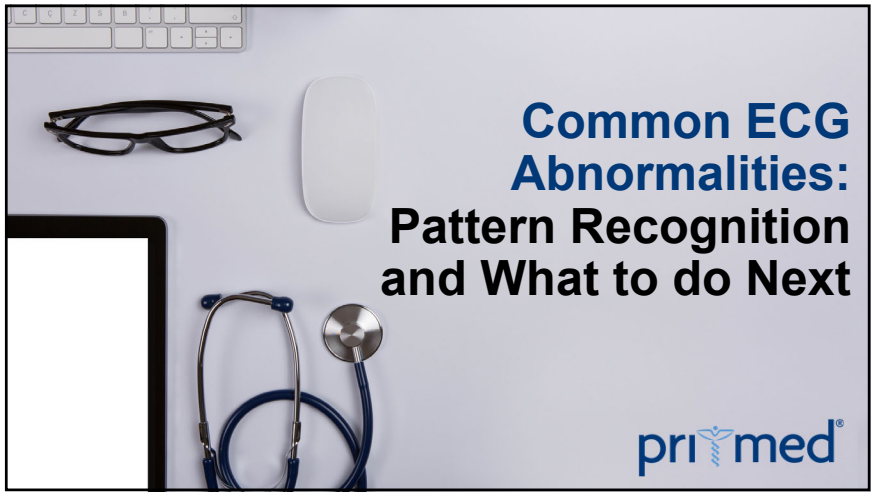

Common ECG Abnormalities: Pattern Recognition and What to do Next

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Faculty Disclosure Information

No relevant financial relationships have been disclosed related to this presentation:

The following faculty, as well as all other individuals contributing to content development and editorial review, have disclosed no relevant financial relationships:

- Ty J. Gluckman, MD, FACC, FAHA
- Charles Vega, MD

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Learning Objectives

1. Employ a systematic process to evaluate and analyze ECG rhythm strips
2. Identify common ECG dysrhythmias in primary care
3. Develop management strategies for common ECG dysrhythmias

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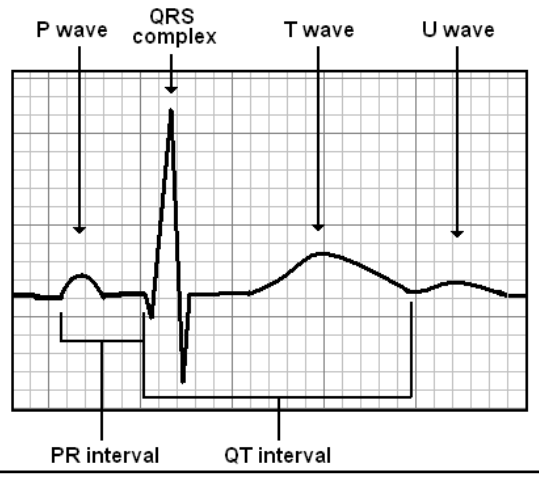
Waveforms and Intervals



Systematic Approach

- **Rate**
- **Rhythm**
- **Axis**
- **Wave Morphology**
  - P, T, and U waves and QRS complex
- **Intervals**
  - PR, QRS, QT
- **ST Segment**

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Heart Rate – Remember the Rule of 300?

Divide the number of "big boxes" between QRS complexes into 300:

# of big boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50

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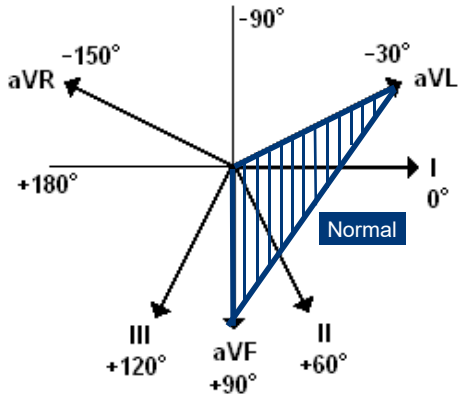
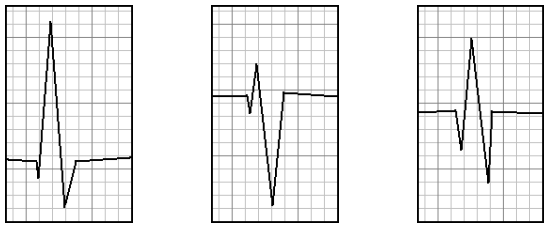
Determining Axis – A Handy Tool



Determining the Axis



Predominantly Positive | Predominantly Negative | Equiphasic

The Equiphasic Approach

1. Determine which lead contains the most equiphasic QRS complex. The fact that the QRS complex in this lead is equally positive and negative indicates that the net electrical vector (i.e., overall QRS axis) is perpendicular to the axis of this particular lead.
2. Examine the QRS complex in whichever lead lies 90° away from the lead identified in step 1. If the QRS complex in this second lead is predominantly positive, than the axis of this lead is approximately the same as the net QRS axis. If the QRS complex is predominantly negative, than the net QRS axis lies 180° from the axis of this lead.

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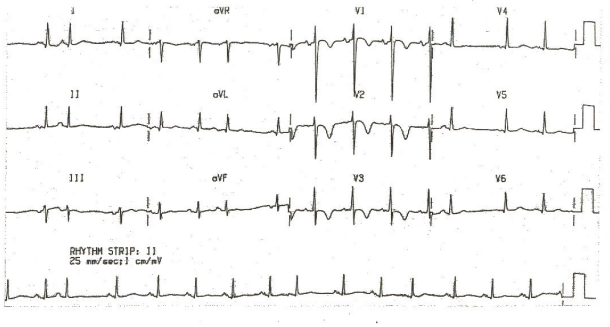
Equiphasic Approach: Example 1

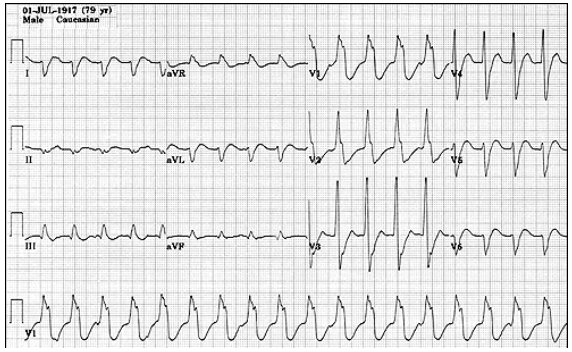
Equiphasic in aVF → Predominantly positive in I → QRS axis ≈ 0°



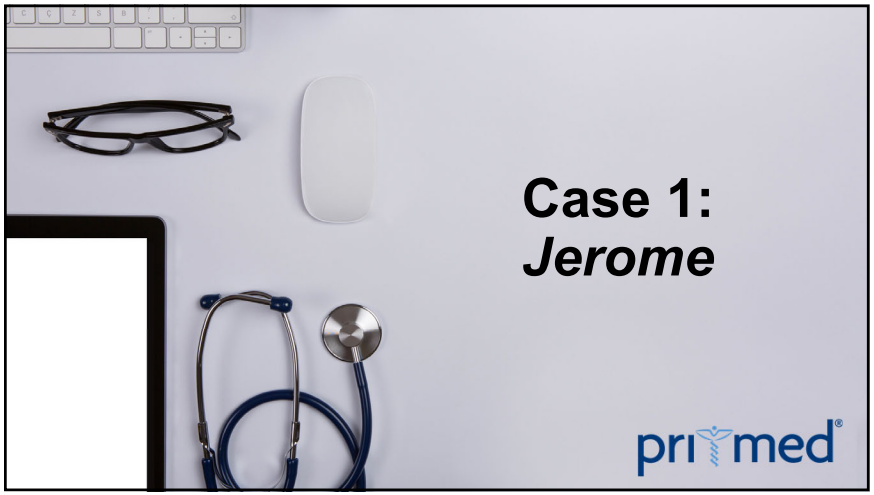
The Alan E. Lindsay ECG Learning Center ; http://medstat.med.utah.edu/kw/ecg/

Equiphasic Approach: Example 2

Equiphasic in II → Predominantly negative in aVL → QRS axis ≈ +150°

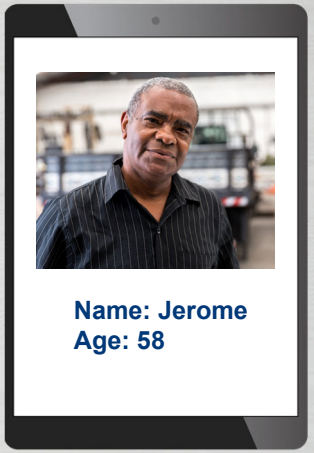


The Alan E. Lindsay ECG Learning Center ; http://medstat.med.utah.edu/kw/ecg/

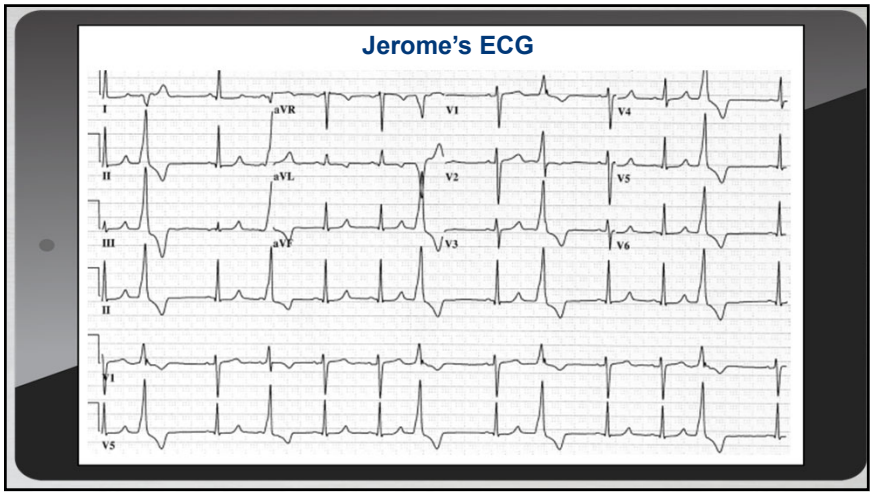


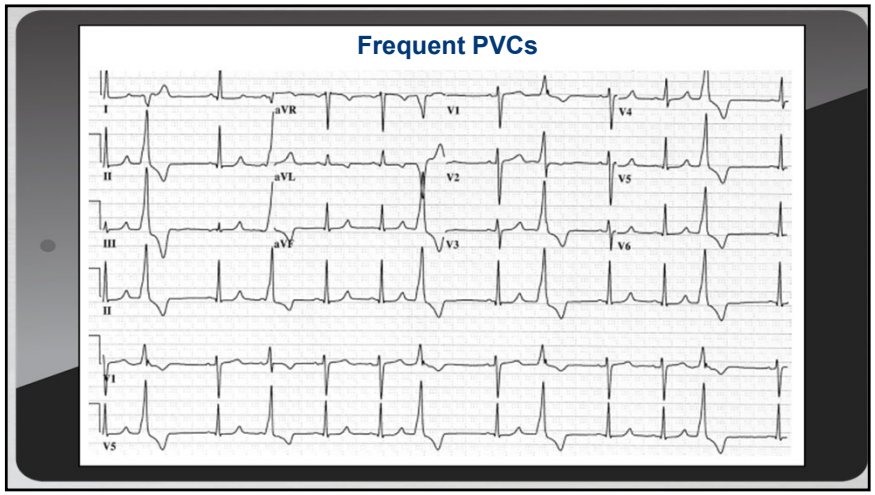
Jerome

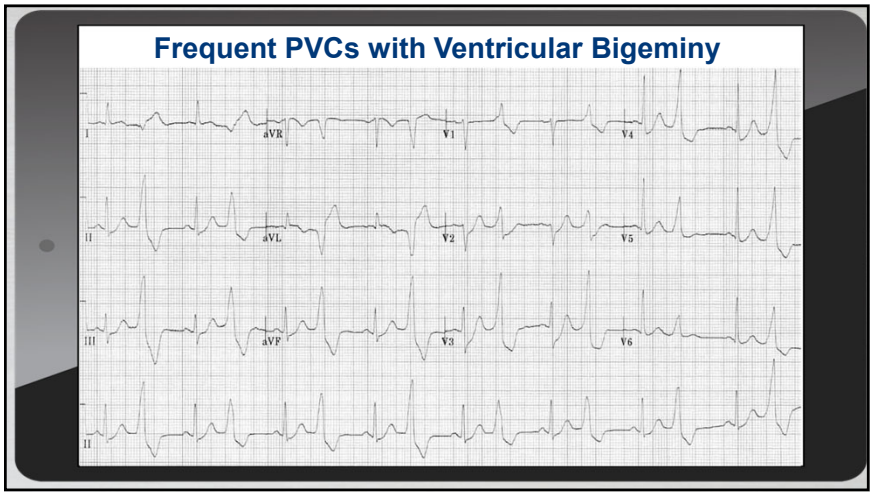
- You are seeing a 58-year-old man with a history of hypertension and obesity.
- He feels well but complains of rare lightheadedness that lasts a few seconds.
- He has never fallen, and the symptoms are not postural.
- Medications include lisinopril and hydrochlorothiazide.
- His blood pressure today is 148/86 mm Hg, and his pulse rate is 76 BPM.



Name: Jerome
Age: 58







Premature Ventricular Contractions (PVCs)
Nomenclature and Prevalence

- Nomenclature
  - Also referred to as ventricular premature beats (VPBs), ventricular premature complexes (VPCs), premature ventricular beats (PVBs) or ventricular extrasystoles
- Epidemiology
  - PVCs are common in those without structural heart disease and those with any form of cardiac disease, regardless of severity
  - It is estimated that PVCs occur in 1% of routine ECGs of 30-60 seconds duration
  - Up to 80% of healthy individuals will have PVCs on 24-hour ambulatory monitoring
  - There is an age-related increase in the prevalence of PVCs among those with and without cardiac disease
  - In an analysis of 15,792 individuals (45-65 yr), 6% had an PVC on a 2-minute ECG

Hiss RG et al. Circulation 1962;25:947-961; Brodsky M et al. Am J Cardiol 1977;39:390-395; Sobotka PA et al. Am Heart J 1981;101:753-759; Simpson RJ Jr et al. Am Heart J 2002;143:535-540; Glasser SP et al. Chest 1979;75:565-568

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Premature Ventricular Contractions (PVCs)—
Symptoms and Diagnostic Evaluation

Associated conditions	Symptoms	Diagnostic evaluation (for symptomatic patients)
• Hypertension • Acute myocardial infarction • Heart failure, myocarditis • Hypertrophic cardiomyopathy • Congenital heart disease • Ventricular tachycardia	• In the vast majority, they produce few or no symptoms • Rarely, palpitations (due to hypercontractility from a post-PVC beat) or dizziness may occur • Most commonly noted in a quiet environment (e.g., at night while lying in bed)	• 12-lead ECG • 24 hour ambulatory arrhythmia monitoring (or longer if necessary) • Echocardiography to assess cardiac structure and function • Stress ECG to assess the response to exercise (and to screen for ischemia) • Laboratory testing (electrolytes, TSH)

Hiss RG et al. Circulation 1962;25:947-961; Brodsky M et al. Am J Cardiol 1977;39:390-395; Sobotka PA et al. Am Heart J 1981;101:753-759; Simpson RJ Jr et al. Am Heart J 2002;143:535-540; Glasser SP et al. Chest 1979;75:565-568

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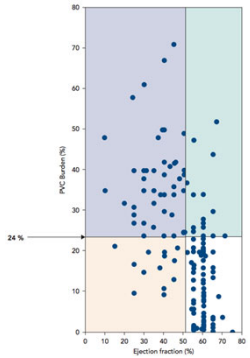
Premature Ventricular Contractions (PVCs)
Prognosis and Treatment

- Prognosis
  - There is an association with increased risk of mortality (>2-fold increased risk over 10 years)
- Treatment (for symptomatic patients)
  - No evidence of benefit from PVC suppression with antiarrhythmic drug therapy in asymptomatic patients
  - Primary focus is treating underlying conditions (triggers) and avoidance of stimulants (e.g., nicotine, alcohol, sympathomimetics [decongestants], illicit drugs)
  - Beta blockers and/or centrally acting calcium channel blockers as 1st line therapy
  - Antiarrhythmic drug therapy and/or catheter ablation may be considered if refractory symptoms
  - Catheter ablation should also be considered in patients with frequent PVCs and left ventricular systolic dysfunction

Hiss RG et al. Circulation 1962;25:947-961; Brodsky M et al. Am J Cardiol 1977;39:390-395; Sobotka PA et al. Am Heart J 1981;101:753-759; Simpson RJ Jr et al. Am Heart J 2002;143:535-540; Glasser SP et al. Chest 1979;75:565-568

Premature Ventricular Contractions (PVCs)—
Induced Cardiomyopathy



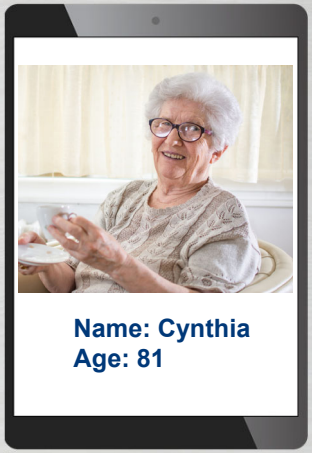
- The occurrence of frequent PVCs (>20% of overall heart beats) is seen in <2% of patients
- A higher frequency of PVCs is associated with a decrease in left ventricular ejection fraction, an increased incidence of heart failure, and increased mortality
- Previous analyses have suggested that a PVC burden >24% is independently associated with PVC-induced cardiomyopathy (a type of tachycardia-induced cardiomyopathy)

Yang J et al. Pacing Clin Electrophysiol 2014;37:1671-1680; Baman TS et al. Heart Rhythm 2010;7:865-869; Dukes JW et al. J Am Coll Cardiol 2015;66:101-109 am

Case 2: *Cynthia*

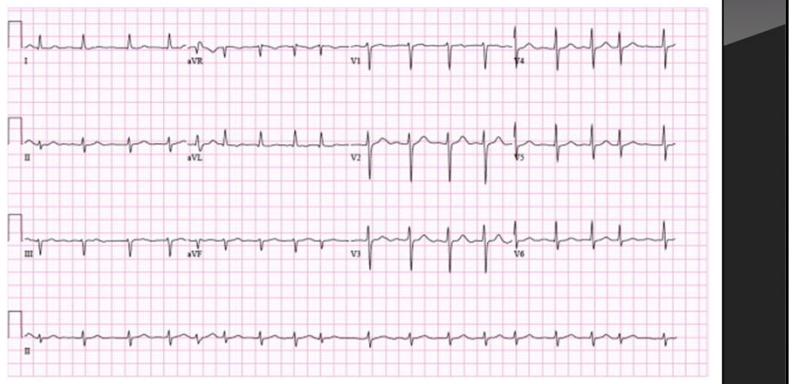
Cynthia

- You are seeing an 81-year-old woman with a history of type 2 diabetes and hyperlipidemia for a routine examination.
- You note that her blood pressure is 130/70 mm Hg and pulse is 102 bpm before entering the room.
- When you examine her heart, you note an irregularly irregular rhythm with an increased heart rate.
- The patient insists she feels fine in response to your multiple questions.



Name: Cynthia
Age: 81

Cynthia's ECG



Cynthia

- How would you interpret Cynthia's ECG?
- How would you further evaluate and treat Cynthia?

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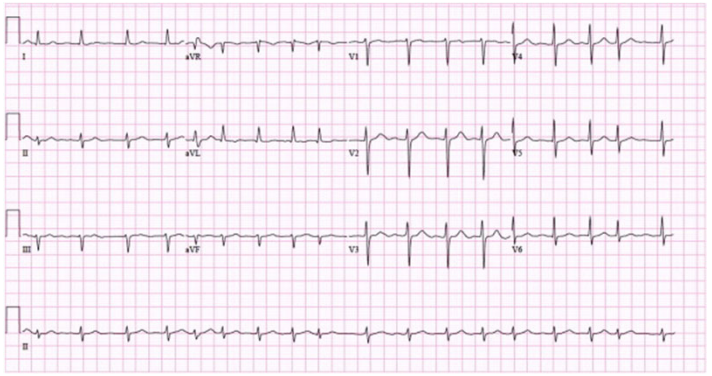
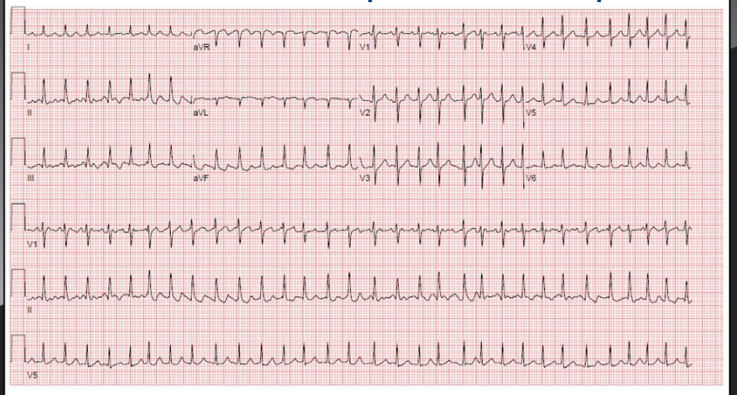
Atrial Fibrillation with a Controlled Ventricular Response

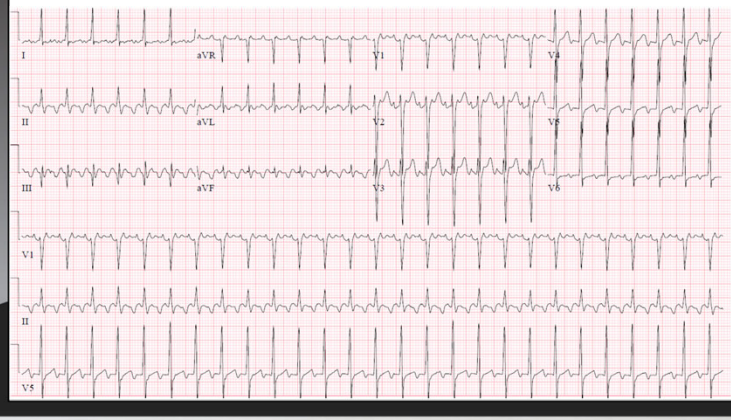


Atrial Fibrillation with Rapid Ventricular Response



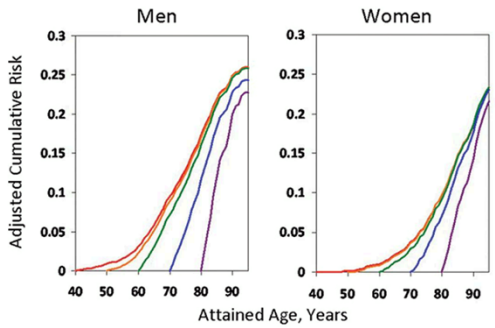
Atrial Flutter with 3:1 Conduction

Atrial Flutter with 2:1 Conduction



Atrial Fibrillation – Epidemiology

- Most common sustained arrhythmia
- Notable increase in prevalence with increased age
- Among men and women without atrial fibrillation at 40 years, 26% and 23% will develop atrial fibrillation by age 80, respectively



Magnani JW et al. Circulation 2011;124:1982-1993

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Atrial Fibrillation – Treatment

Should the patient be managed with a rate-control (AV nodal blocking agents) or rhythm-control (antiarrhythmic drug and/or catheter ablation) strategy?

- **Treatment**
  - Most patients with symptoms benefit from slowing of the ventricular rate
  - Across broad populations, rate-control and rhythm-control strategies have been associated with similar rates of stroke or systemic embolism
  - No difference in outcomes when the rate is rate <80 bpm vs. <110 bpm
- **Limitations of clinical trial data**
  - In the two largest trials (AFFIRM and RACE), the mean age was 70 and 68 years. As such, does the approach differ for those that are younger?
  - Approximately one half of patients in the AFFIRM trial had symptomatic episodes less than 1 time per month. As such, does the approach differ for those with a higher symptom burden?

Magnani JW et al. Circulation 2011;124:1982-1993

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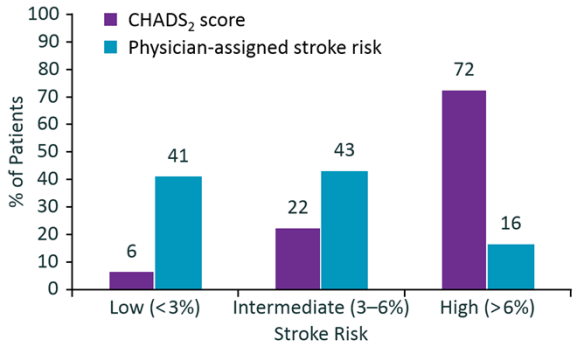
Atrial Fibrillation – Treatment

Formal assessment of stroke risk should be performed



Steinberg BA et al. Circulation 2014;129:2005-2012

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Atrial Fibrillation – Treatment

Should the patient be treated with long-term antithrombotic therapy?

CHA_2DS_2-VASc Score	Recommended Therapy	Class of Recommendation
0 (Men) 1 (Women)	Omit anticoagulant therapy	I IIa IIb III B
1 (Men) 2 (Women)	Oral anticoagulant	I IIa IIb III C
≥2 (Men) ≥3 (Women)	Warfarin (A) NOAC (B)	I IIa IIb III A I IIa IIb III B

*The same antithrombotic recommendations apply to atrial flutter (Class I, Level C)
^NOACs are recommended over warfarin in NOAC-eligible patients with atrial fibrillation except with moderate-severe mitral stenosis or a mechanical heart valve (Class I, Level A)

January CT et al. J Am Coll Cardiol 2019:Epub ahead of print

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Atrial Flutter

- Atrial flutter is unusual in patients without heart disease
  - It is often associated with mitral valve disease, prior heart surgery, pericardial disease, and acute or chronic pulmonary disease
- Clinical manifestations of atrial flutter are similar to those of atrial fibrillation
- The treatment strategies of atrial flutter are similar to atrial fibrillation
  - It is more difficult to achieve rate control with atrial flutter compared to atrial fibrillation, especially in those with 2:1 flutter
  - Recurrence of atrial flutter is common among those without a correctable cause
  - Long-term antiarrhythmic medications are infrequently used because of the high success rate of catheter ablation for typical atrial flutter

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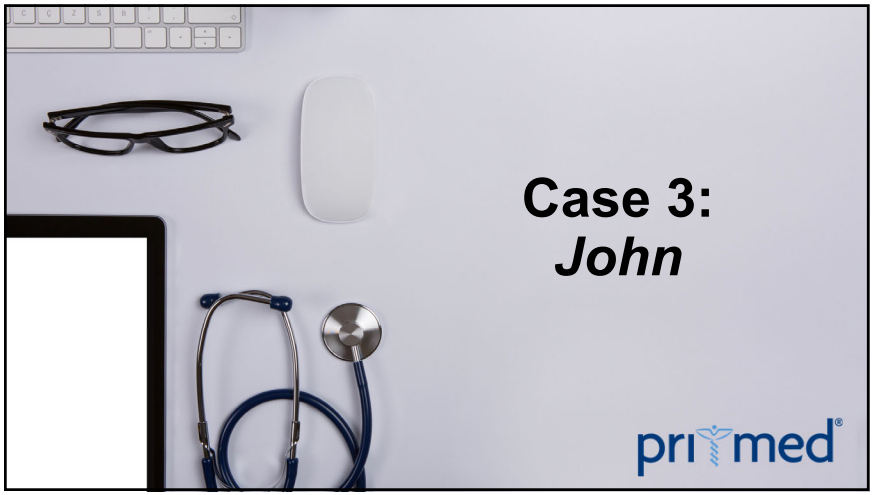
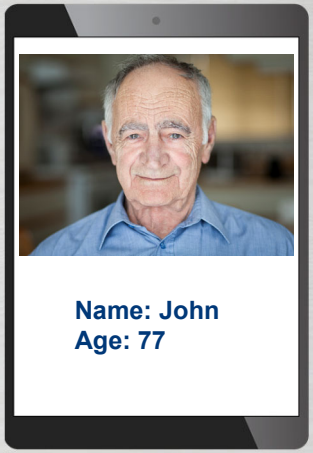


John

- You are seeing a 77 year-old man with a history of coronary stents placed 3 years ago.
- He complains of intermittent chest pain in his central chest that does not radiate.
- It can last for hours and sometimes gets worse when he is agitated or physically active.
- He tried an old prescription for nitroglycerin, and it had no effect on the pain.
- His vital signs and physical examination is normal.



Name: John
Age: 77

[John]

- How would you interpret John's ECG?
- How would you further evaluate and treat John?

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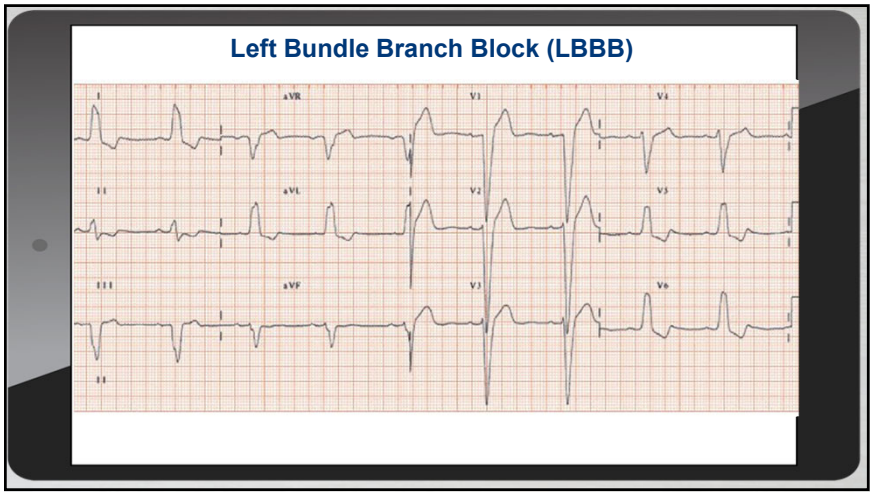


Left Bundle Branch Block (LBBB)

Epidemiology

- Prevalence increases with age (0.05% at age <30, 0.4% at age 50, 2.3% at age 75, 5.7% at age 80)
- Associated with higher rates of hypertension, cardiomegaly and coronary heart disease
- Most commonly due to slow, progressive degeneration of the conduction system

Prognosis

- Mixed data as to the prognosis in asymptomatic patients
- Higher risk of mortality among those with coronary heart disease

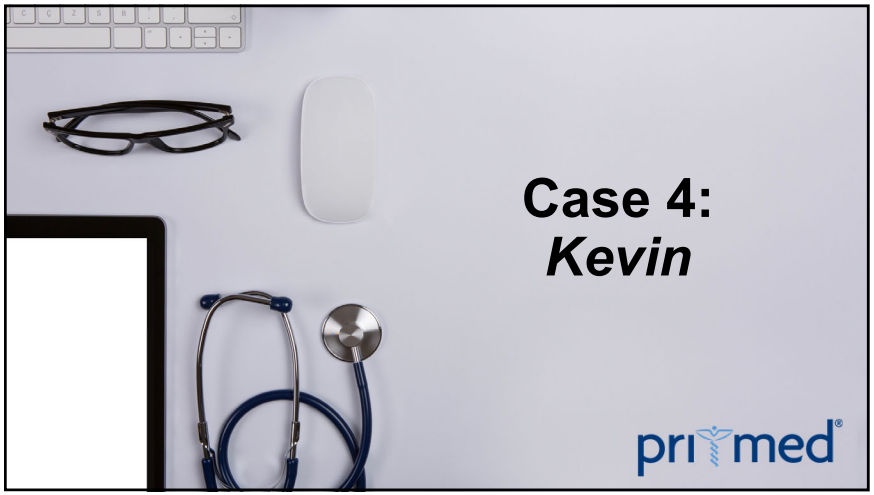
Evaluation

- Echocardiogram to exclude underlying structural abnormalities

Treatment

- No specific treatment in asymptomatic individuals
- Permanent pacemaker in those with symptoms related to conduction block

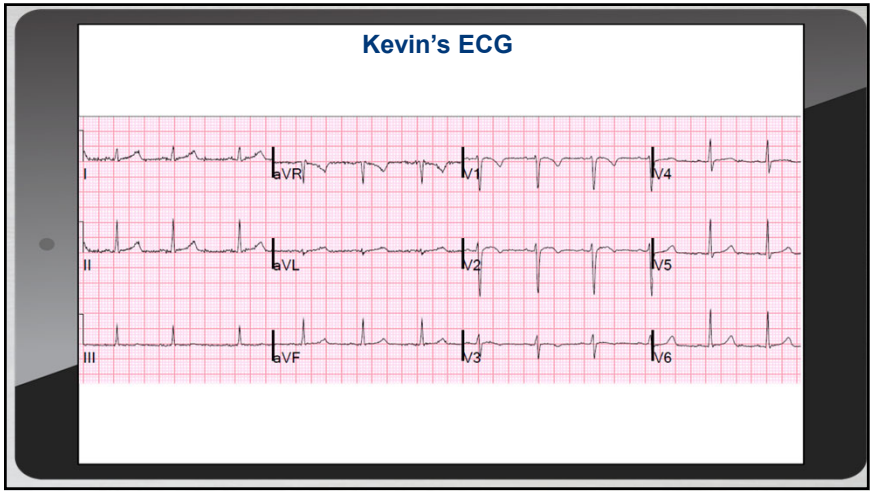
Rotman M et al. Circulation 1975;51:477-484; Eriksson P et al. Circulation 1998;98:2494-2500



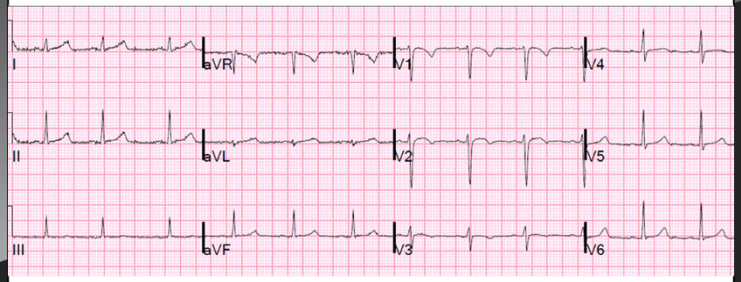
Kevin

- You are seeing a 50 year-old man who was brought in by friends from the construction site where they work.
- He had become dizzy and fallen over, and his colleagues noted that he was diaphoretic and clearly uncomfortable.
- The patient says that he just has a virus.
- He has a past medical history of type 2 diabetes, hyperlipidemia, and obesity.
- His blood pressure is 160/94 mm Hg, and his pulse is 80 bpm.

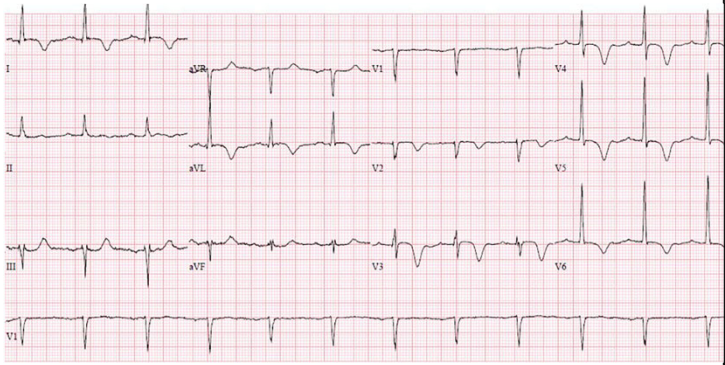
Name: Kevin
Age: 50



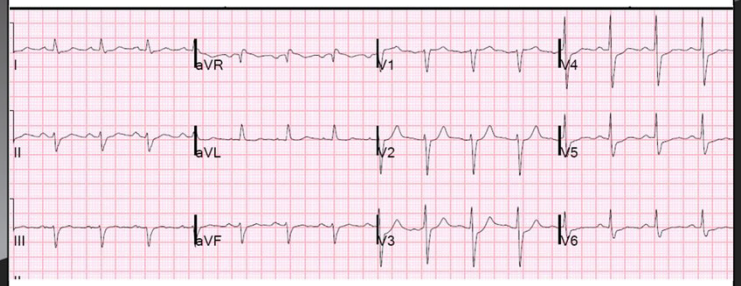
Ischemic ECG Changes–T Wave Inversion



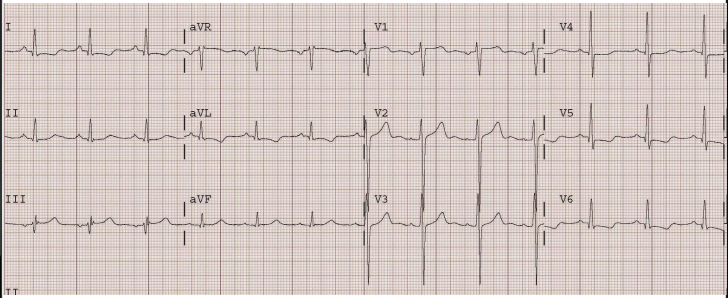
Ischemic ECG Changes–T Wave Inversion

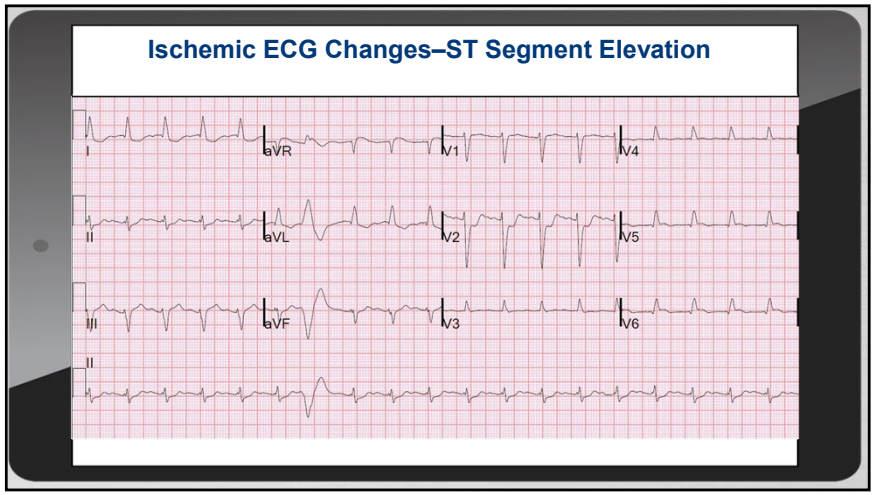


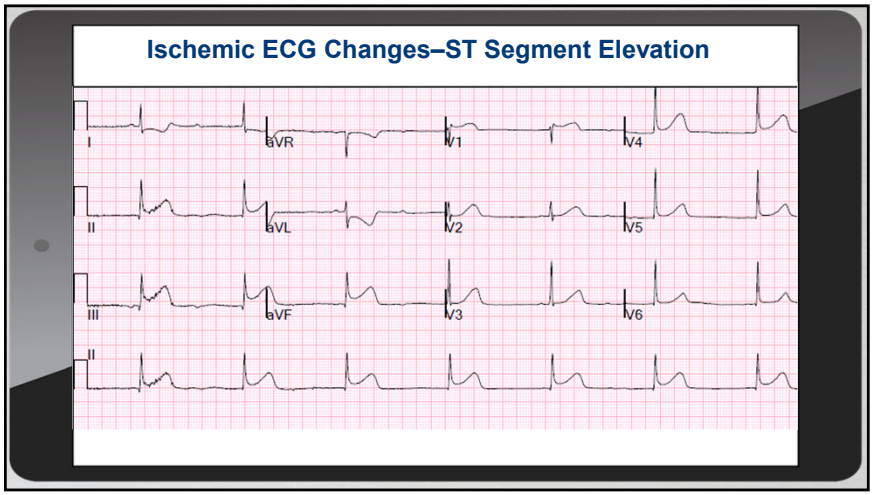
Ischemic ECG Changes–ST Segment Depression



Ischemic ECG Changes–ST Segment Depression







Acute Coronary Syndrome
(Includes Unstable Angina, NSTEMI, and STEMI)

- Epidemiology
  - 957,000 myocardial infarction cases and 382,000 unstable angina cases in 2014
  - STEMI accounts for approximately 23% of ACS cases
- Evaluation
  - An ECG should be performed within 10 minutes of arrival in those with symptoms suggestive of an acute coronary syndrome
  - The ECG serves to categorize patients into two groups:
    - ST-segment elevation myocardial infarction (STEMI)
    - Non-ST-segment elevation acute coronary syndrome (NSTE-ACS)
  - Because the initial ECG is often non-diagnostic, it should be repeated every 15-30 minutes until the symptoms resolve or a definitive diagnosis is made
  - A completely normal ECG in a patient with chest pain does not exclude an acute coronary syndrome, as 1-6% of patients will have a myocardial infarction and 4% will have unstable angina

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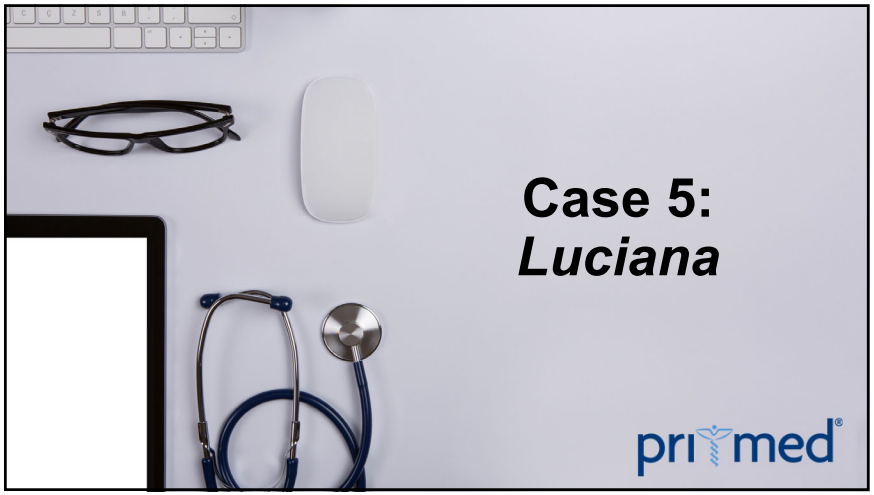
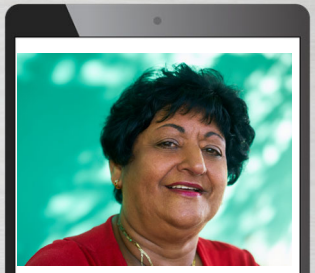
Benjamin EJ et al. Circulation 2018;137:e67-e492; Amsterday EA et al. J Am Coll Cardiol 2014;64:e139-228



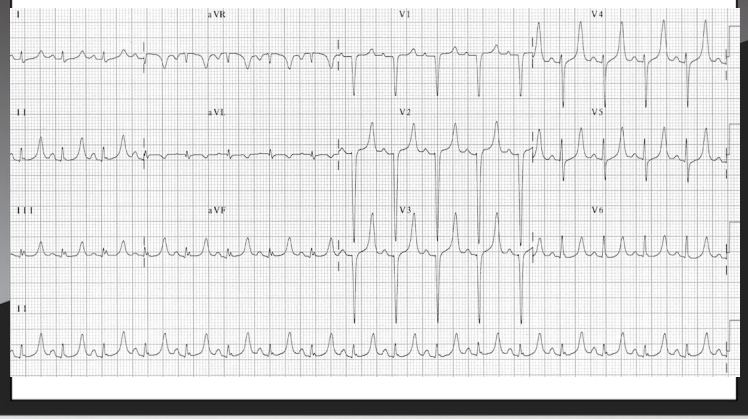
Luciana

- You are seeing a 60 year-old woman who complains of general fatigue for the past 5 days.
- She has a history of hypertension, type 2 diabetes, osteoarthritis, chronic kidney disease, and heart failure.
- Her medications include benazepril, naproxen, metformin, spironolactone, and metoprolol succinate.
- Her vital signs and physical examination are unremarkable.

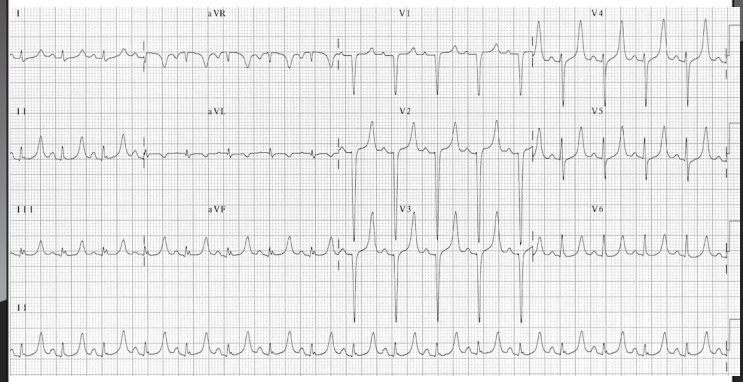


Name: Luciana
Age: 60

Luciana's ECG



Hyperkalemia



Hyperkalemia (K+ > 5 mEq/L)

- Epidemiology
  - There are multiple causes of hyperkalemia (e.g., increased ingestion, cellular shift, impaired renal excretion, etc.)
  - Prevalence of 1.6% for the overall population and 6.4% among those with chronic kidney disease and/or heart failure in 2014
- Evaluation
  - An ECG has poor sensitivity (around 30%) for detection of hyperkalemia
  - As the potassium level increases, however, progressive ECG findings may be observed
    - Peaked T waves that are tall, narrow and symmetric → ST-segment depression → widening of the PR interval → widening of the QRS interval → loss of the P wave → sine-wave pattern

Betts KA et al. Curr Med Res Opin 2018;34:971-978; Palmer BF et al. Cleve Clin J Med 2017;84:934-942

Resources

Online Resources:

Overall resource:

http://utmc.utoledo.edu/depts/nursing/pdfs/Basic%20EKG%20Refresher.pdf

More basic:

https://www.youtube.com/watch?v=FThXJUFWUrw

https://www.practicalclinicalskills.com/ecg-tutorial

https://bjcardio.co.uk/2014/03/my-top-10-tips-for-ecg-interpretation/

https://www.slideshare.net/meducationdotnet/a-students-guide-to-ecg-interpretation

Less basic:

https://www.practicalclinicalskills.com/ekg

https://www.skillstat.com/tools/ecg-simulator

https://www.rcplondon.ac.uk/file/11118/download?token=uBqRQSqG

Print Resources:

More basic:
https://www.alibris.com/The-Complete-Guide-to-ECGs-James-H-OKeefe-Jr/book/35265647

Less basic:
https://www.amazon.com/Marriotts-Practical-Electrocardiography-Galen-Wagner/dp/1451146256

https://www.amazon.com/Rapid-Interpretation-EKGs-Sixth-Dubin/dp/0912912065

https://www.elsevier.com/books/clinical-electrocardiography-a-simplified-approach/goldberger/978-0-323-08786-5

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