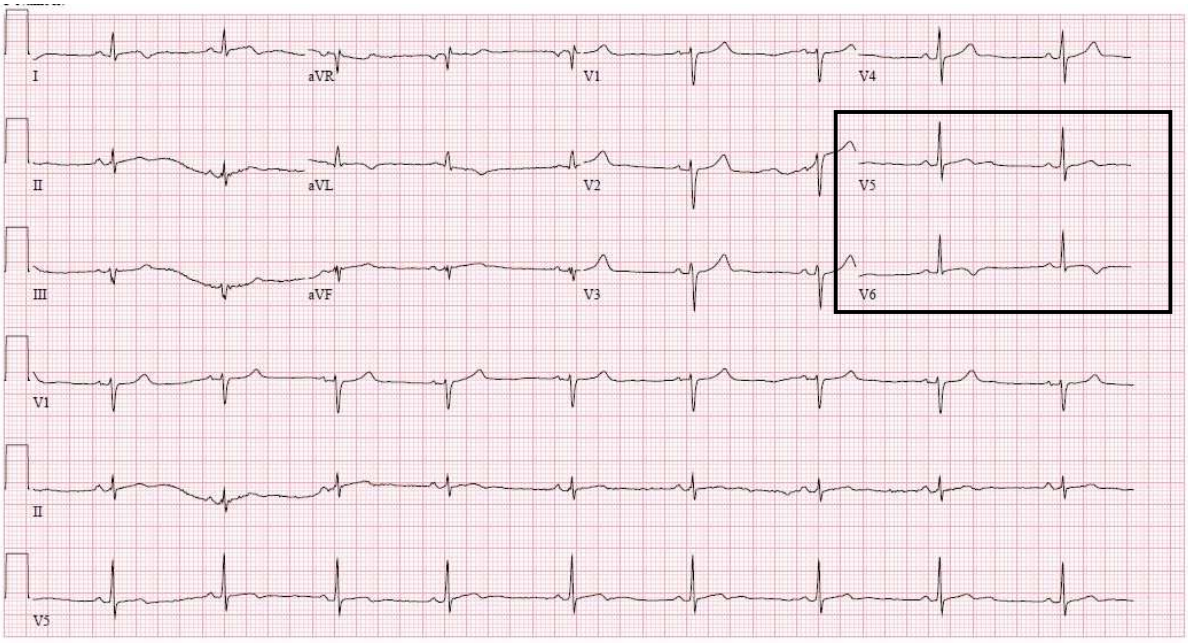

+Troponin in the absence of overt ischemic heart disease

Type II MI	Non-ischemic myocardial damage	Indeterminate/ Multifactorial
Tachyarrhythmias Shock HTN urgency/emergency Cocaine use	Cardiac contusion Defibrillator shocks Myocarditis Cardiotoxic agents	Stress cardiomyopathy Severe pulmonary embolism Severe neurologic disease Infiltrative cardiomyopathy Sepsis

Thygesen K et al. Eur Hear J. 2010;31(18):2197-2206.

Case 9

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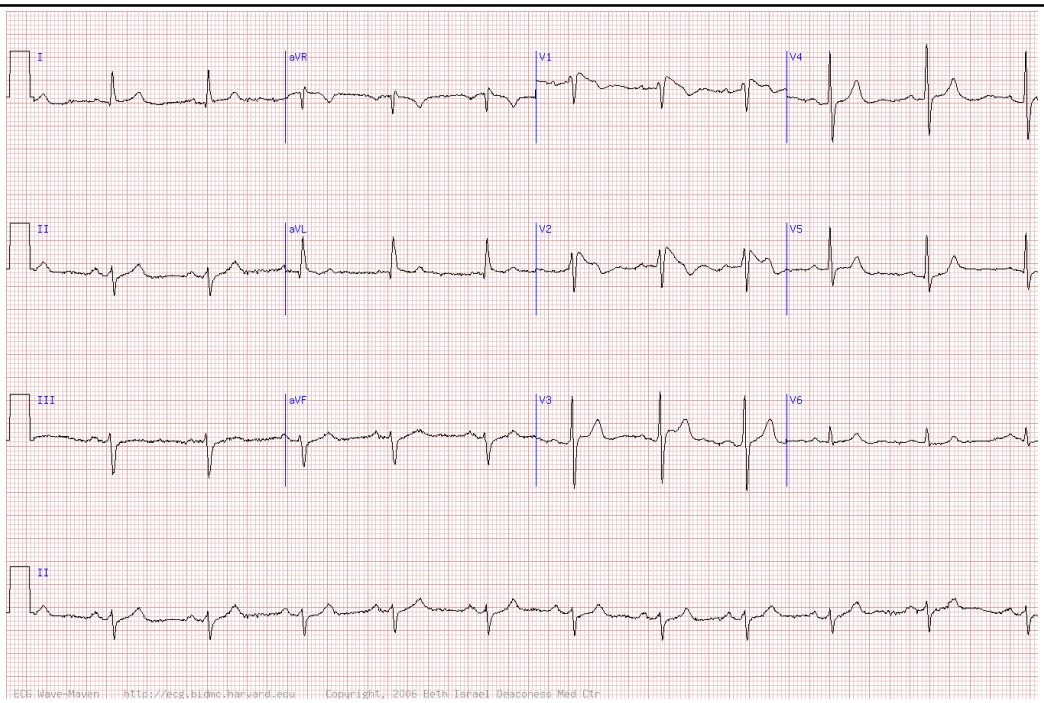
2. Right ventricular hypertrophy
3. Right ventricular strain
4. Brugada pattern



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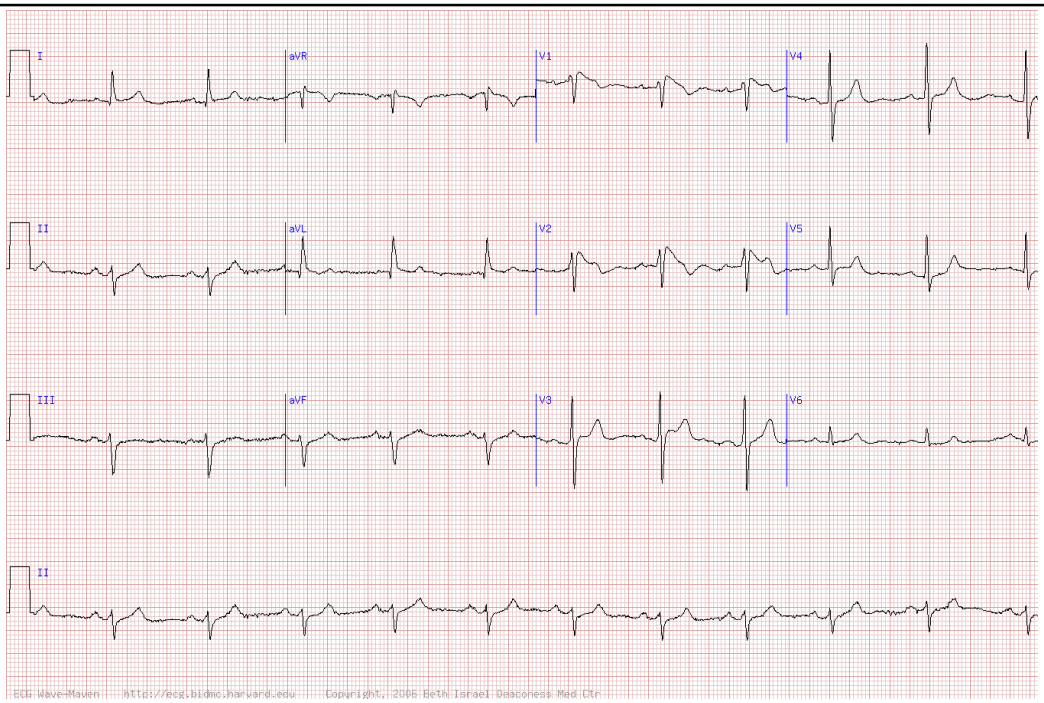
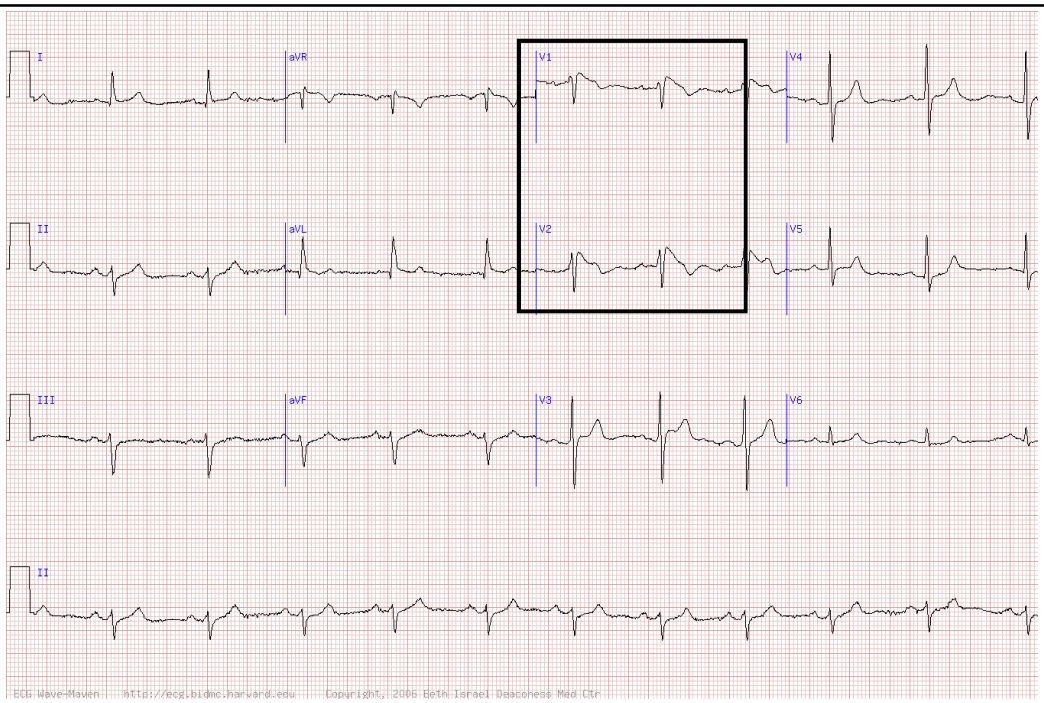
A 61-year-old male presents to urgent care clinic due to non-exertional, sharp chest pain over the last 2-3 months. An ECG is obtained. Evidence of which of the following is present on his ECG?

1. Right bundle branch block
2. Right ventricular hypertrophy
3. Right ventricular strain
4. **Brugada pattern**



63

Nathanson LA et al. http://ecg.bidmc.harvard.edu.



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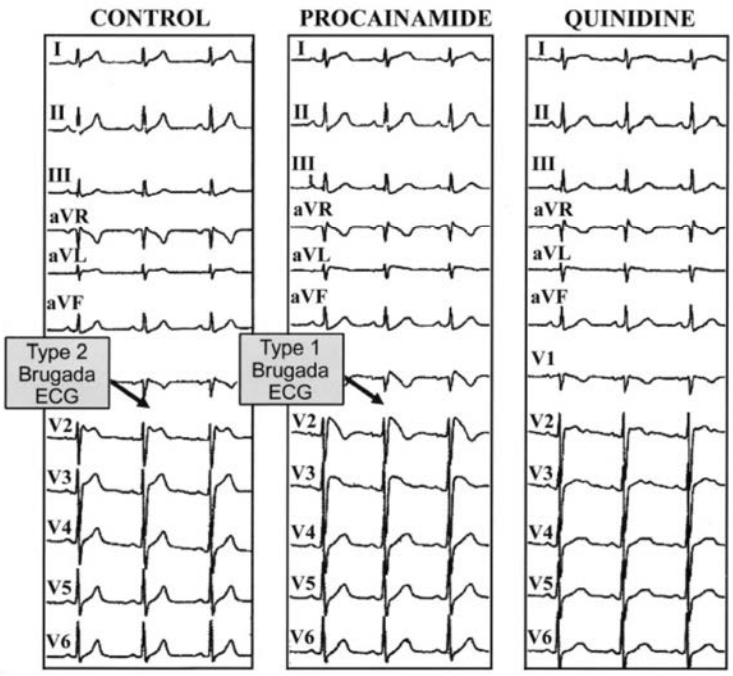


Antzelevitch C et al. Circulation 2005 Feb 8;111(5):659-70.

Brugada Syndrome

Associated with a high risk for sudden cardiac death

- Estimated to be responsible for at least 4% of all sudden deaths and at least 20% of sudden deaths in patients with structurally normal hearts

- Causative mutations in the SCN genes SCN5A and SCN10A (encode α subunit of the cardiac sodium channel gene)

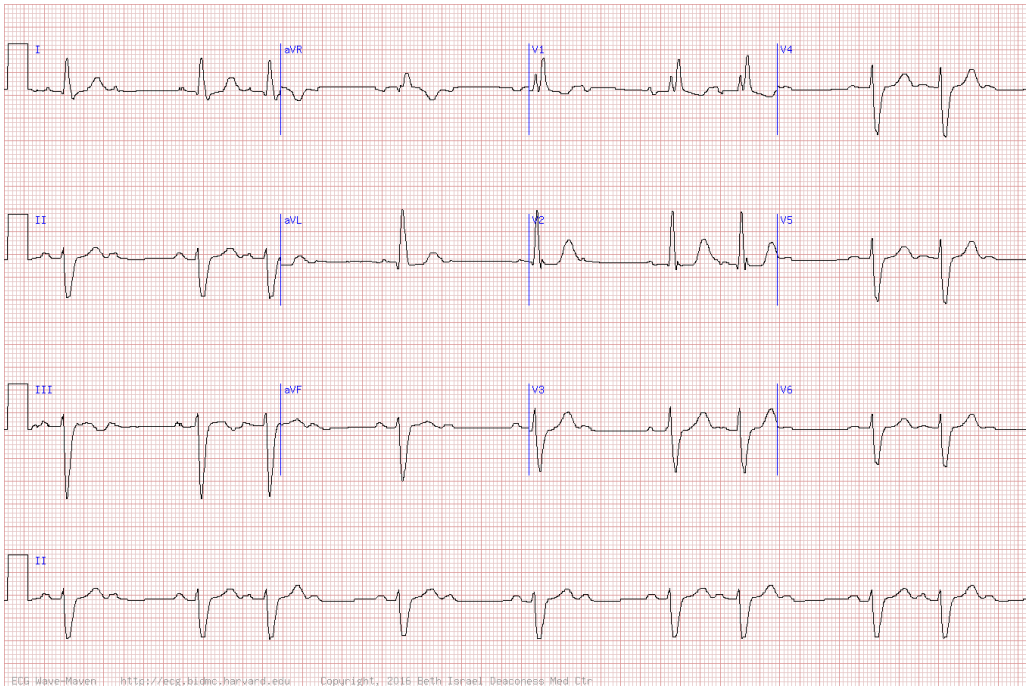
- **Cases of suspected Brugada syndrome should have evaluation for underlying heart disease by a cardiologist and imaging**

Antzelevitch C et al. Circulation 2005 Feb 8;111(5):659-70.

Case 10

An 80-year-old man presents to the emergency room due to recurrent episodes of dizziness and lightheadedness not associated with activity. Examination is notable for bradycardia. An ECG is obtained. Which of the following is present?

1. 1st Degree AV block
2. Mobitz Type I 2nd Degree AV Block
3. Mobitz Type II 2nd Degree AV Block
4. 3rd Degree AV Block



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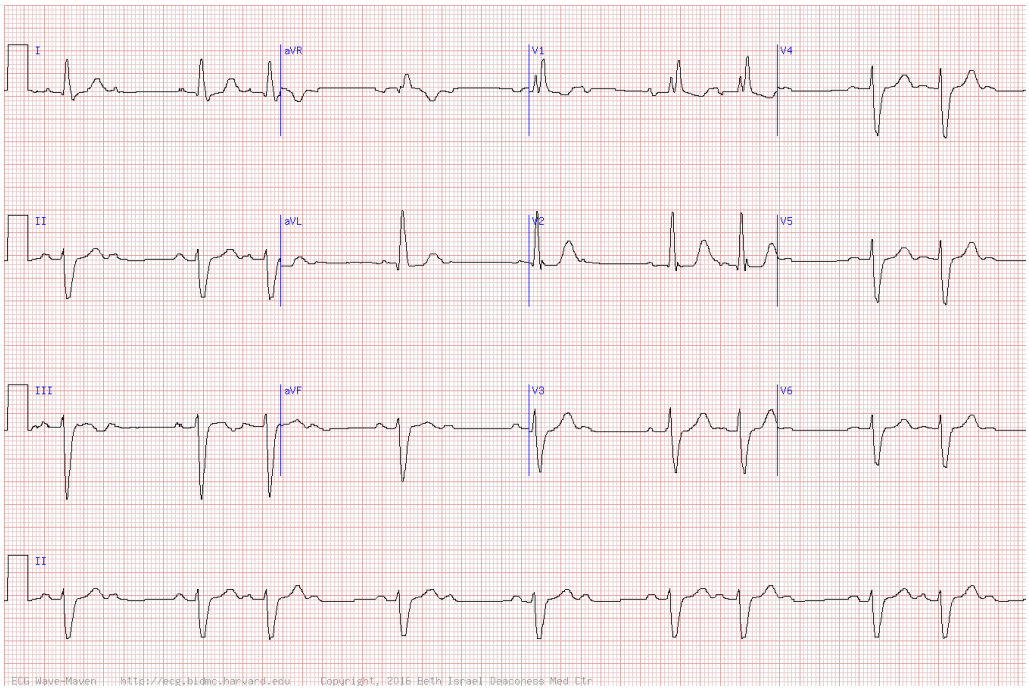

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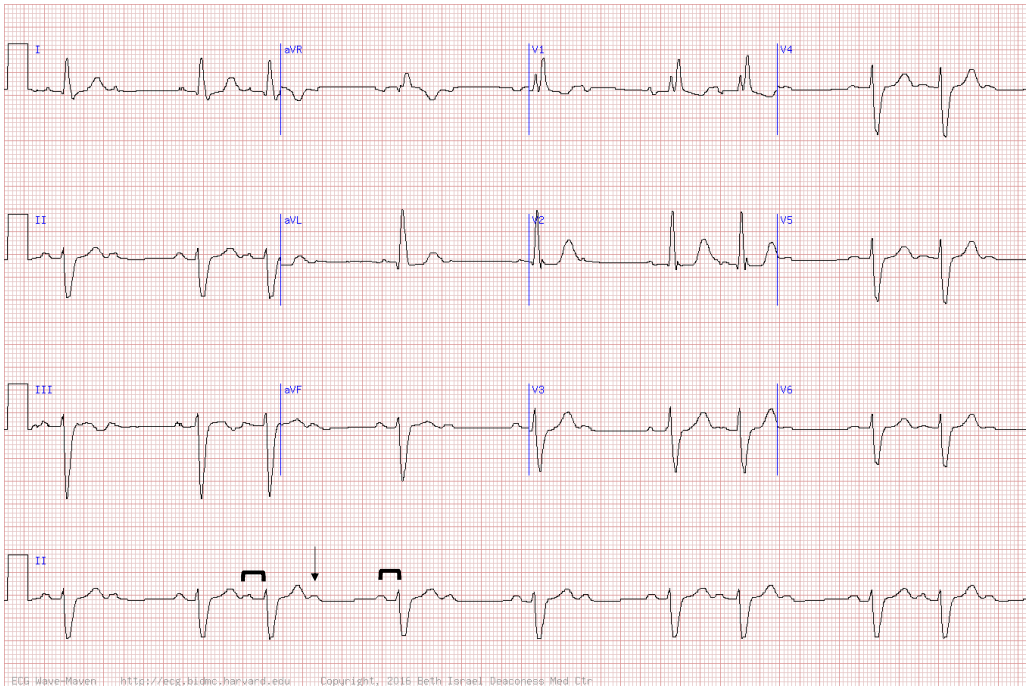
Nathanson LA et al. http://ecg.bidmc.harvard.edu.



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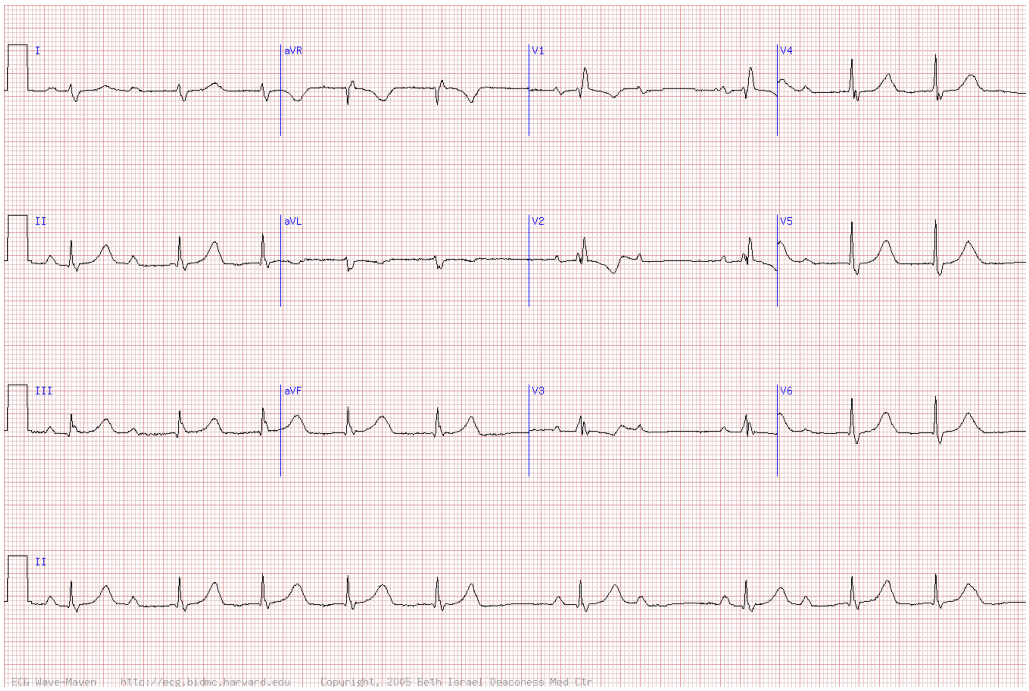
Nathanson LA et al. http://ecg.bidmc.harvard.edu.



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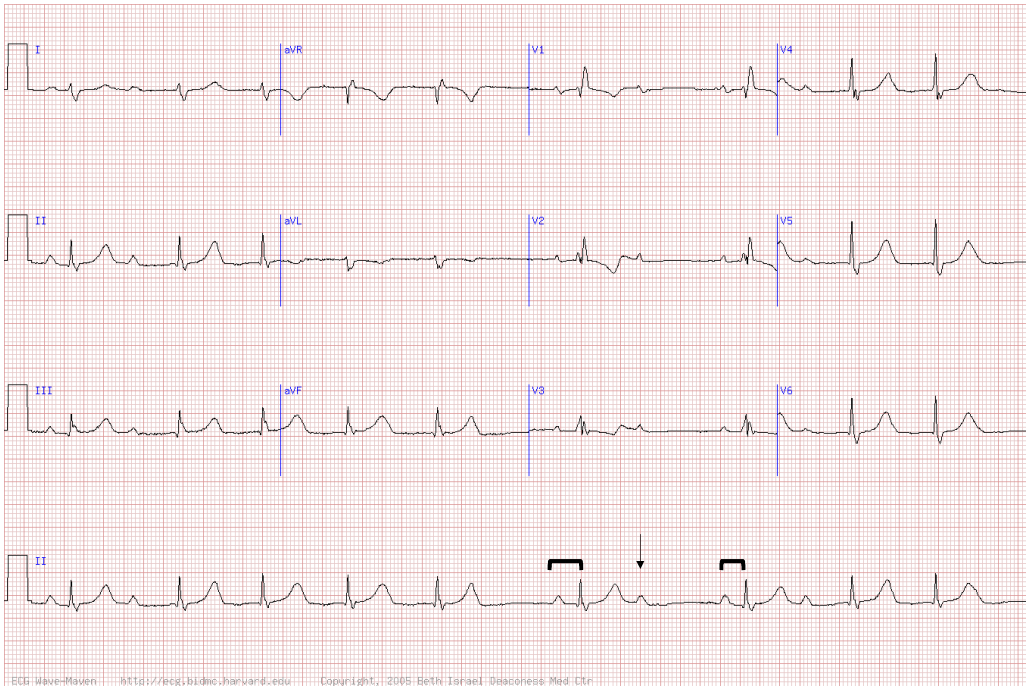
Nathanson LA et al. http://ecg.bidmc.harvard.edu.



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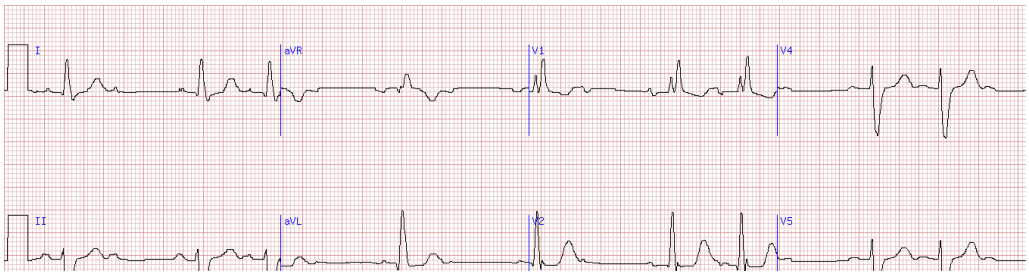
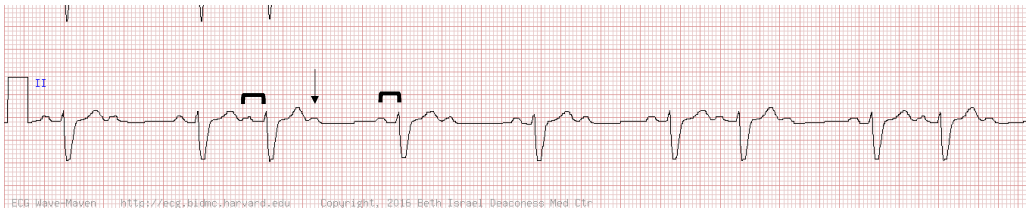
Nathanson LA et al. http://ecg.bidmc.harvard.edu.



The PR intervals before and after the non-conducted P-wave are about the same duration in Mobitz Type II 2nd Degree AV Block

Mobitz Type II 2nd Degree AV Block is an indication for PPM placement if no reversible causes are identified



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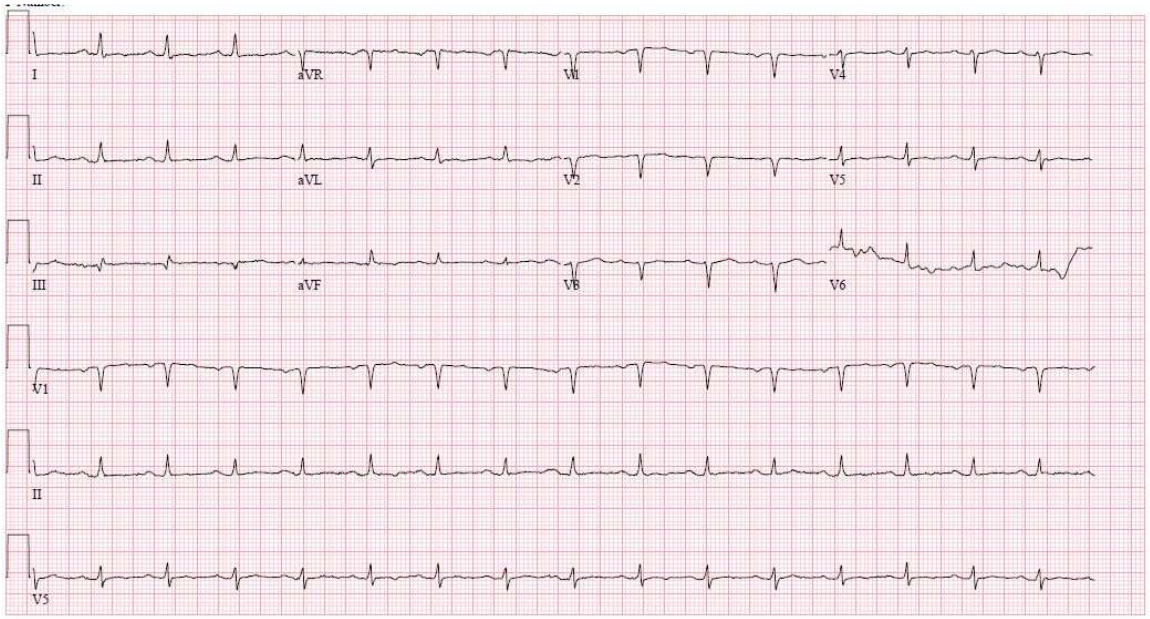
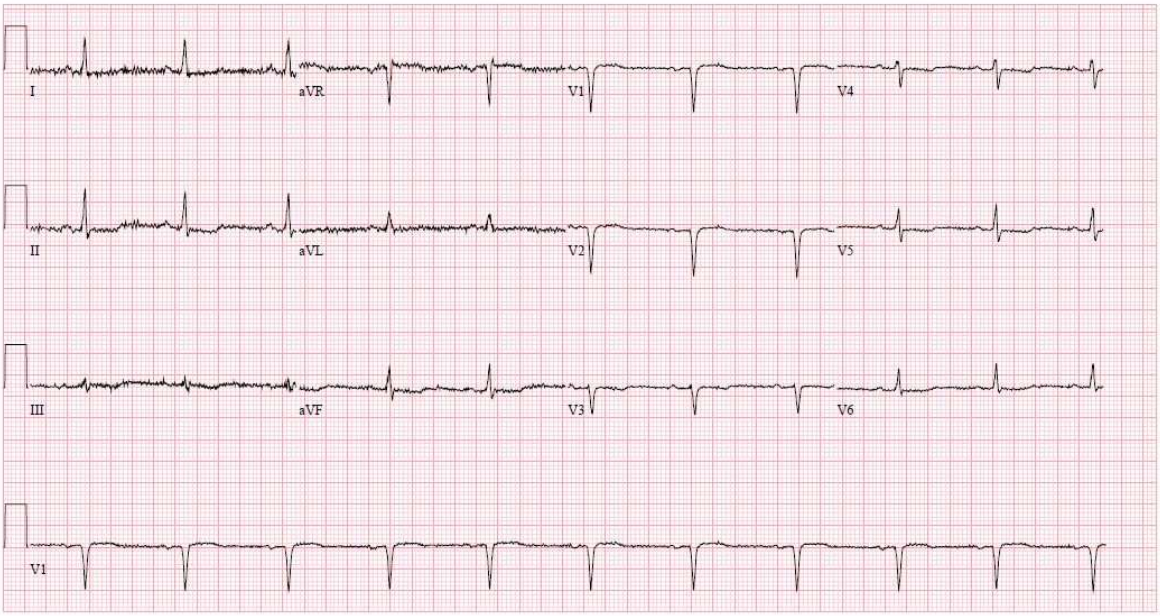
Case 11

A 33-year-old female with systemic lupus erythematosus presents to her rheumatologist's office with increased shortness of breath over the last two weeks. The examination is notable for tachycardia. An ECG is obtained. What is the likely etiology of the patient's shortness of breath based on the ECG?

1. Pulmonary embolism
2. Interstitial lung disease
3. Pericardial effusion
4. Ischemic heart disease


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5

77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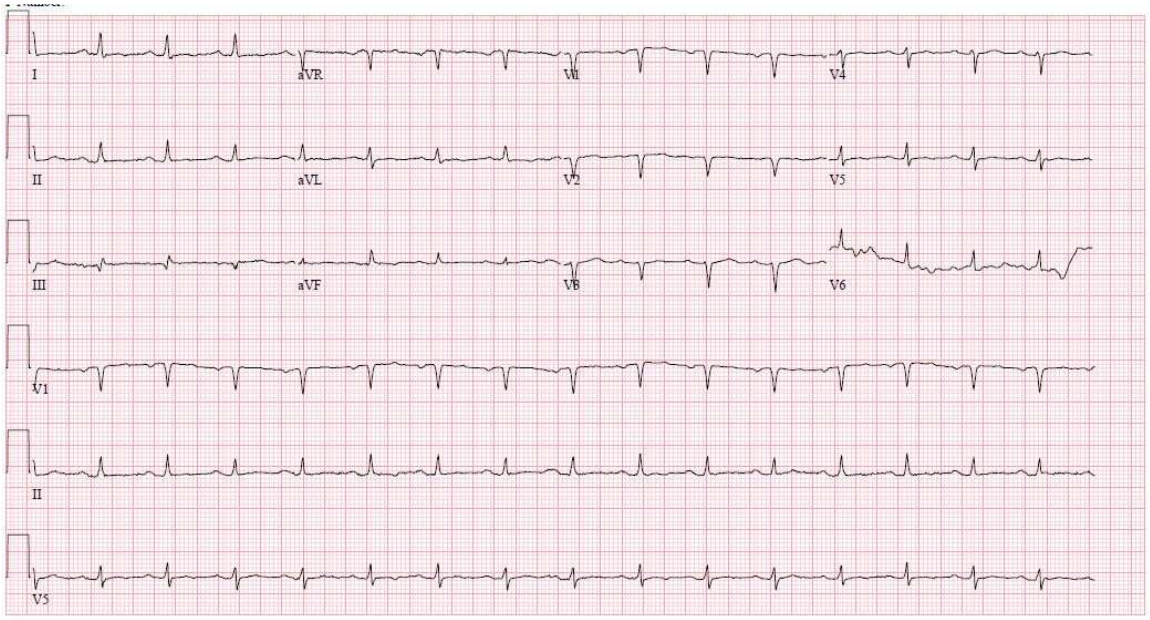

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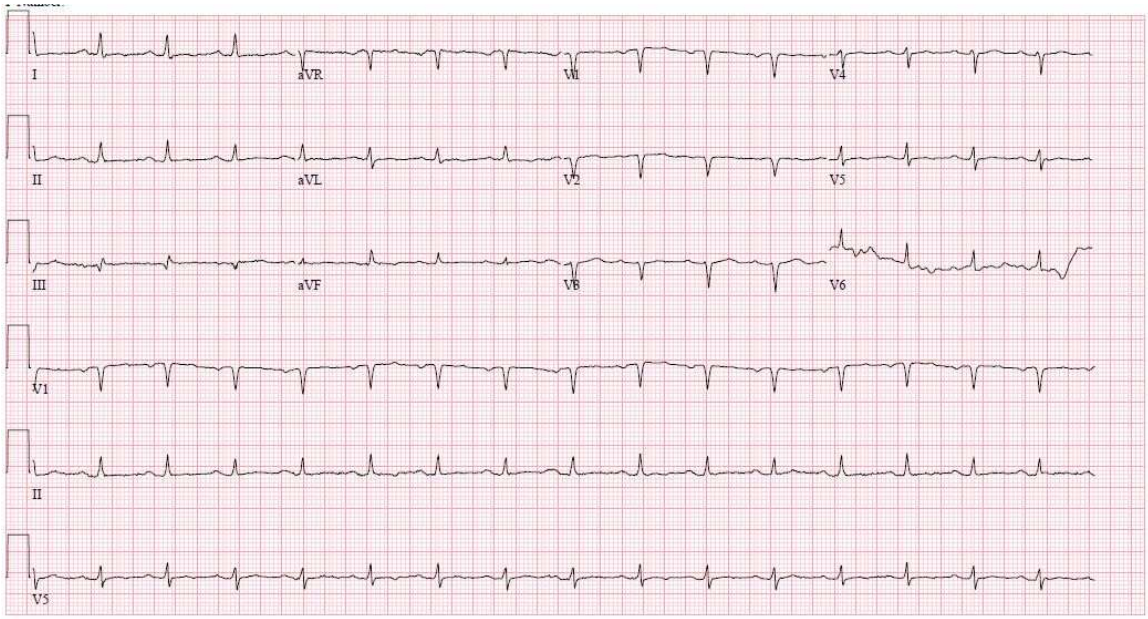

Low-Voltage

- QRS amplitude <5 mm in limb leads and <10 mm in the precordial leads

Madias JE et al. J Am Coll Cardiol. 2001;38(3):756.

Low-Voltage

- QRS amplitude <5 mm in limb leads and <10 mm in the precordial leads
- Causes:
  - **Pericardial and pleural effusions**
  - **Infiltrative cardiomyopathy**
  - **Pulmonary disease**
  - **Hypothyroidism**
  - Constrictive pericardial disease
  - Diffuse myocardial necrosis or fibrosis
  - Normal variant

Madias JE et al. J Am Coll Cardiol. 2001;38(3):756.

Electrical Alternans

- Alternating QRS amplitude from beat to beat on ECG

Rosenbaum DS et al. N Engl J Med. 1994 Jan 27;330(4):235-41.

Electrical Alternans

- Alternating QRS amplitude from beat to beat on ECG
- Causes:
  - **Pericardial effusion**
  - Supraventricular tachycardia
  - Wolff-Parkinson-White (WPW)
  - Ventricular tachycardia
  - Myocardial disease
  - Pneumothorax
  - Emphysema

Rosenbaum DS et al. N Engl J Med. 1994 Jan 27;330(4):235-41.

Case 12

A 32-year-old man with a history of schizophrenia and current tobacco use presents to an urgent care clinic due to palpitations. An ECG is obtained. This patient is at risk for developing which of the following?

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2. Torsades de pointes
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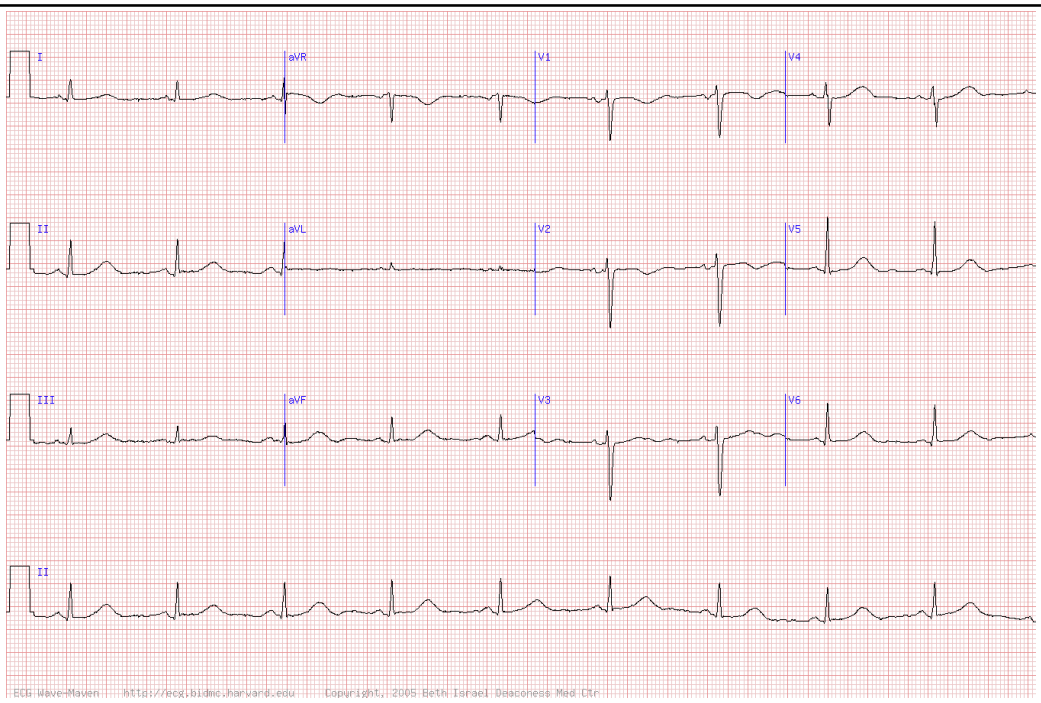

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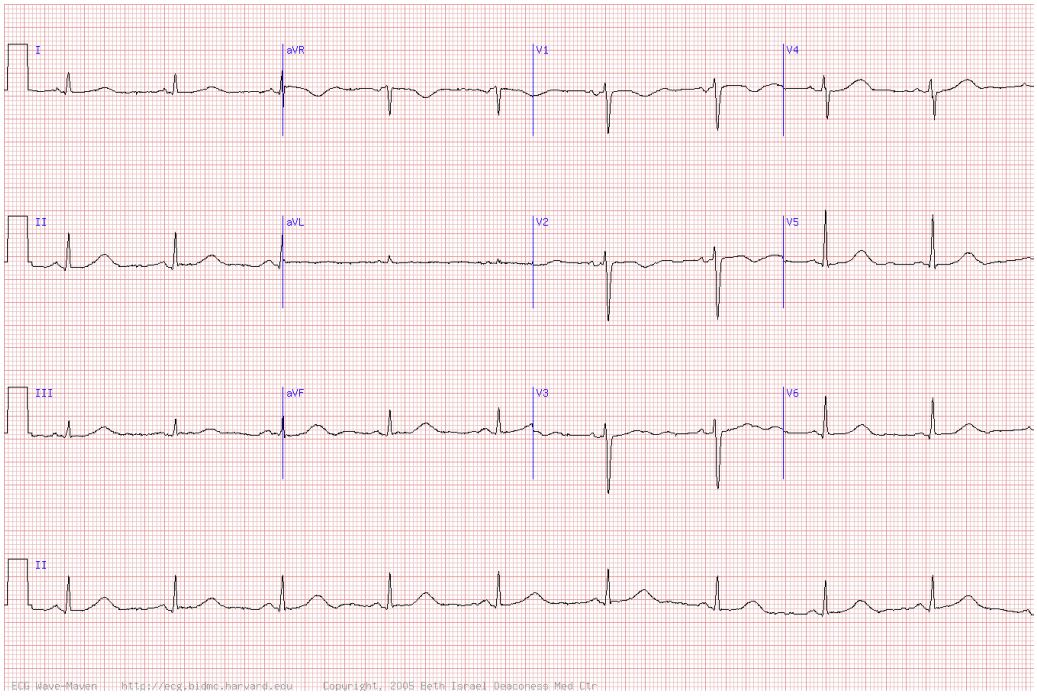

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Nathanson LA et al. http://ecg.bidmc.harvard.edu.

Table 1
The current methods of QT correction and their mathematical formulas.

QT Correction (QTc)	Formula
1. Bazett	$QTcB = QT/RR^{1/2}$
2. Fridericia	$QTcFri = QT/RR^{1/3}$
3. Framingham	$QTcFra = QT + 0.154\ (1\text{-}RR)$
4. Hodges	$QTcH = QT + 0.00175$

92

Pourmand A et al. Am J Emerg Med. 2017 Dec;35(12):1928-1933.

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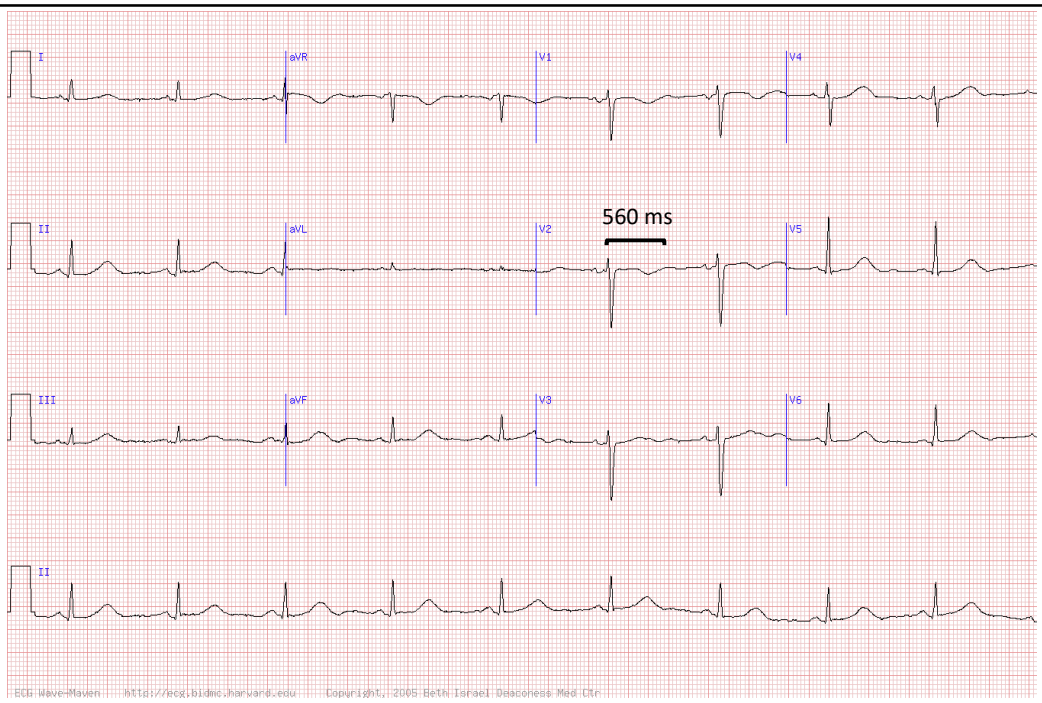

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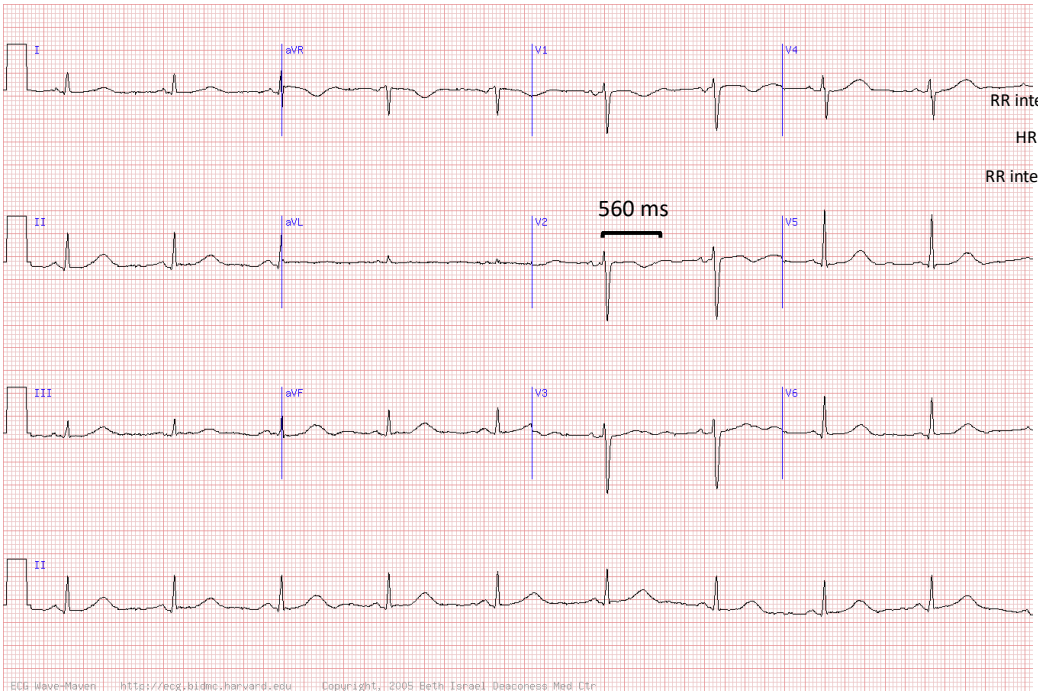

RR interval = 60/HR

HR = 55 bpm

RR interval = 1.09 sec

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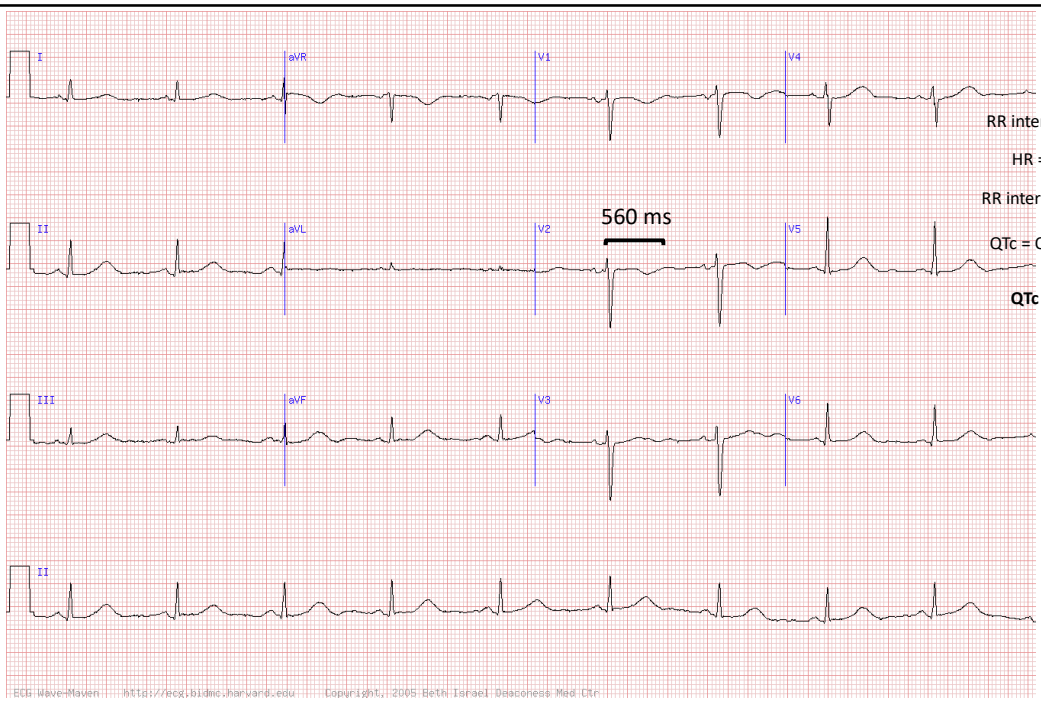

RR interval = 60/HR

HR = 55 bpm

RR interval = 1.09 sec

QTc = QT/(sqrt(RR))

QTc = 536 ms

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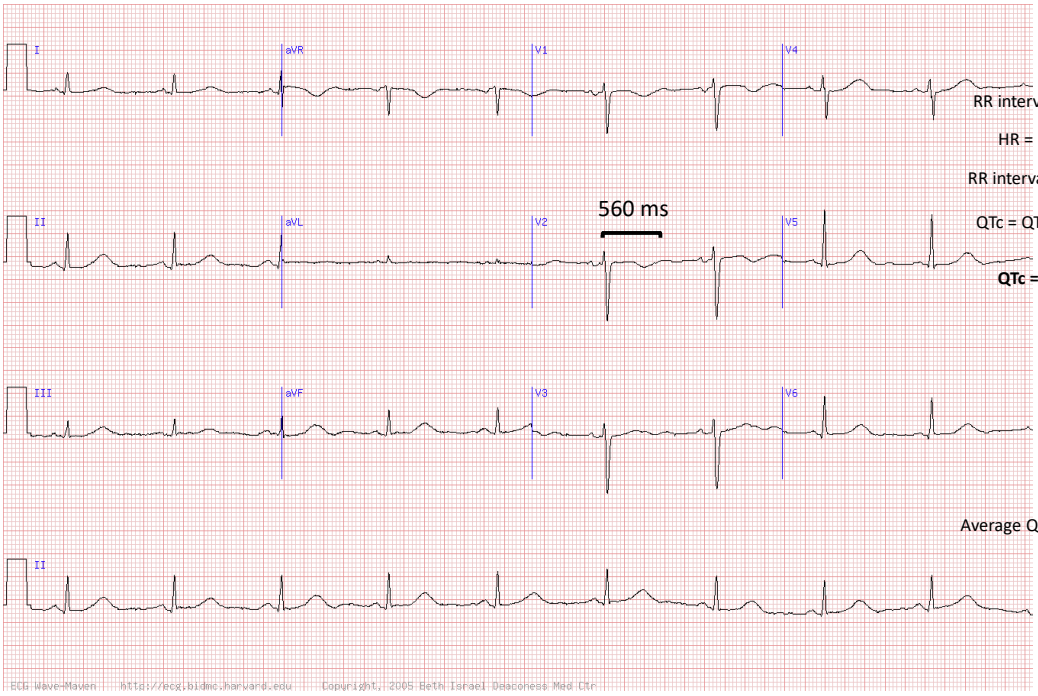
Nathanson LA et al. http://ecg.bidmc.harvard.edu.



97

Nathanson LA et al. http://ecg.bidmc.harvard.edu.

Table 3
Medications that prolong the QTc interval.

Medication category	Medications prolonging QTc	Implicated mechanism of QTc prolongation
Antipsychotics	Thioridazine, Pimozide, IV Haloperidol	Direct IKr channel antagonism [13]
Antiarrhythmics	Class IA (Quinidine)	Na + channel blockers: reentry arrhythmia [18]
	Class III (Sotalol, Amiodarone)	K+ channel blockers: delayed repolarization [18]
Antibiotics	Macrolides (Erythromycin and Clarithromycin), Trimethoprim, Pentamidine, Azoles, Fluoroquinolones	Indirect IKr channel blockage and dispersion of repolarization [19,20]
Antiemetics	Ondansetron (Zofran), Granisetron	Potent IKr channel blockage [21]

IKr (rapidly-activating potassium currents); IV (intravenous); Na + (sodium); K+ (potassium).

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Pourmand A et al. Am J Emerg Med. 2017 Dec;35(12):1928-1933.

AHA/ACCF Scientific Statement

Prevention of Torsade de Pointes in Hospital Settings

A Scientific Statement From the American Heart Association and the American College of Cardiology Foundation

Endorsed by the American Association of Critical-Care Nurses, the International Society for Computerized Electrocardiology, and the Heart Rhythm Society

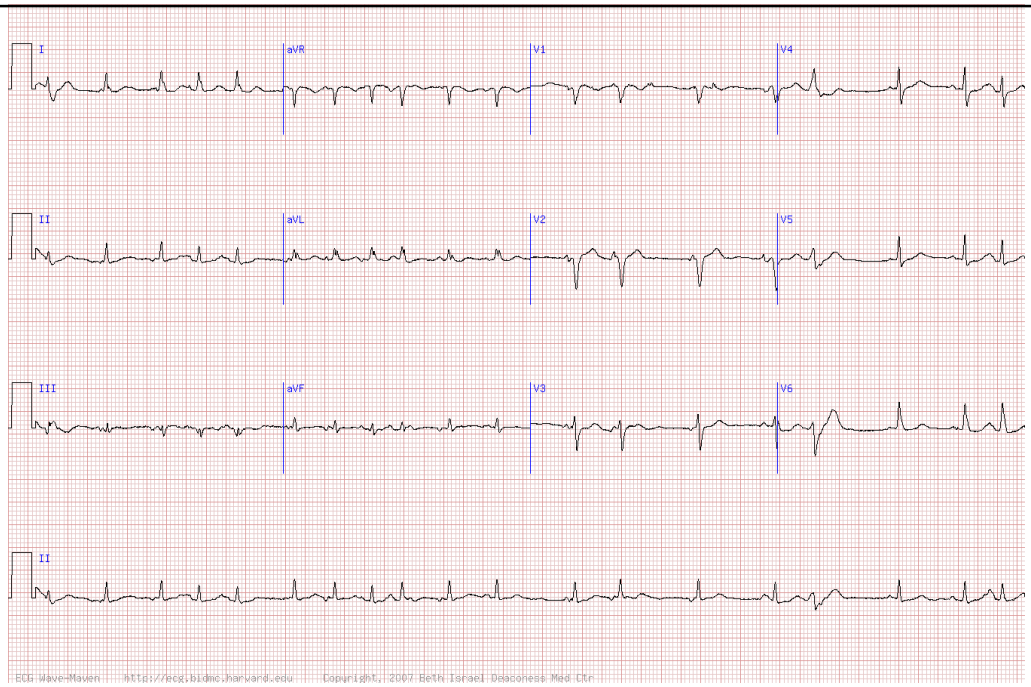
After initiation of a drug associated with TdP, ECG signs indicative of risk for arrhythmia include an **increase in QTc from pre-drug baseline of 60 ms** and marked **QTc interval prolongation >500 ms**

Drew BJ et al. Circulation 2010 Mar 2;121(8):1047-60.

Case 13

A 76-year-old man with COPD is admitted to the medical ICU with urosepsis. What arrhythmia is present?

1. Atrial fibrillation
2. AVNRT
3. Multifocal atrial tachycardia
4. Sinus tachycardia with sinus arrhythmia



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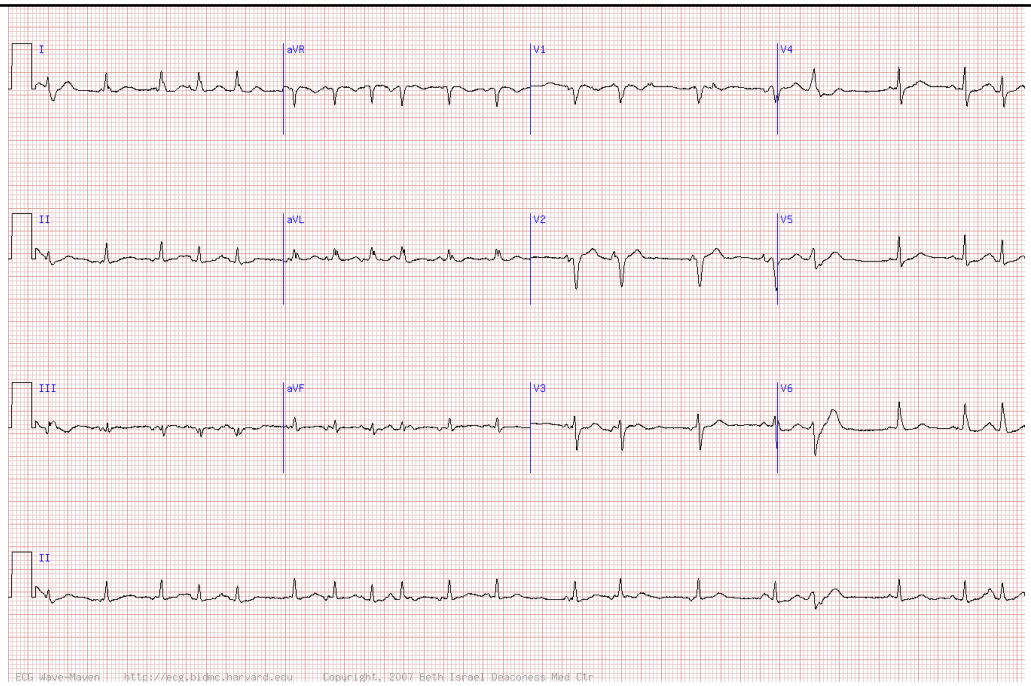

Nathanson LA et al. http://ecg.bidmc.harvard.edu.

Multifocal Atrial Tachycardia

- SVT resulting in a rapid, irregular atrial rhythm that is caused by multiple ectopic foci within the atria
- Heart rate is > 100 beats per minute with organized atrial activity yielding three or more different non-sinus P-wave morphologies
- Typically seen in elderly patients with underlying chronic conditions, such as COPD
- If heart rate is ≤ 100 beats per minute, rhythm is called wandering atrial pacemaker

Custer AM et al. 2023.

Case 14

A 42-year-old man is admitted to the general medicine service with cellulitis. An ECG is obtained due to a slow heart rate. What is the rhythm?

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2. Sinus rhythm
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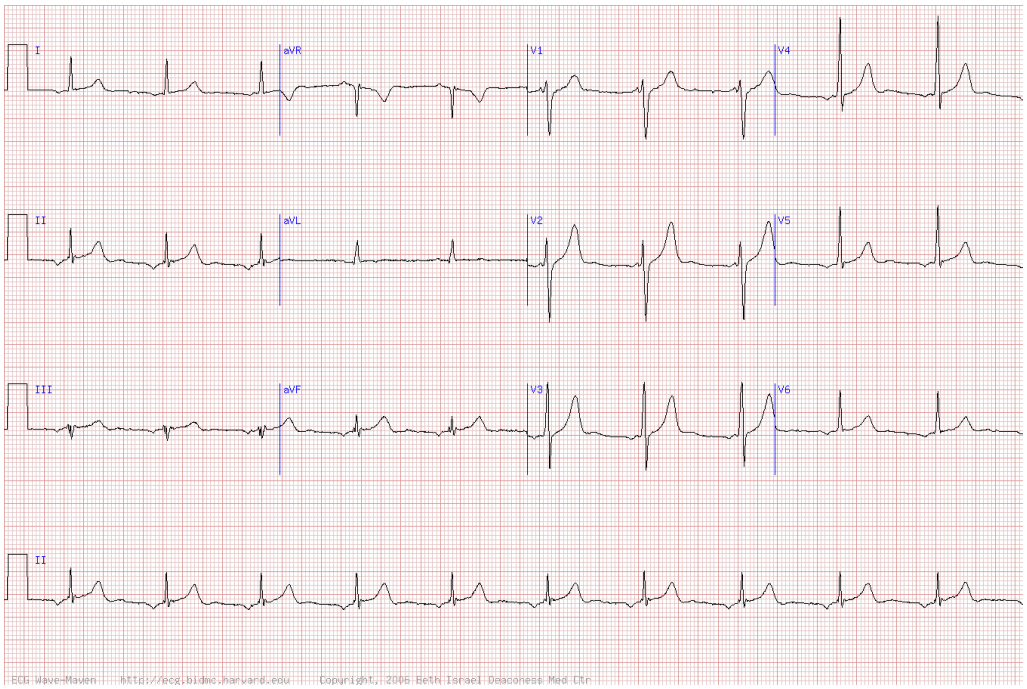

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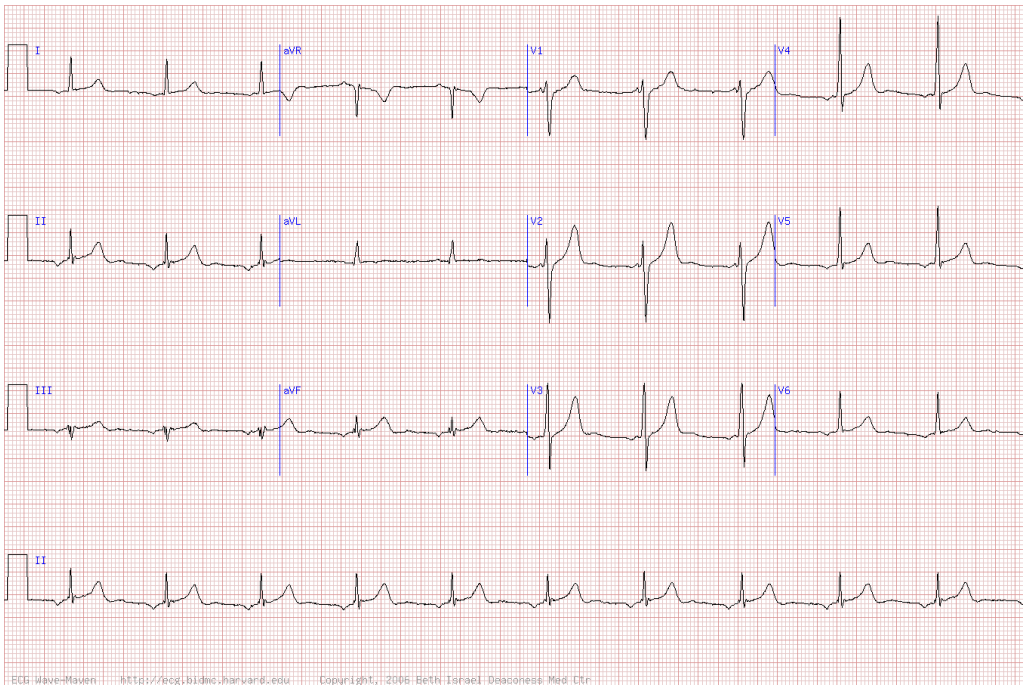

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A 31-year-old woman is admitted to the general medicine service due to recurrent syncope. What is the most important finding on the ECG?

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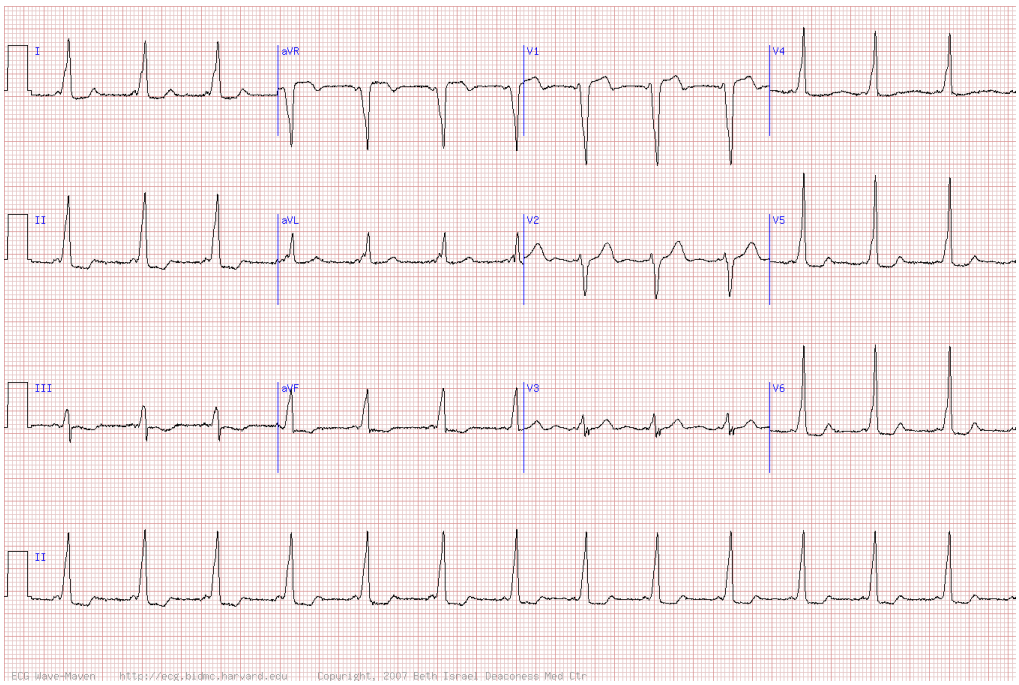

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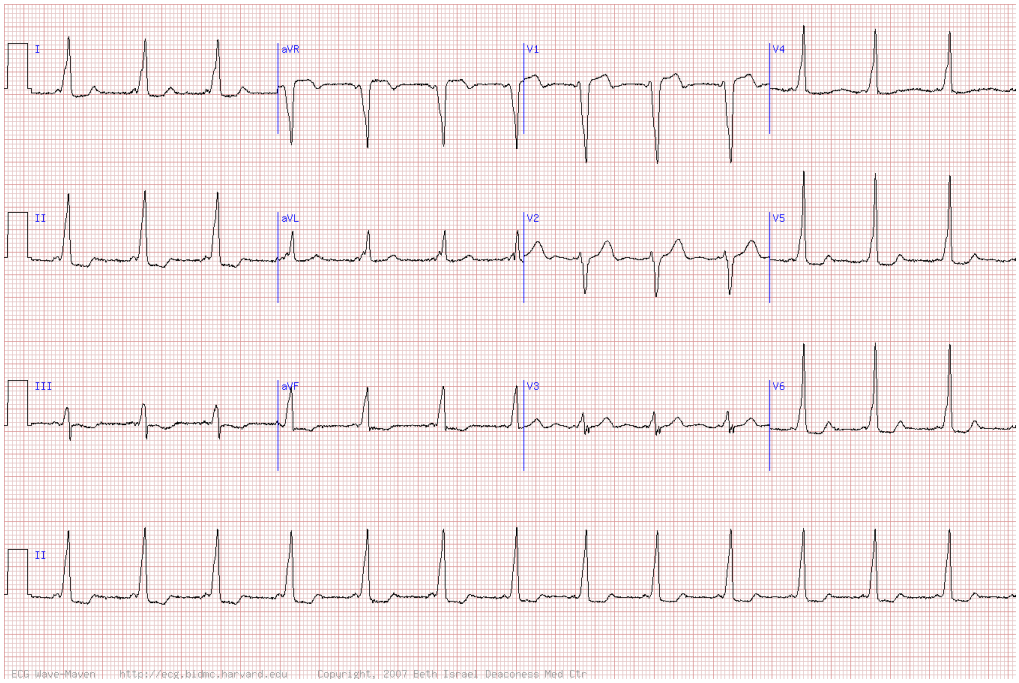

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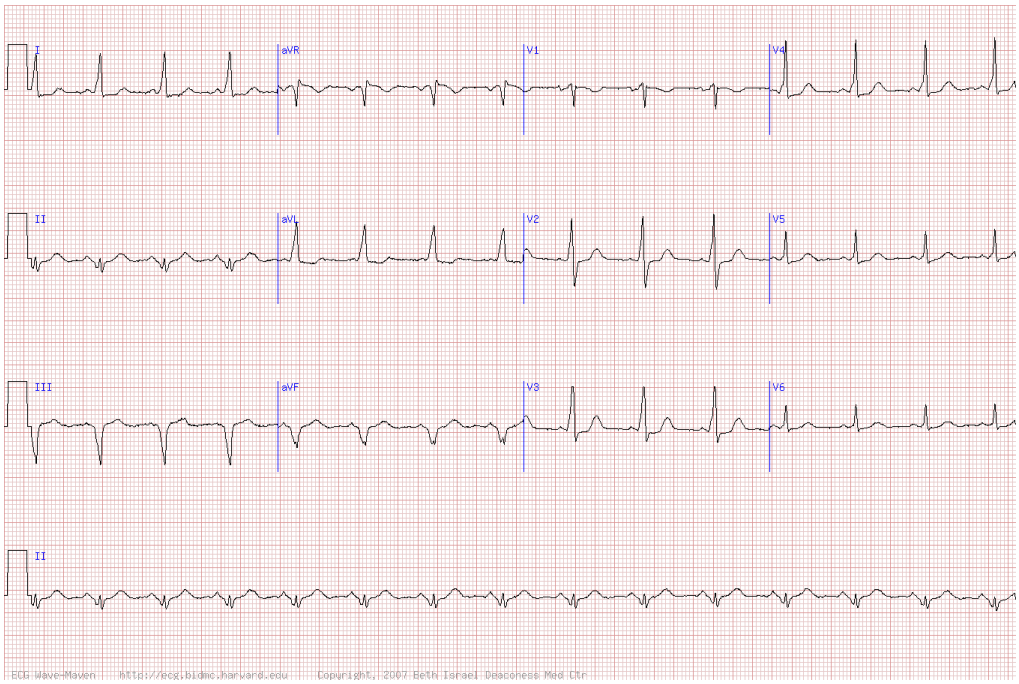

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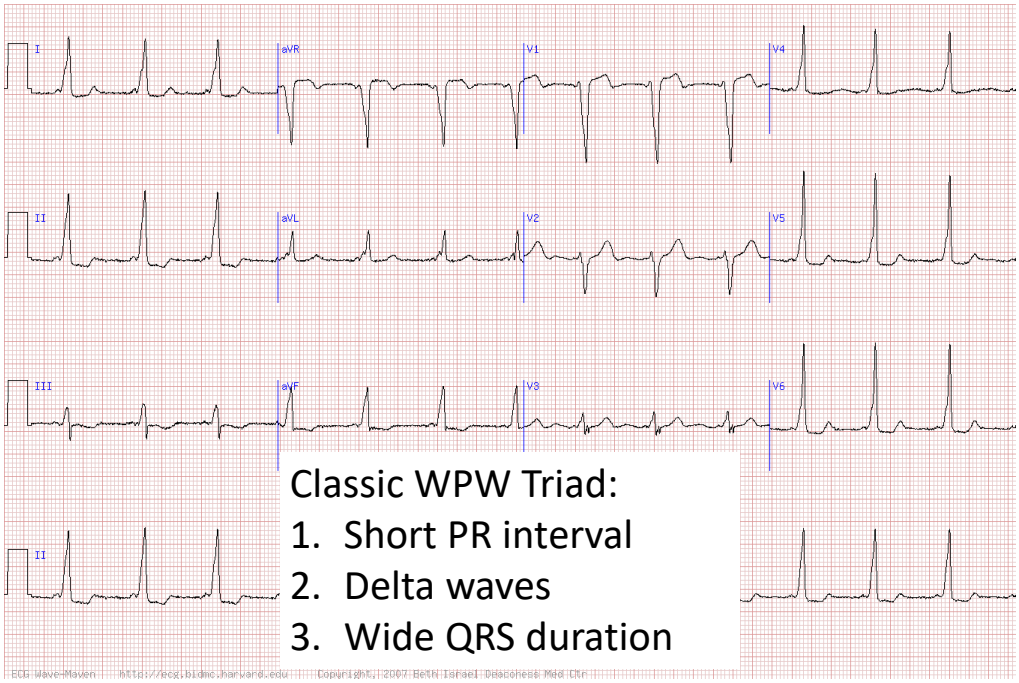

Classic WPW Triad:

1. Short PR interval
2. Delta waves
3. Wide QRS duration

Nathanson LA et al. http://ecg.bidmc.harvard.edu.

Thank You

- Dale S. Adler, MD
- Leonard S. Lilly, MD
- Nathanson LA, McClennen S, Safran C, Goldberger AL. ECG Wave-Maven: Self-Assessment Program for Students and Clinicians. http://ecg.bidmc.harvard.edu.