

ECG's Step by Step

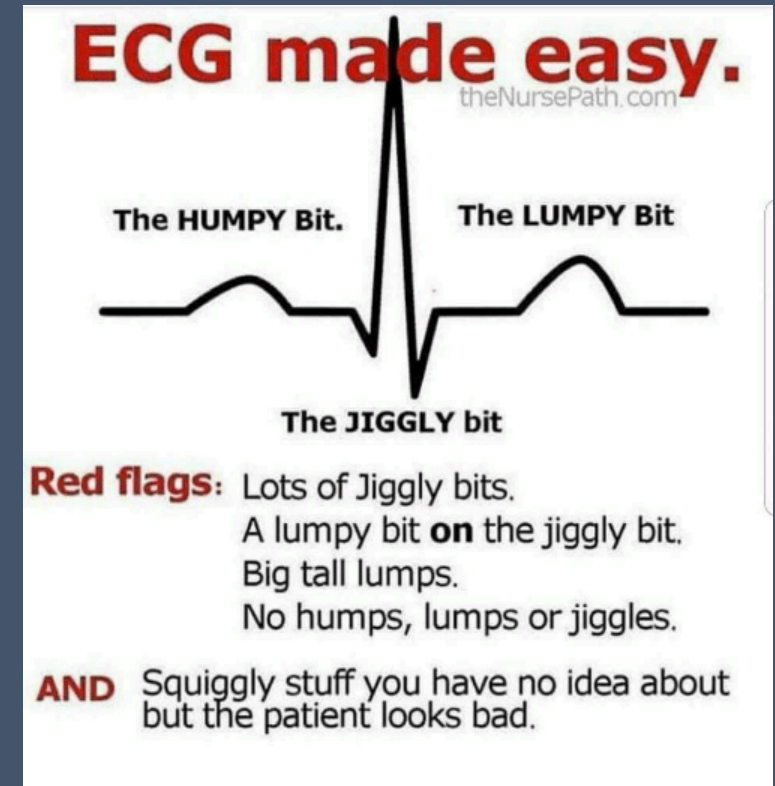
A Clinical Review

by

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ECG Interpretation Guide



History of the 12 Lead

- Einthoven built first clinical EKG in 1903 and coined the term as well as the convention “PQRST” deflections; earning him a Nobel Prize in 1924.
- In 1934, Dr. Frank N. Wilson of the University of Michigan developed the concept of the ‘central terminal’ blazing the way for the precordial leads “V1-6” as adopted by the AHA in 1938.
- In 1942, Dr. Goldberger, using Wilson's central terminal, constructed unipolar leads with the central (zero) terminal and connected to additional positive unipolar leads on each of the left and right arms and the left leg resulting in AVR, AVL and AVF.
- In 1954, the AHA recommended for standardization of 12-lead electrocardiogram

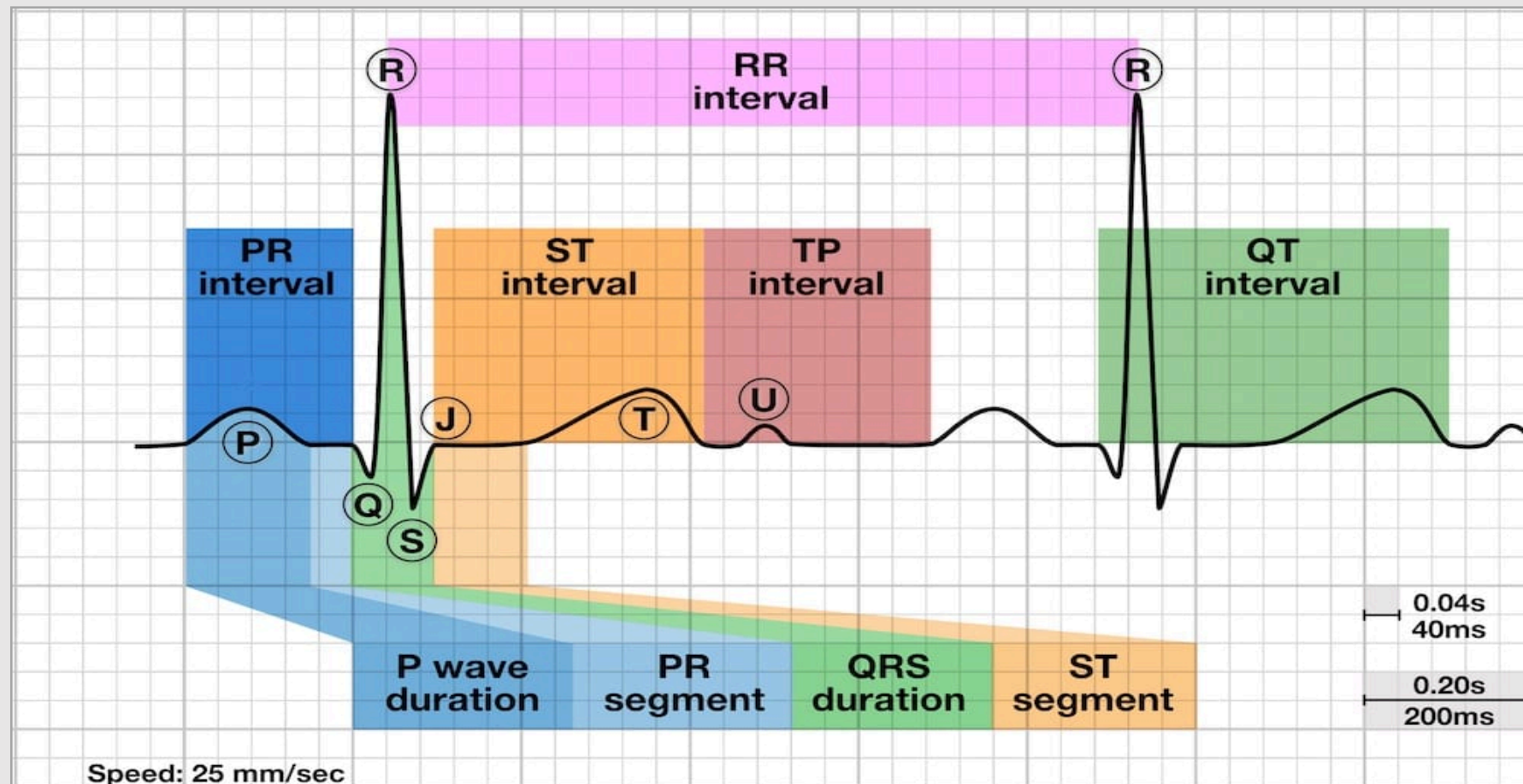


Learning Objectives

- Following this ECG review, students should be able to:
 - Do the things



Electro-Kardio-Gram



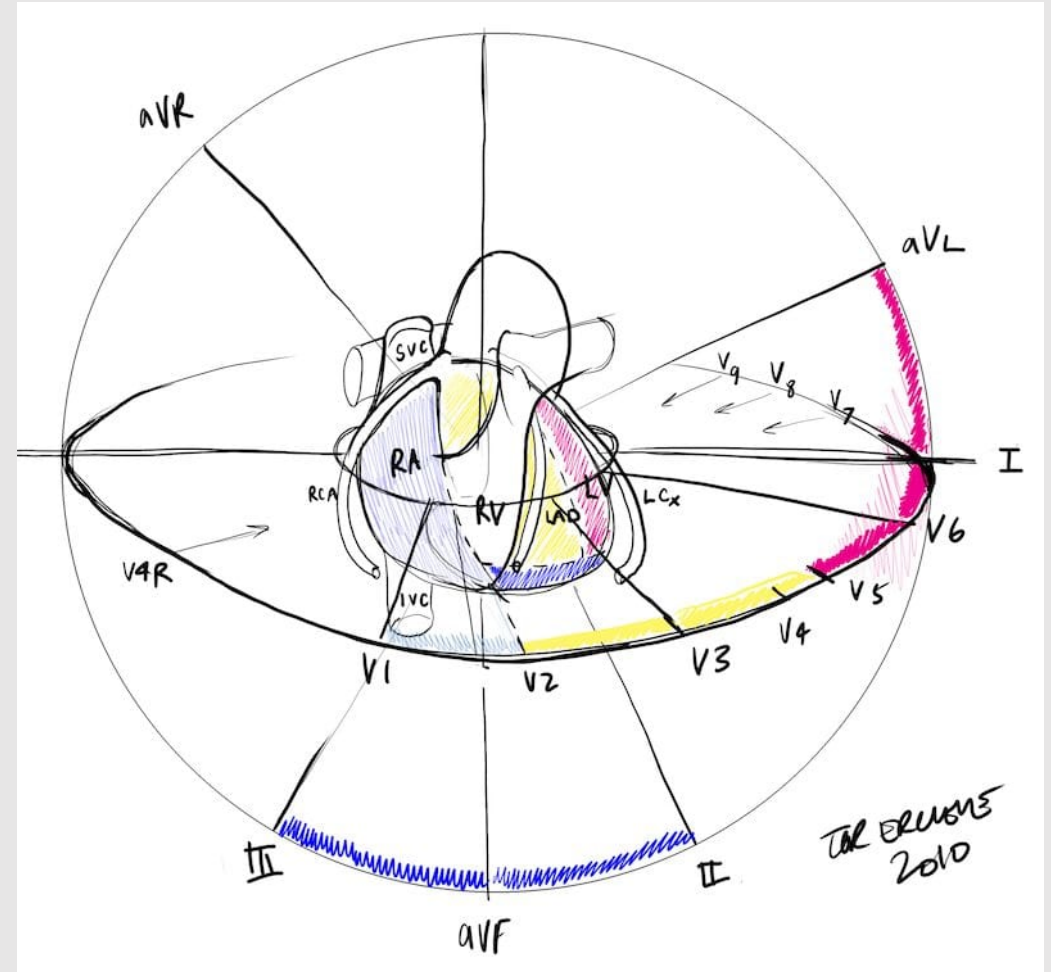
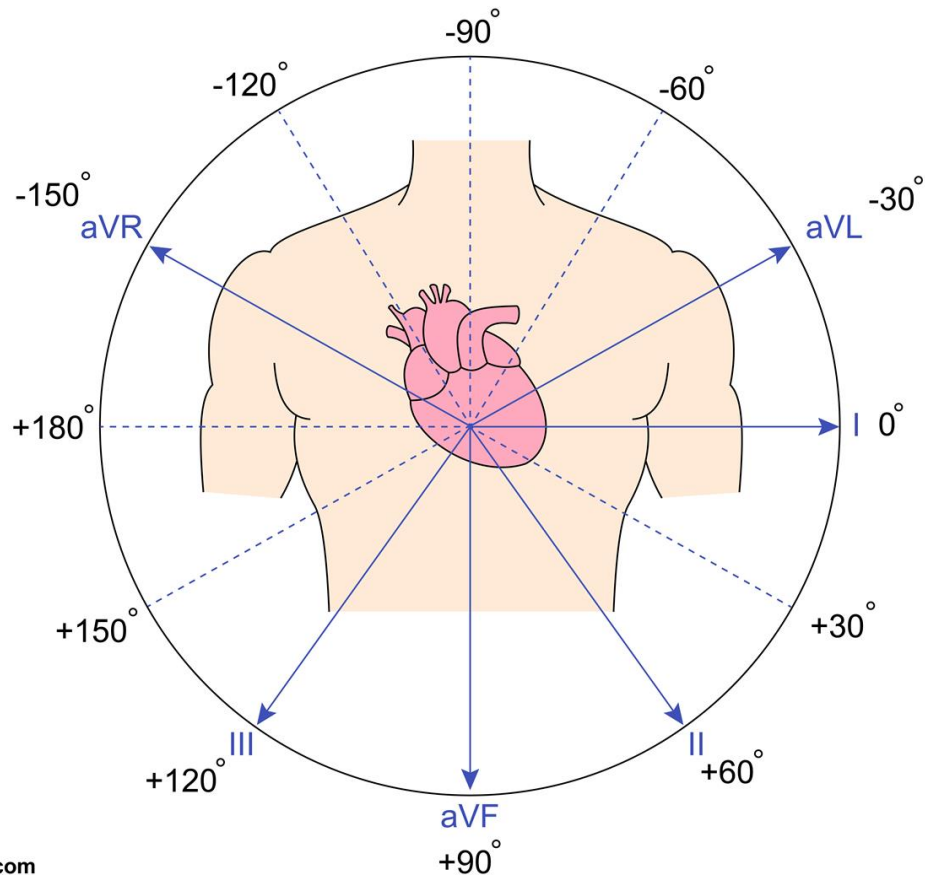
Key Terms

- **Wave:** A positive or negative deflection from baseline that indicates a specific electrical event. The waves on an ECG include the P wave, Q wave, R wave, S wave, T wave and U wave.
- **Interval:** The time between two specific ECG events. The intervals commonly measured on an ECG include the PR interval, QRS interval (also called QRS duration), QT interval and RR interval.
- **Segment:** The length between two specific points on an ECG that are supposed to be at the baseline amplitude (not negative or positive). The segments on an ECG include the PR segment, ST segment and TP segment.
- **Complex:** The combination of multiple waves grouped together. The only main complex on an ECG is the QRS complex.
- **Point:** There is only one point on an ECG termed the J point, which is where the QRS complex ends and the ST segment begins. Call



Where the leads go

Limb Leads



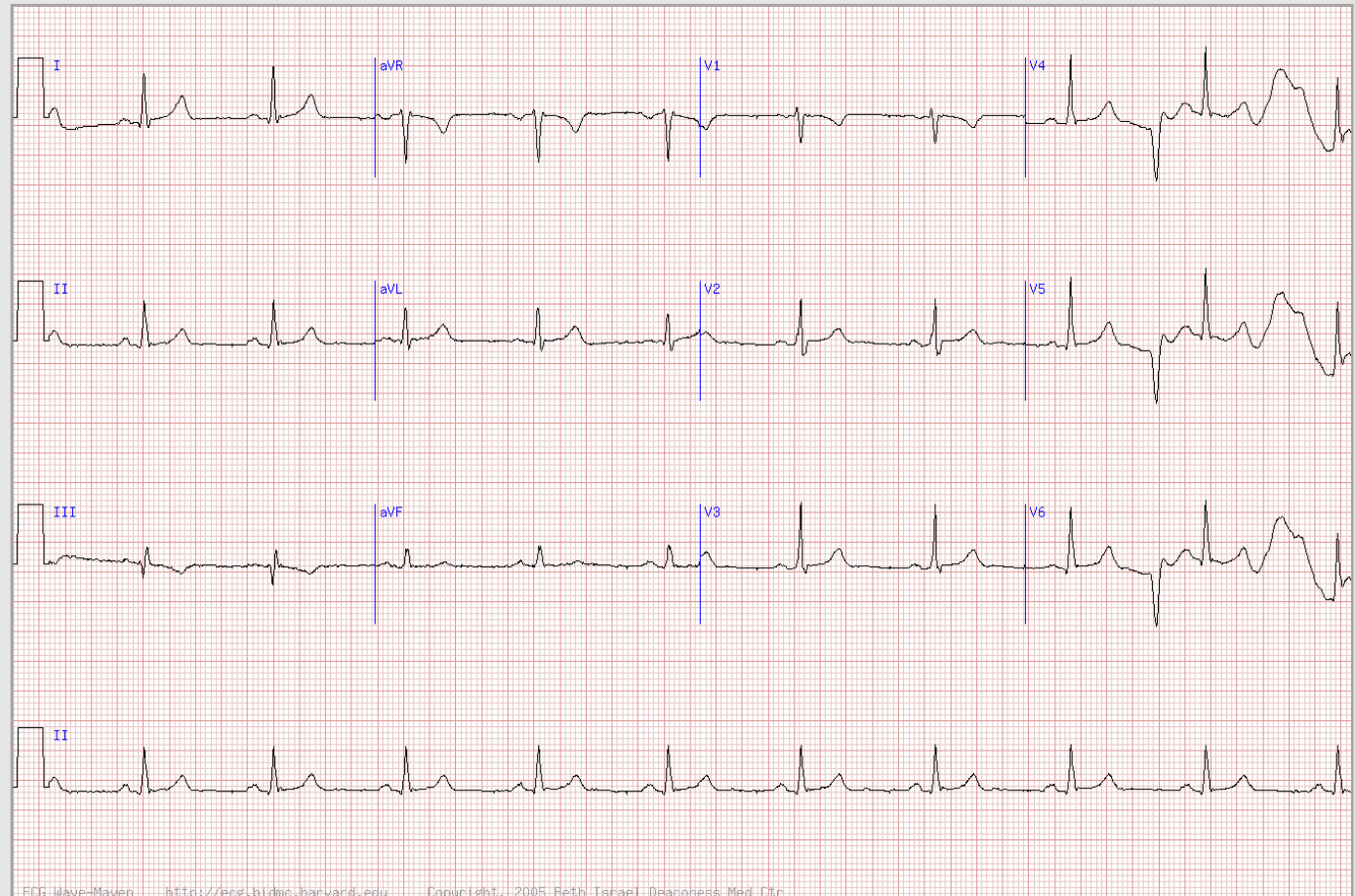
Step By Step Approach

- Develop a uniformed approach to reading every EKG so that you are not distracted by findings or bias!
- Helpful ECG Pocket review guide by Dr. Akshay Deshpande
 - Rate, Rhythm, Axis, Intervals, Ps and Qs, ST/Ts and Summery



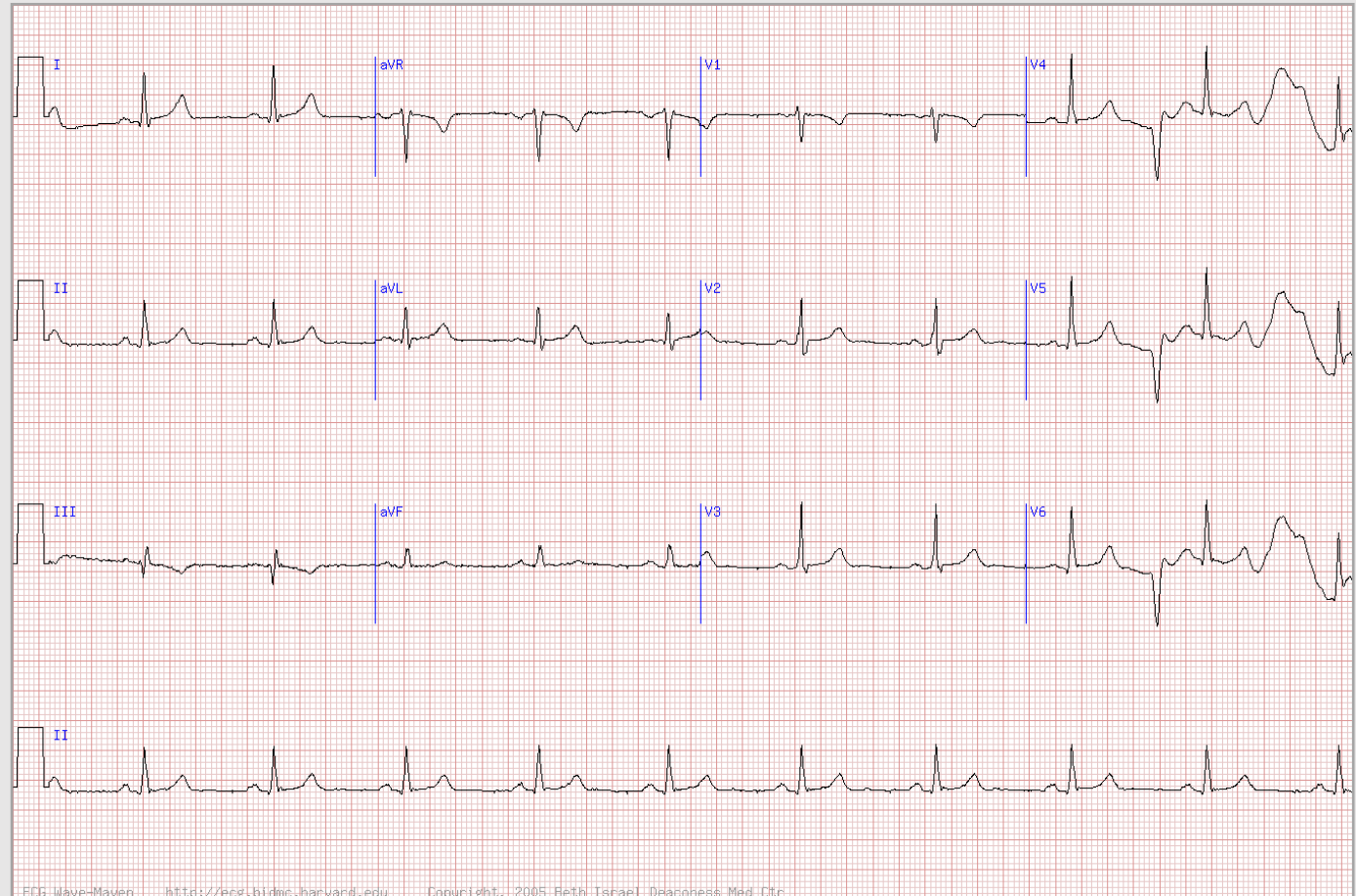
Step 1: Rate

- 2 Methods centered around principles of small boxes are 0.04s and large boxes are 0.2s
- Rate by Boxes
 - 300, 150, 100, 75, 60, 50, 43...
- Strip Method
 - R waves x 6



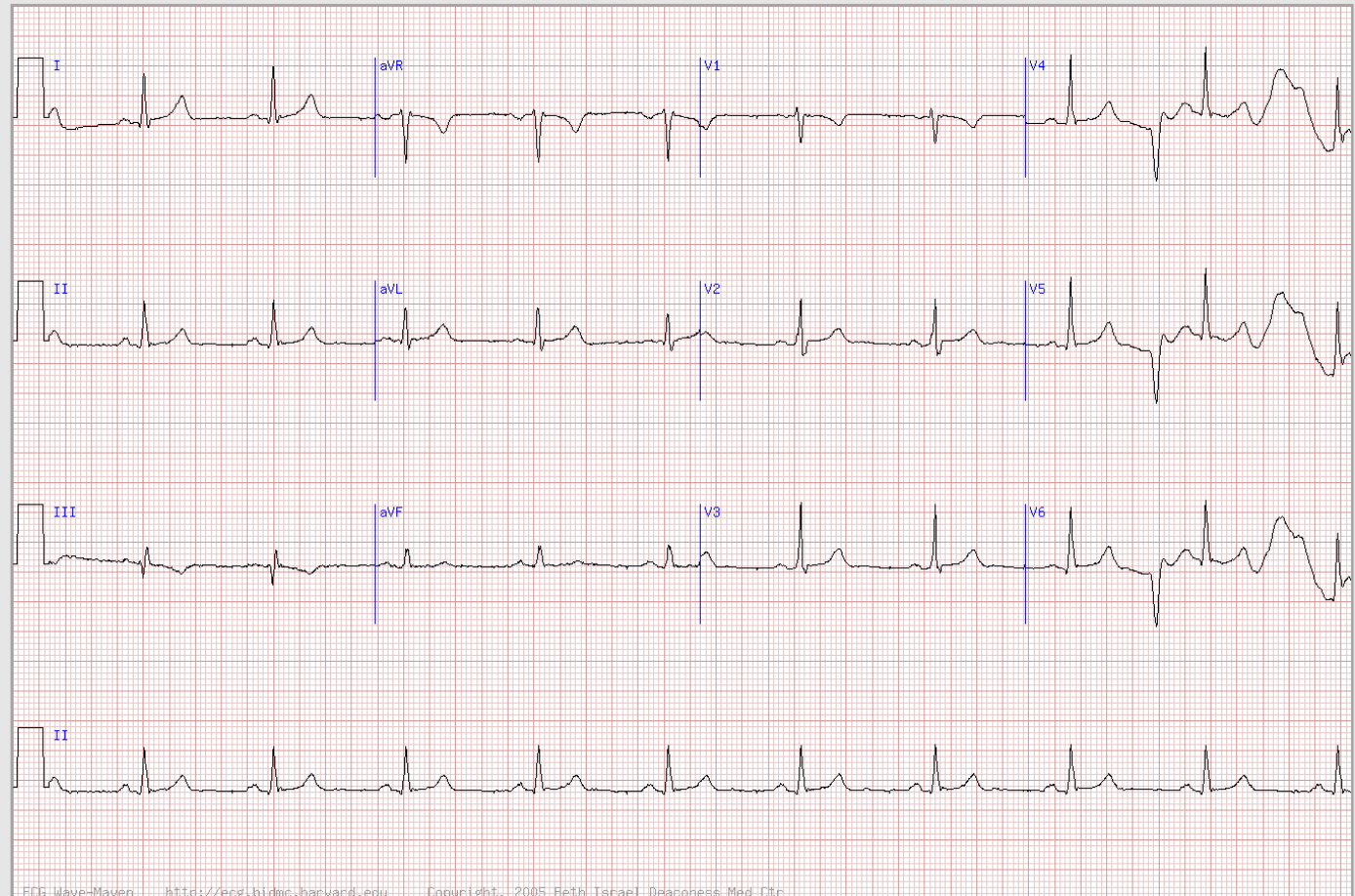
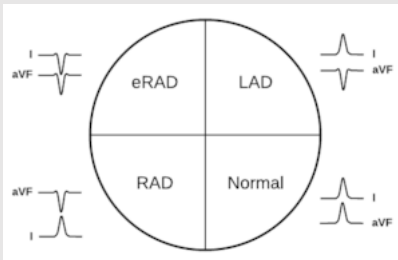
Step 2: Rhythm

- Is there a single, regular P before every Q wave?
 - Sinus Rhythm
- Varying P waves?
 - WAP or MAT
- No P waves
 - Buried* A fib, junctional or ventricular origins



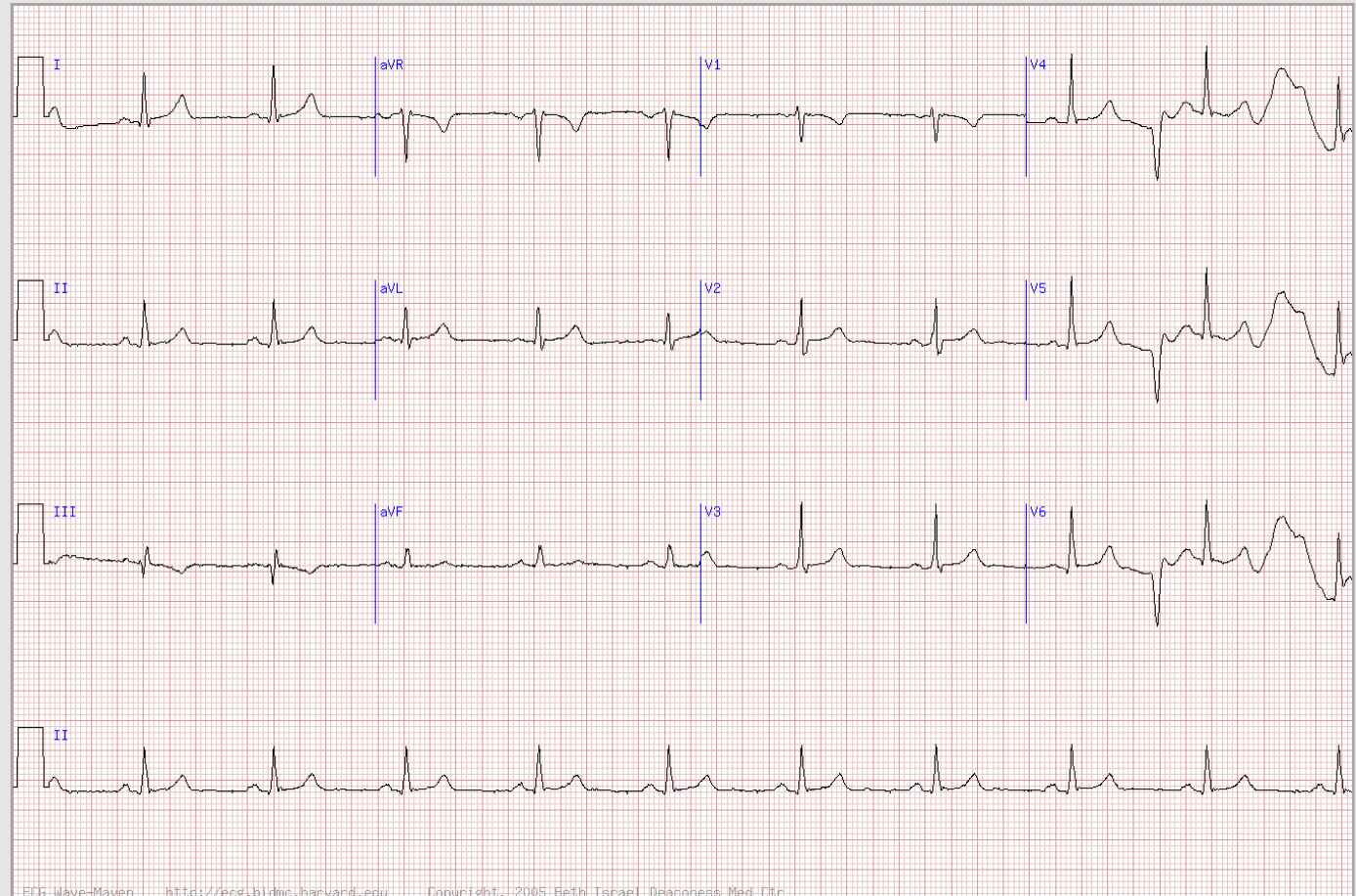
Step 3: Axis

- Look at I and AVF:
 - Up Up = Normal
 - Up Down = Left
 - Down Up = Right
 - Down Down = Extreme



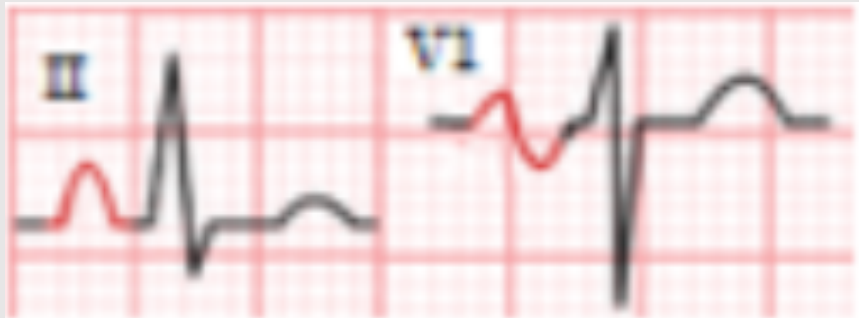
Step 4: Intervals

- PR interval
 - Normal = 0.12 - 0.2 (<1 big box)
 - AV Blocks
- QRS interval
 - Normal < 0.12 (3 small boxes)
- QT/QTc interval
 - Screen with T < 50% between Q-Q

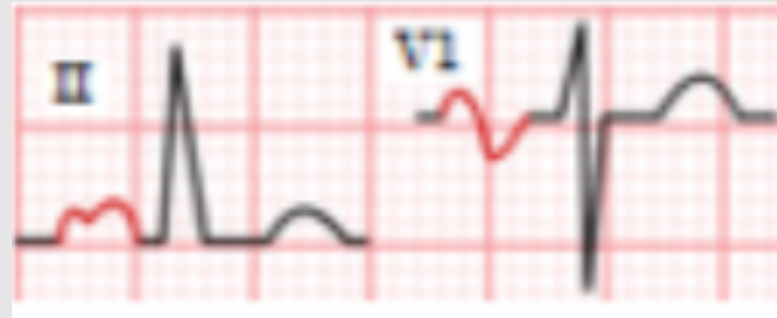


Step 5: Ps and Qs

- Right Atrial Enlargement:
 - Tall or peaking (2-3 small boxes) P wave in II
 - Biphasic P in V1



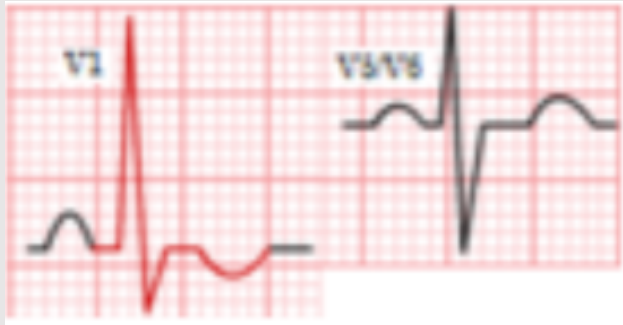
- Left Atrial Enlargement:
 - Wide (3 small boxes) P wave in II
 - Notched P wave in V1



Step 5: Ps and Qs

- Right Ventricle Enlargement:

- rsR' in V1 and S waves in V5/V6
- Right "Stain" Pattern- T wave inversion in the right-sided leads
- RAE
- RAD



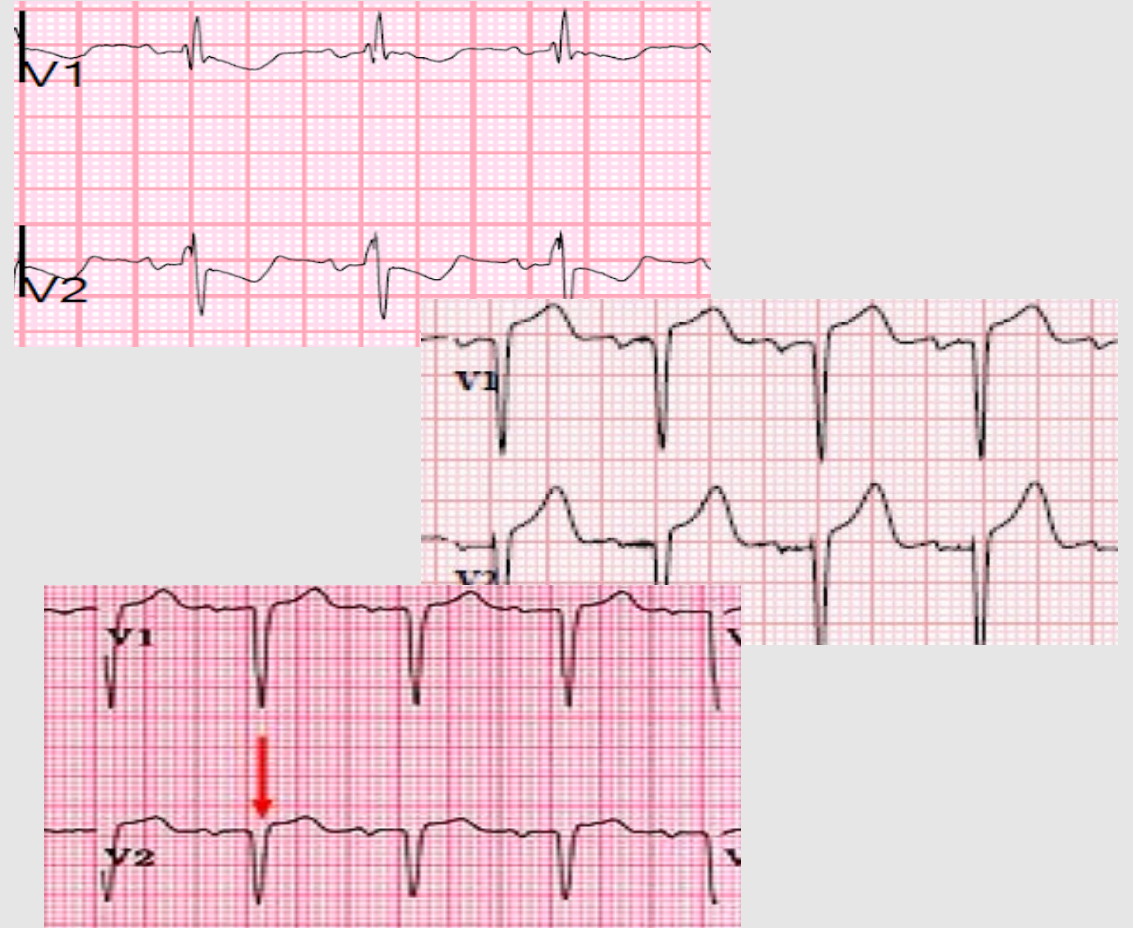
- Left Ventricle Enlargement:

- ESTES and CORNELL [Criteria](#)
 - Big R wave in V5 or V6 plus Big S wave in V1
- Left "Stain" Pattern- T wave inversion in the left-sided leads
- LAE
- LAD

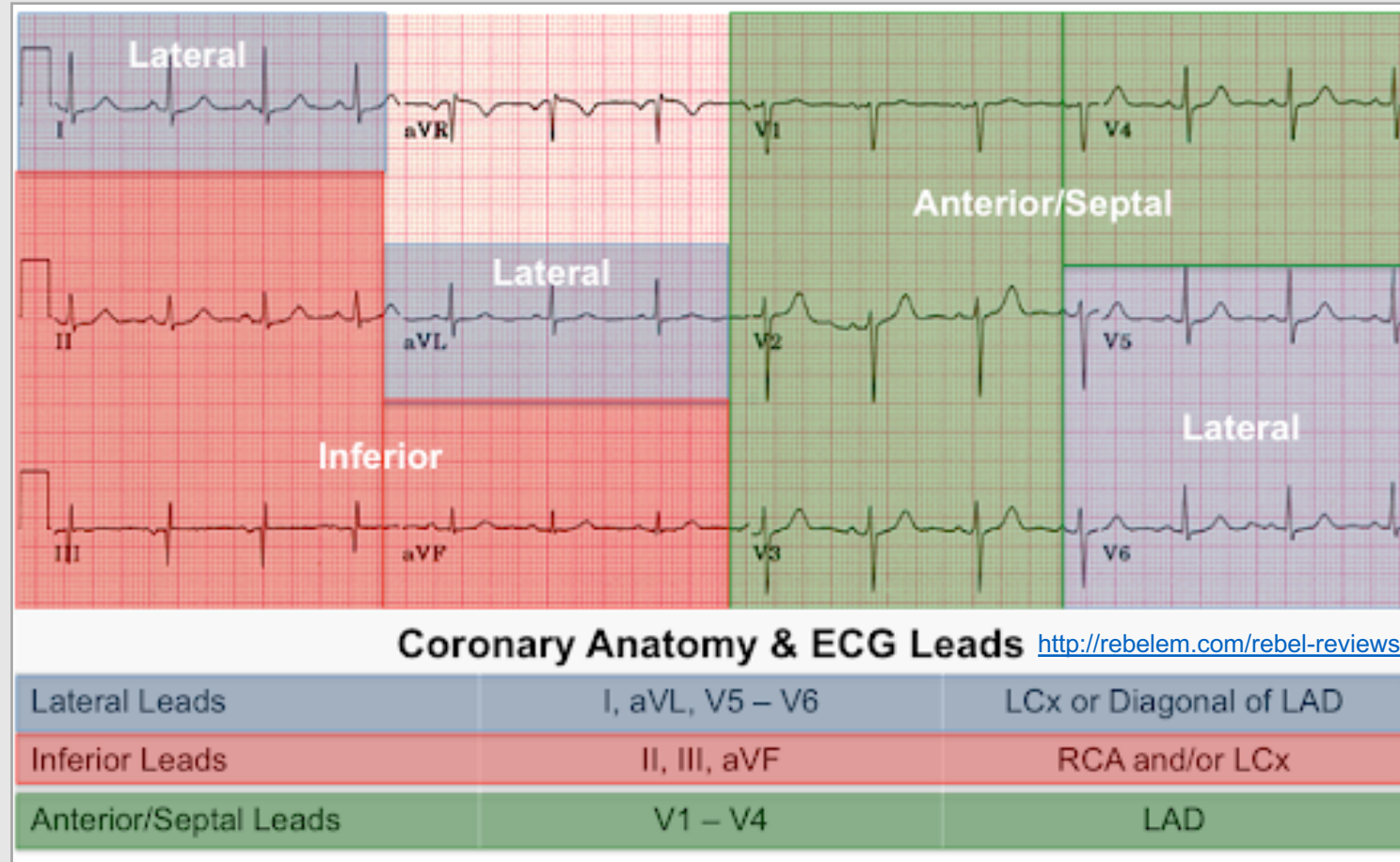


Step 6: ST/Ts

- Ischemia
 - ST depressions and T wave inversions in consecutive leads
- Injury
 - ST elevations, peaked T waves or T wave inversions in consecutive leads
- Infarction
 - Q waves $> 1/3$ height of QRS or > 1 small box width in consecutive leads (not in III and aVR)



Location location location



Step 7: Special Cases

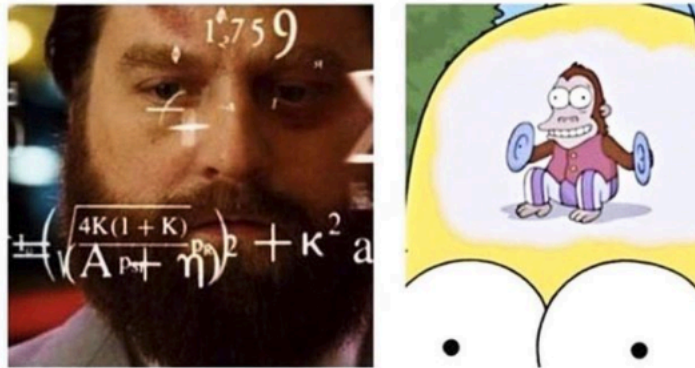
- Targeted to WHY you ordered an ECG in the first place
 - [Right and left bundle branches](#)- “William Marrow”, bunny ears or RsR’
 - [AV Blocks](#)- 1st-3rd degree blocks and treatment
 - [Delta Waves](#)- Shark fins sign for Wolf Parkinson White
 - [Peaked Ts or U waves](#)- Hyper and Hypokalemia
 - [S1Q3T3](#)- Not sensitive but most specific ECG sign of PE
 - [Brugada Syndrome](#)- AD cause of long QT and sudden cardiac death
 - [Epsilon Waves](#)- Specific finding for ARVC



Step 8: Overall Review

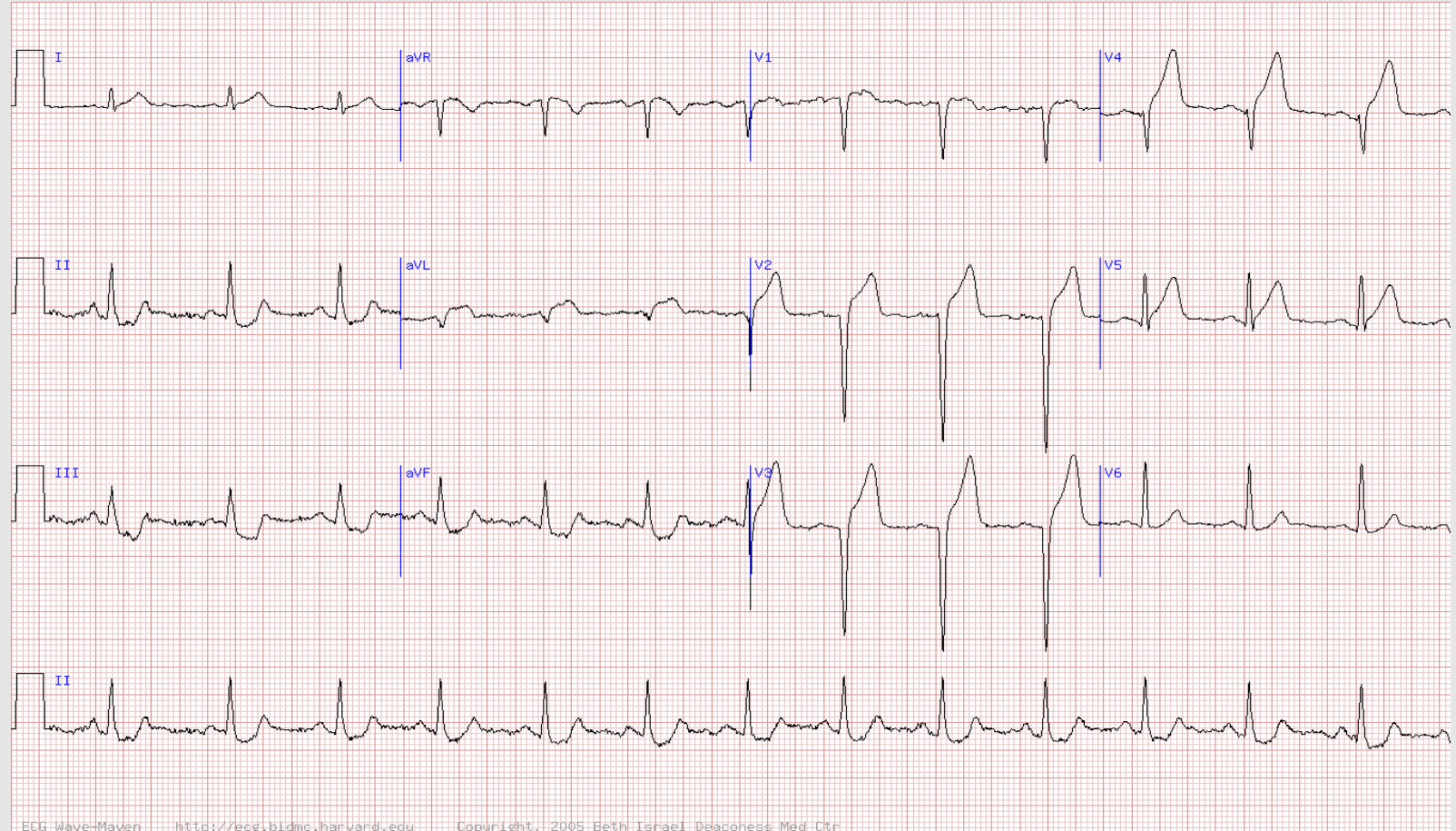
- Review the findings and write the final summery statement of the EKG:
 - Ex: Abnormal EKG with sinus tachycardia, LAD, prolonged QRS and LVH.

what it looks like when i read an
ECG vs. what's actually happening



Practice Case 1

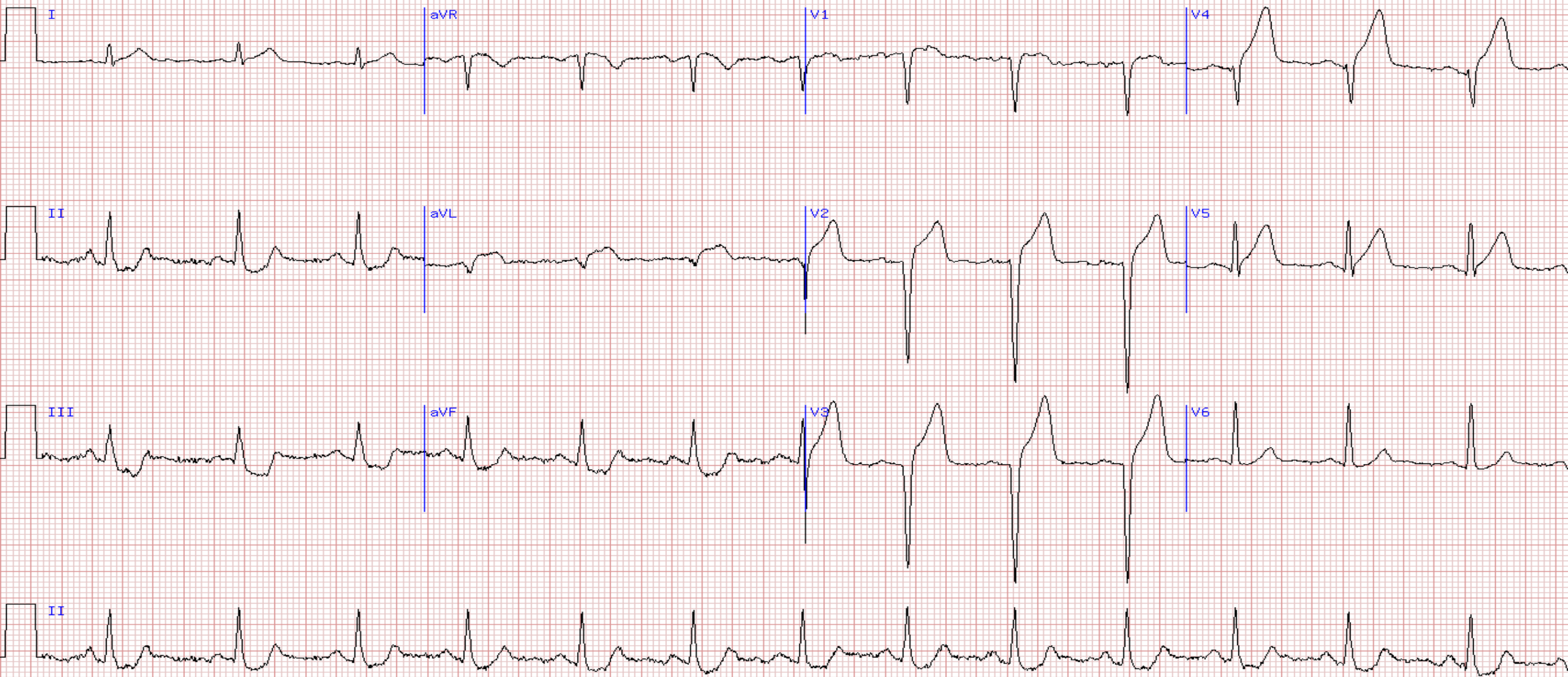
- A 59 year old smoker with a history of DM2, HLD and HTN presents for acute onset crushing chest pain.



Case 1 Questions

- Interpretation:
- Q1: What is your diagnosis?
- Q2: What vessel supplies this area?
- Q3: What are your best treatments acutely and long term?
- Q4: What are some of his risk factors?
- Q5: What are short and long term complications?





Case 1 Answers

- Case 1: The ECG shows classic findings of acute/hyperacute anterior wall Q wave myocardial infarction (MI), with reciprocal inferior ST depressions.
- The distribution of changes is consistent with a proximal left anterior descending (LAD) occlusion
- **MONA BASSH**- Morphine, Oxygen, Nitroglycerine, Aspirin/Clopidogrel and Beta Blocker, ACE Inhibitor/ARB, Statin, Short acting Nitrates, Heparin/LMWH (ExTRACT TIMI 25 and ESSENSE trials)
 - CABG: L main, 3 vessels, 2 vessels + DM (>70% occlusion), pain despite maximum medical tx, or post-infarction angina
 - Always quit smoking, manage comorbidities aggressively (HTN, DM2 etc.)
- Premature atherosclerosis here was associated with multiple risk factors for coronary artery disease: hypertension, hyperlipidemia, Diabetes, and tobacco.



Post MI Complications

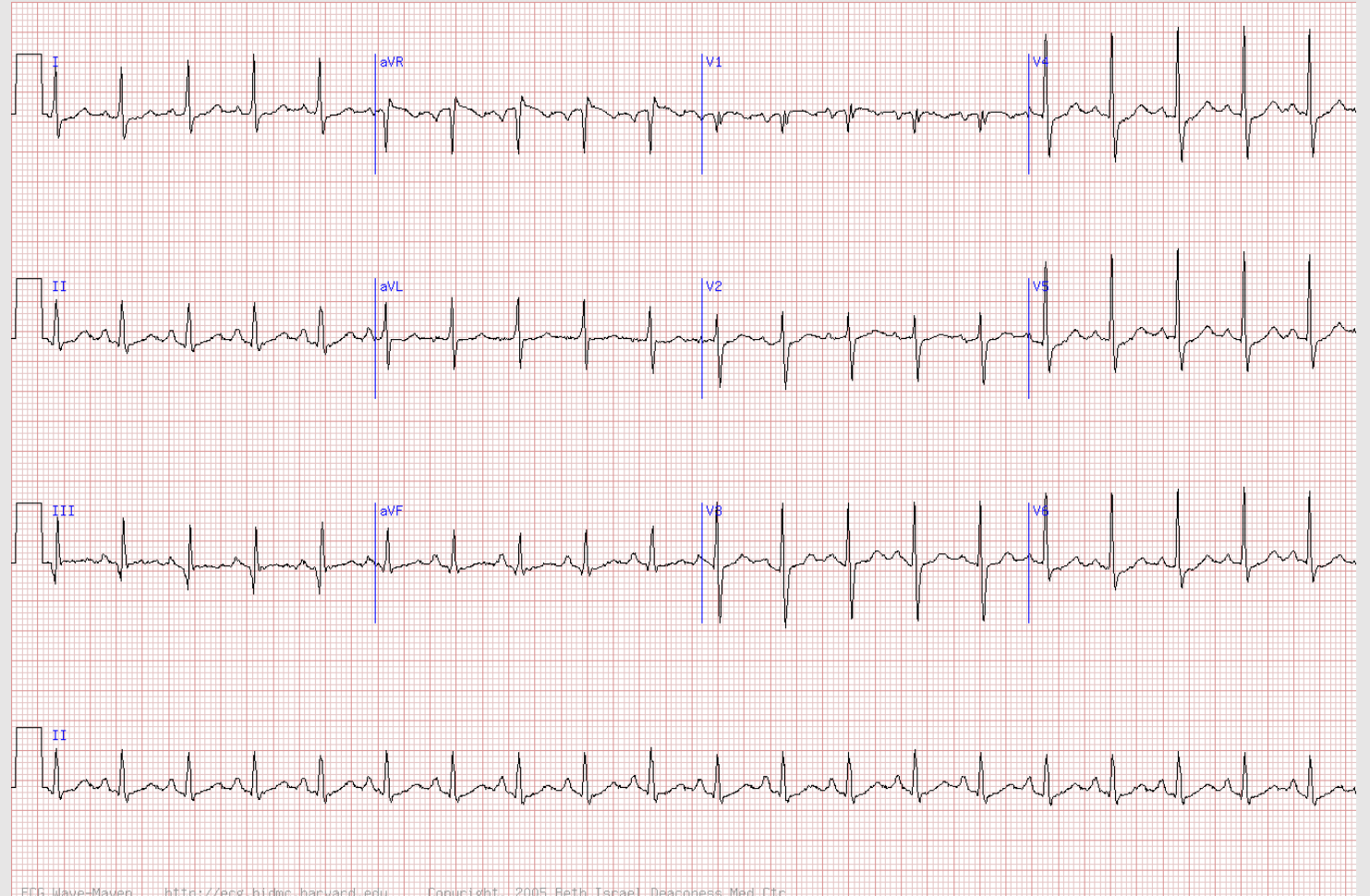
- Most common cause of death?
 - Arrhythmias. V-fib
- New systolic murmur at apex and SOB?
 - Papillary muscle rupture
- Acute severe hypotension, pulsus paradoxus?
 - Ventricular free wall rupture
- Increase in O2 from RA → RV and holosystolic murmur at Erb's Point?
 - Ventricular septal rupture

- Cold blue toe and lacy rash?
 - Cholesterol Emboli Syndrome. Look for eosinophilia and AKI.
- Persistent ST elevation ~1mo later?
 - Ventricular Aneurysm
- Palpitations and “Cannon A-waves”?
 - 3rd degree heart block. Tx w/ pacer
- 5-10wks later pleuritic CP, low grade temp?
 - Dressler's syndrome. autoimmune pericarditis. Tx w/ NSAIDs and aspirin.



Practice Case 2

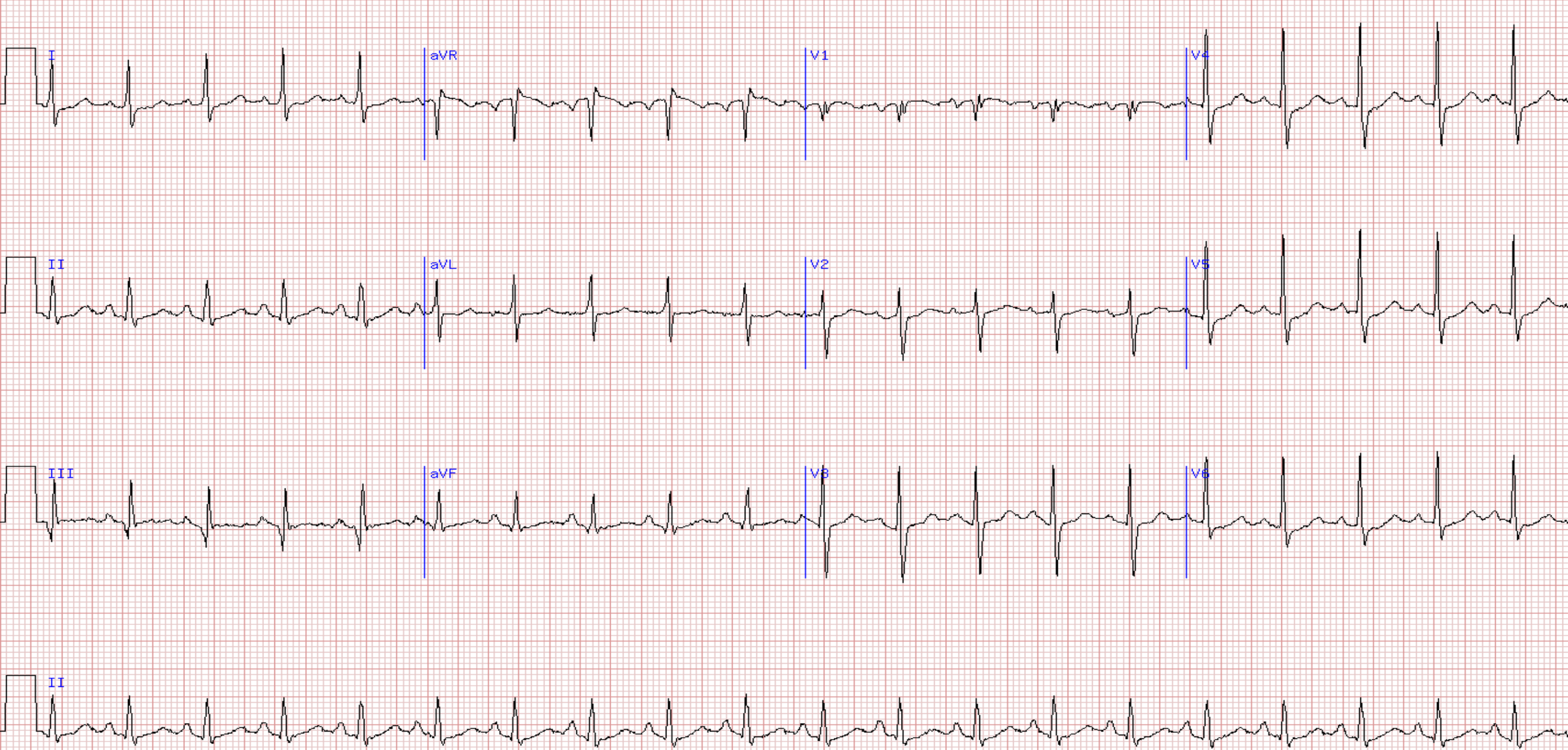
- 23-year-old with no pmhx on OCPs presents for a leg cramp and feels short of breath with activity. EKG is shown.



Case 2 Questions

- Interpretation:
- Q1: What is your diagnosis?
- Q2: What is the sensitivity and specificity of this EKG finding?
- Q3: What are some common scoring criteria for this diagnosis?
- Q4: What are your treatment options and doses for this patient?





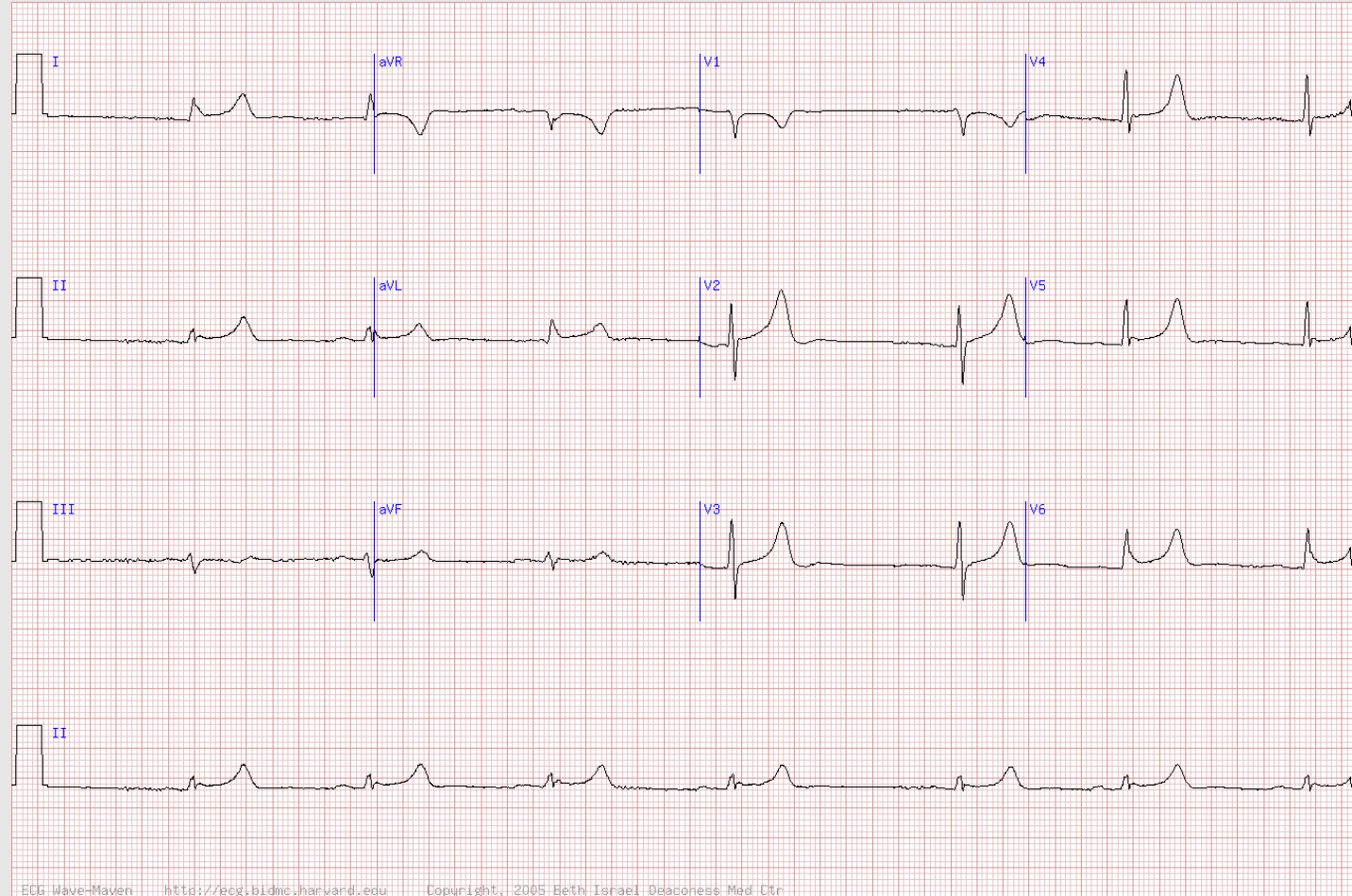
Case 2 Answers

- Case 2: The ECG shows sinus tachycardia at rest with an S1Q3 pattern and a minor right ventricular (RV) conduction delay
- The classic S1Q3T3 pattern is described to be present only in 20 % of cases, Ferrari et al found that this pattern had a sensitivity of 54% and a specificity of 62%. The initial characterization of electrocardiographic abnormalities associated with pulmonary embolism was reported by McGinn and White in 1935.
- PERC, WELLS scoring for diagnosis. PESI for outcomes at 30 days.
- Treatments: DOAC, Lovenox, heparin drip, warfarin bridge, EKOS, systemic thrombolytics, thrombectomy.



Practice Case 3

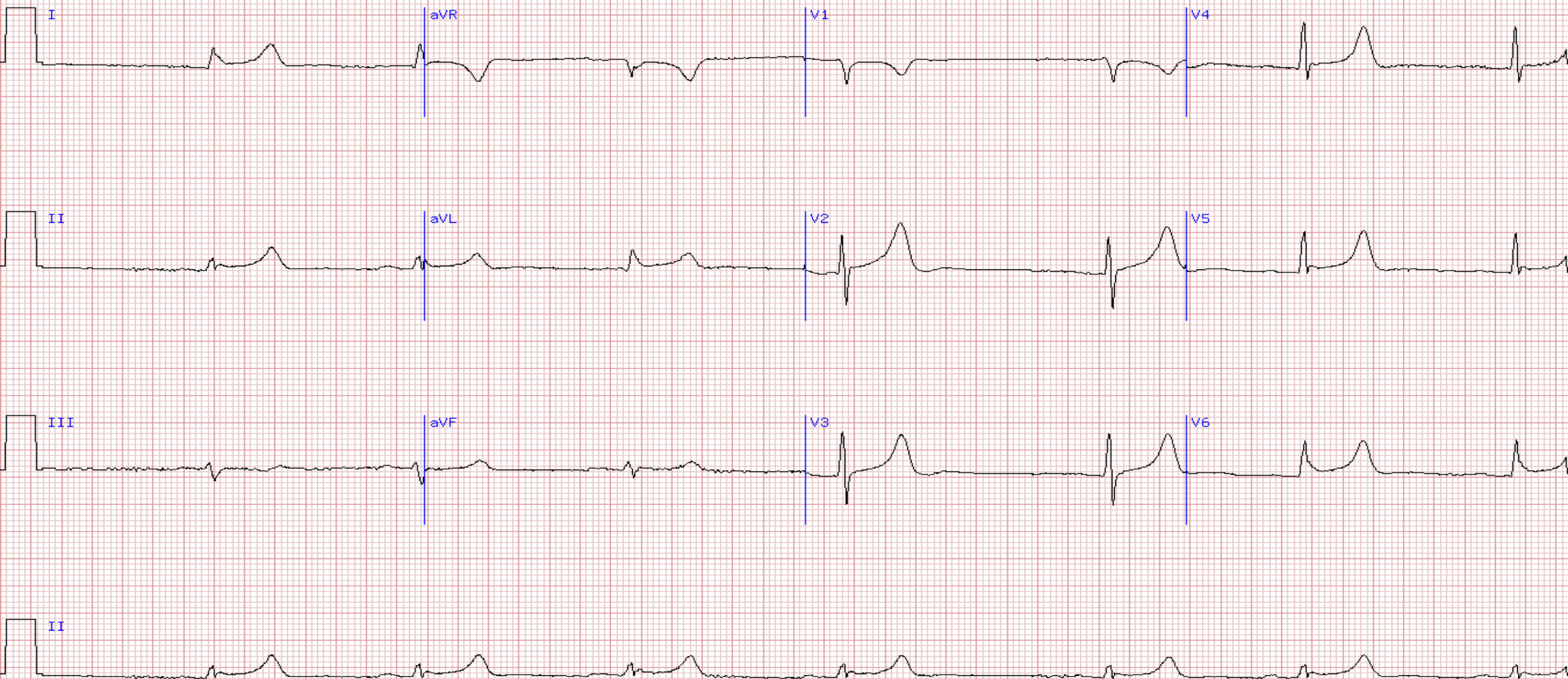
- A 39-year-old patient with ESRD due to SLE presents for N/V after missing his last dialysis appointment. He was trying a new juicing cleanse with lots of fruits. EKG was obtained.



Case 3 Questions

- Interpretation:
- Q1: What electrolyte disturbance is likely?
- Q2: What treatment options are available and in what order?
- Q3: Can you tell what level his K is based on EKG changes? Why or why not?
- Q4: What fruit has the highest level of this electrolyte?





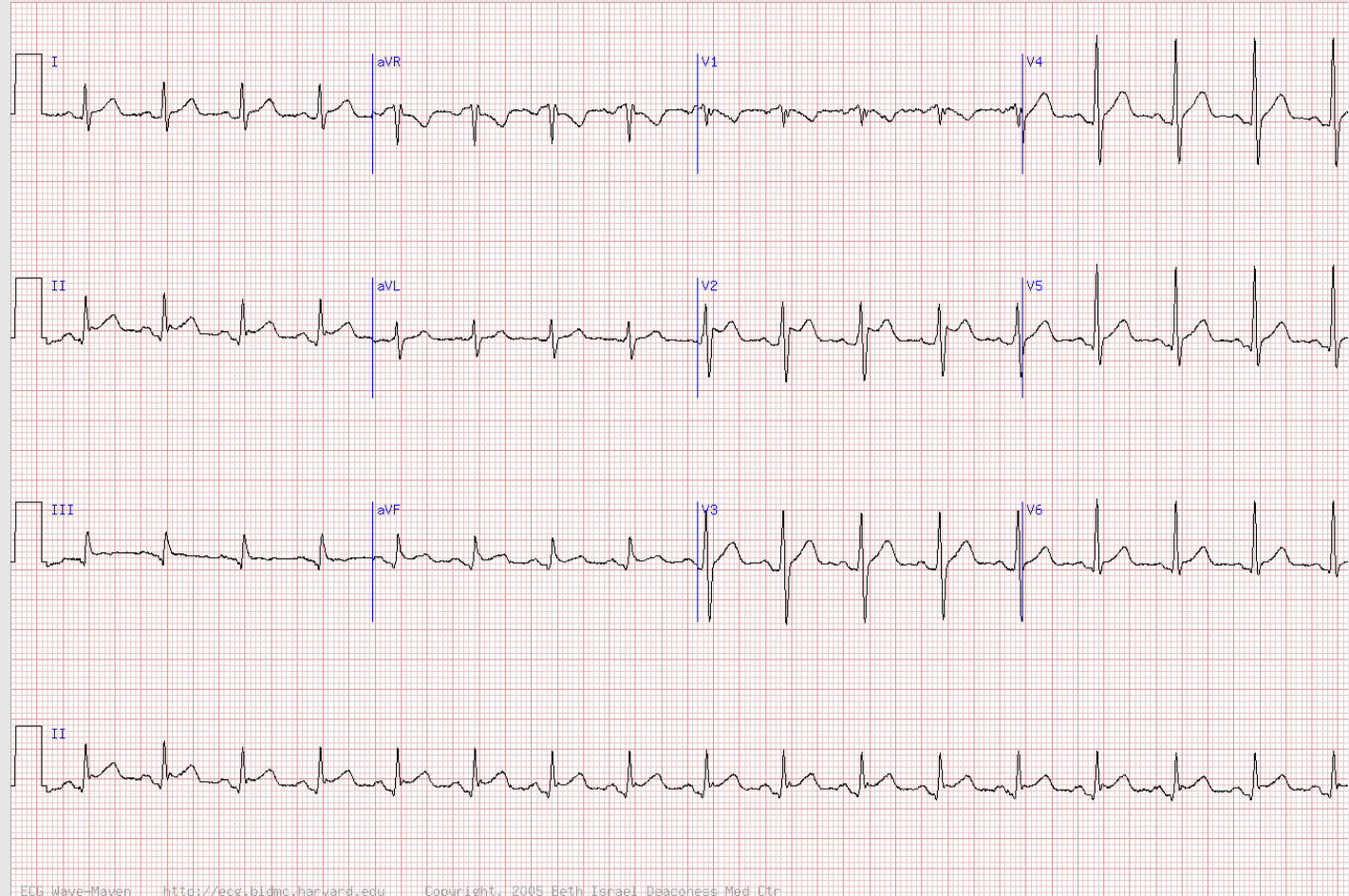
Case 3 Answers

- Case 3 Answer: Hyperkalemia ($K^+ = 8.7 \text{ mEq/L}$) secondary to acute on chronic renal failure. The ECG shows symmetrically peaked ("tented") T waves associated with potassium levels in excess of 6 mEq/L . The tracing also shows broad and flattened sinus P waves that may precede frank sino-ventricular conduction seen with severe hyperkalemia
- CaGluconate/CaCl, Insulin D5, Albuterol, Lactulose, Lasix, SPS
- Note that T wave peaking with hyperkalemia is a relative finding: the absolute magnitude of the T waves cannot be used to rule in or rule out hyperkalemia. It's all about the rate that the K^+ goes up. Thus specific levels of serum potassium cannot be linked to unique ECG patterns!
- Avocados, Guavas and Kiwis all have more K per 100g than a banana.



Practice Case 4

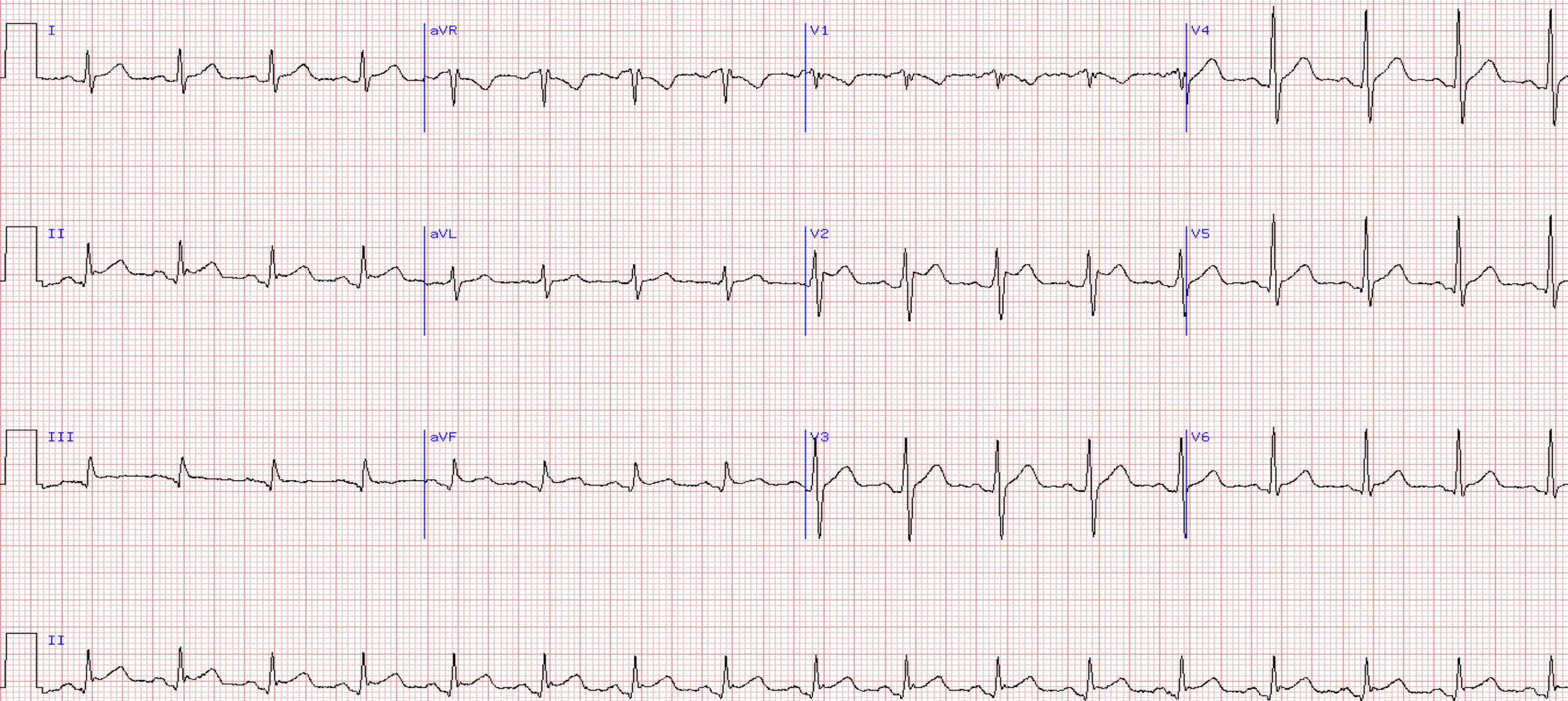
- A 35 year old with a history of lupus and recent URI presents for chest pain. They are sitting up in bed and wince with every breath. EKG is shown.



Case 4 Questions

- Interpretation:
- Q1: What is your diagnosis?
- Q2: what is your lab workup and imaging after this EKG?
- Q3: What are common causes of this?
- Q4: What are your treatment options for this patient?





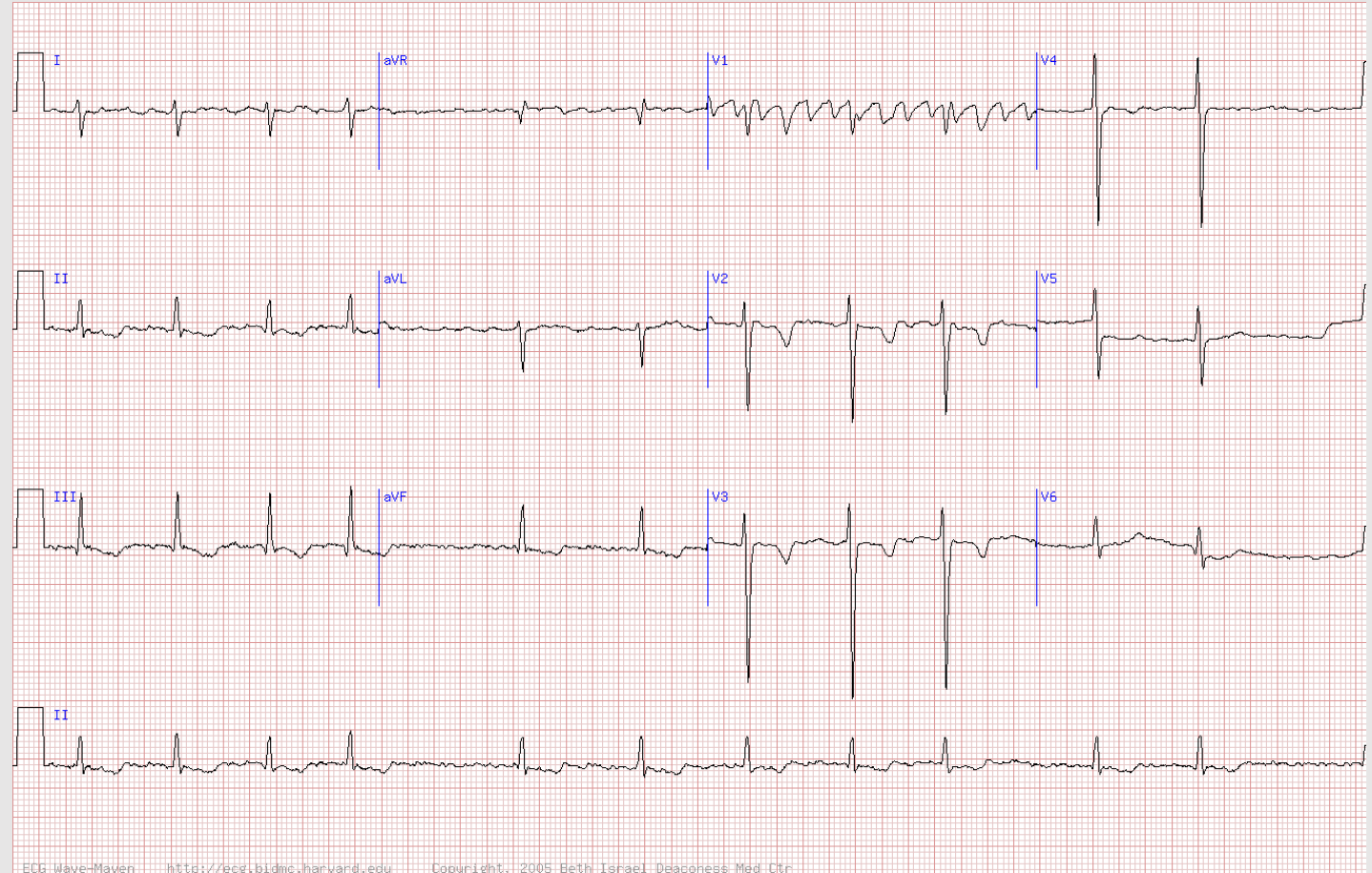
Case 4

- Case 4: The ECG shows classic findings for acute pericarditis. These include diffuse ST segment elevations (I, II aVF, V2-V6). In addition, there are subtle PR segment deviations (elevated in aVR and depressed in the inferolateral leads). There are also non-diagnostic inferior Q waves. The S1Q3 pattern here is a non-specific finding.
- CBC, CMP, ESR, CRP, Trop, CXR, TTE, COVID, +/- serologies
- Post-infectious (viral, protozoa, mycobacteria), autoimmune (SLE, RA, sarcoid, Amyloidosis), post-infarct, hemopericardium, neoplastic, uremia, drug induced, radiation
- NSAIDS, Colchicine, prednisone, pericardiocentesis, pericardial window.



Practice Case 5

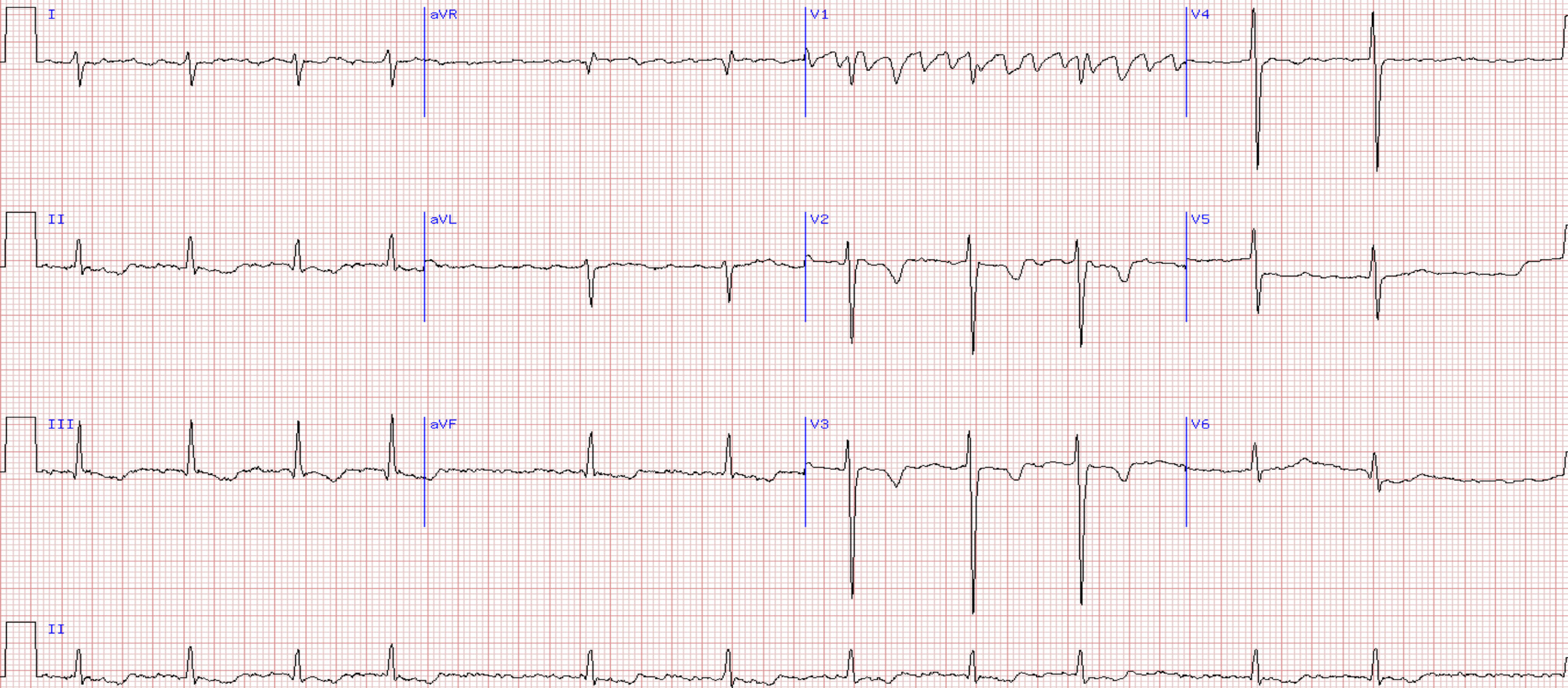
- A 61 year old female with a history of rheumatic heart disease as a child presents to her PCP with increasing dyspnea on exertion. Her exam is notable for a 4/6 systolic murmur.



Case 5 Questions

- Interpretation:
- Q1: What is your diagnosis?
- Q2: what is your lab workup and imaging after this EKG?
- Q3: What are common causes of this?
- Q4: What are your treatment options for this rhythm?





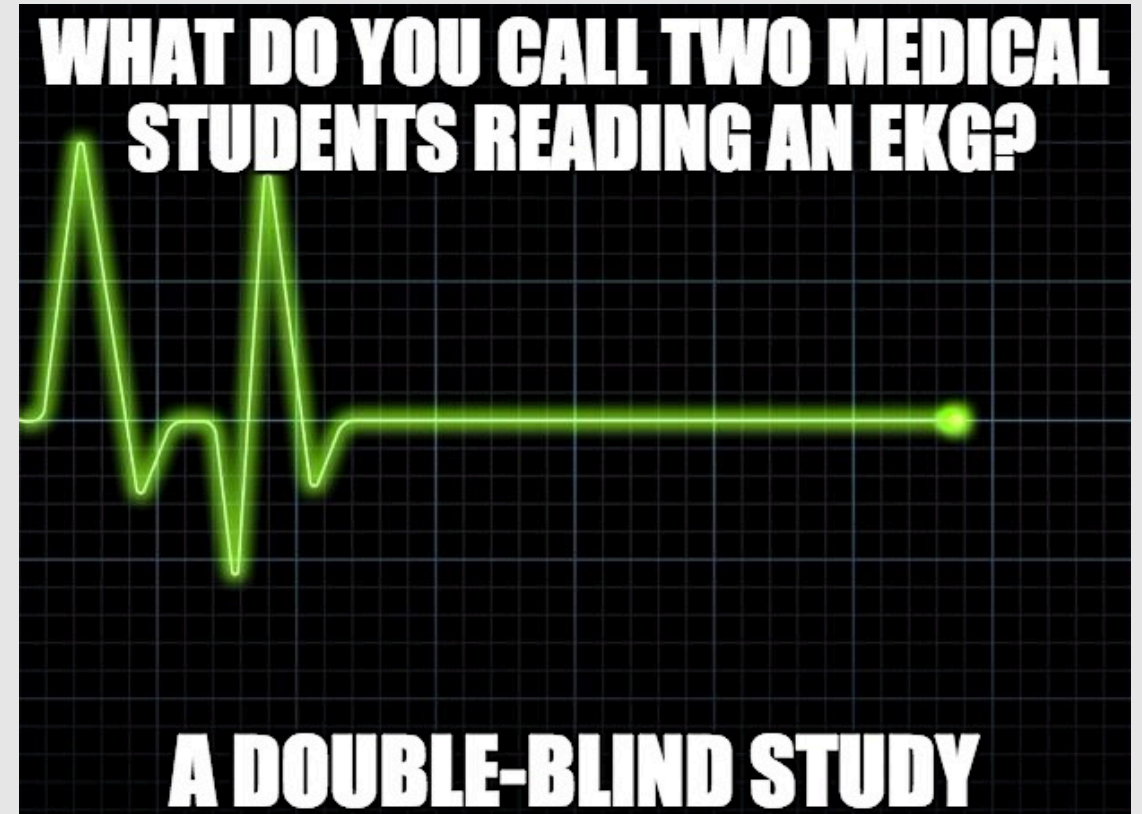
Case 5

- Case 5: The ECG shows very coarse atrial fibrillation with RAD, along with T wave inversions in V1-V4 (strain pattern), all consistent with right ventricular overload.
- Atrial Fibrillation and possible right heart strain/pulmonary hypertension.
- CBC, CMP, TSH, Troponin, BNP. Echocardiogram and possible RHC.
- AV nodal blockers such as BB, CCB, Digoxin or conversion with Amiodarone or cardioversion.



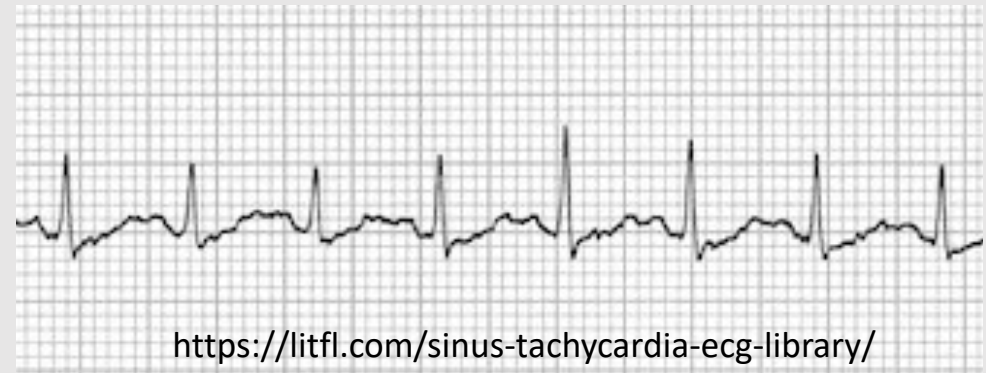
EKG Patterns and Buzzwords

- Pattern recognition and illness scripts
 - Wide = Ventricular
 - Narrow = Atria
 - Regular = Sinus Tach, AVNRT, WPW, Aflutter or Vtach
 - Irregular = MAT, Afib or Vfib



Sinus Tachycardia

- *A 49 year old man presents to the ED because of fever and a change in mental status. He works as a construction worker and had cut himself incidentally earlier in the week but did not clean the wound. Vital signs are BP 105/63, pulse 123 and regular, Temperature 38.8 and respirations 22. His skin is flushed and diaphoretic. Initial labs show a leukocytosis with left shift.*
- Look for: Narrow regular pattern with discernible P waves (lookout for camel hump)
- Causes- Think:
 - Pain/Anxiety
 - Hypoxia/Hypovolemia
 - PE – most common EKG finding for PE
 - Sepsis
 - Acidemia
- Tx: Fix the underlying cause!
 - Ivabradine



SVT or AVNRT

- *A 38 year old women suddenly felt dizzy and calls 911 because “her heart is going to beat out of her chest”. She has had 2 episodes of this before that resolved spontaneously. When she presents to the hospital, vital signs are BP 128/72, pulse 158 and regular, respirations 22. EKG is shown below.*



- Look for: Narrow + regular pattern without discernible P waves
 - Most common cause of SVT is AVRT where 2 pathways (one fast and one slow) within AV node forming re-entrant loop usually Initiated or terminated by PACs
- Tx: Adenosine, verapamil, vagal stimulation (carotid massage etc.)



Wolf-Parkinson-White

- A 23 year old medical student experiences sudden onset palpitations and shortness of breath while studying for final exams. He had stayed up all night and consumed multiple cups of coffee and energy drinks. On presentation to the ED, his EKG is shown below.*



- Look for: Swooping R waves, shortened PR interval and pseudo- widened QRS
 - Pathophysiology: An accessory pathway from atria to ventricles through the **bundle of Kent** early ventricular activation because the AV node does not slow conduction.
- Tx: unstable - synchronized cardioversion, stable- procainamide. Long term/definitive Tx is radiofrequency ablation



Atrial Flutter

- A 67 year old gentleman with episodic dizziness and shortness of breath is placed on a Holter monitor. On analysis of his read out you see the rhythm shown below.

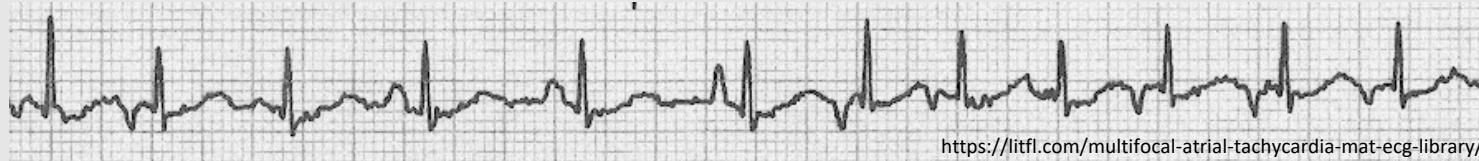


- Look for: **Sawtooth Pattern** with regular rate 150-200 bpm
- Causes- Think:
 - Heart disease: Heart failure (most common association), rheumatic heart disease, CAD
 - COPD
 - Atrial septal defect (ASD)
- Treat: AV nodal blocking agents or ablation (IVC/tricuspid isthmus)



Multifocal Atrial Tachycardia

- A 78 year old veteran presents to the hospital for shortness of breath. He has a 60 pack year smoking history and has a history of severe COPD requiring 5L continuous oxygen support. His medication reconciliation shows multiple beta agonist inhalers and theophylline. Vital signs show BP 112/63, pulse of 129 and irregular, temperature of 37.2, and respirations are 18 per minute and prolonged expirations. On chest exam, diffuse wheezes are heard in all lung fields with prolonged respirations and an increased AP diameter. There is a loud P2 and a right heart heave. EKG shows the rhythm below:

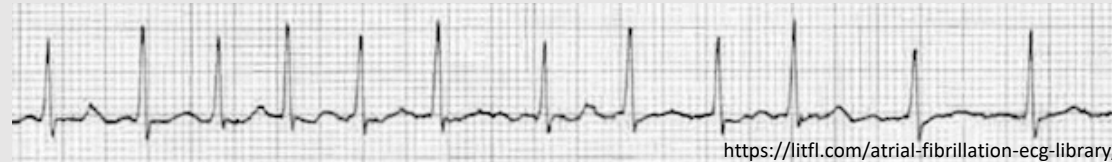


- Look for:
 - Three + morphologically distinct P waves in the same lead
 - Varying PR intervals.



Atrial Fibrillation

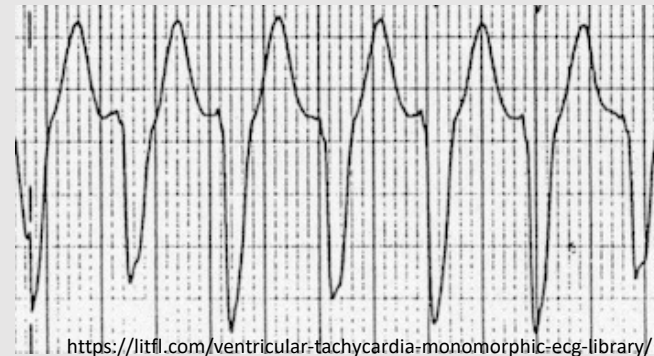
- A 78 women with a history of diabetes, hypertension, hypothyroidism, and MI has a syncopal episode at home. She lives alone and is unsure how long she was unconscious but denies tongue biting, urinary incontinence or confusion upon awakening. She also notices her left leg feels weak. She describes feeling her heart beat very fast at times but did not seek treatment for this. A code stroke is called and EKG shows:*



- Look for: “Undulating baseline”, no discernible p-waves, irregular R-R interval
- Causes- Think
 - Heart disease: CAD, MI, HTN, mitral regurge, Pericarditis, rheumatic disease
 - Pulmonary disease, including PE
 - Hyperthyroidism, hypothyroidism or Pheo
 - Excessive alcohol intake “holiday heart syndrome”
- Treatment: AV nodal blockers or synchronized cardioversion if unstable. CHA₂DS₂-VASc score to determine anticoagulation.

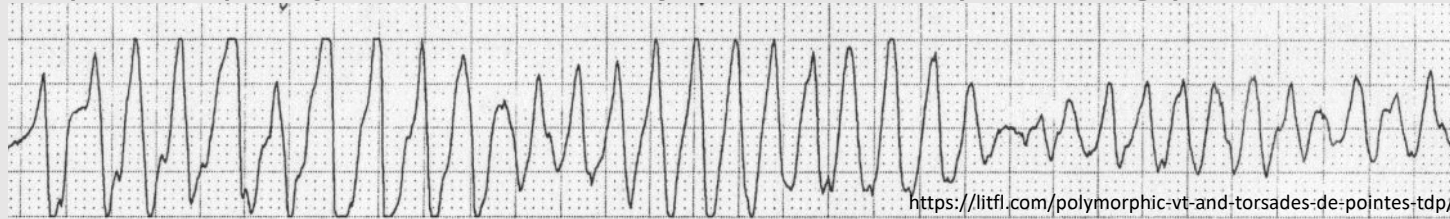
Ventricular Tachycardia

- *A page brings you to the room of a 67 year old who is post op day 1 from an emergent CABG status post STEMI. He is unresponsive with this EKG rhythm:*
- Look for: > 30 seconds of wide QRS, with a regular rhythm
- Causes- Think:
 - CAD with prior MI- most common cause
 - Active ischemia, hypotension
 - Cardiomyopathies
 - Congenital defects
 - Prolonged QT syndrome
- Tx: Amiodarone or Sotalol if hemodynamically stable. Cardioversion if unstable. ACLS if pulseless.
 - All those with impaired EF and sustained Vtach need an ICD!



Ventricular Fibrillation

- *A 57 year old patient on the general medicine floor is suddenly found to be unconscious. She is being treated for pneumonia with azithromycin. Her history includes amitriptyline for depression and fibromyalgia, quetiapine for bipolar depression, ondansetron for nausea and methadone for pain. Upon further review of the telemetry reading you notice this rhythm.*



- Look for: Wide irregular rhythm. Torsades is polymorphic
- Causes- Think:
 - Ischemic heart disease- most common cause
 - Antiarrhythmic drugs, especially those that cause prolonged QT intervals (Anti-ABCDE-Os) and electrolyte abnormalities (hypokalemia and hypomagnesemia)
- Tx: ACLS algorithm + Mg for torsades



Ectopic Beats

- A 23 year old medical student presents for palpitations and tachycardia. He Just finished an overnight call and has an exam upcoming. He consumed countless cups of coffee in an effort to study. An EKG performed shows random segments of this rhythm.*

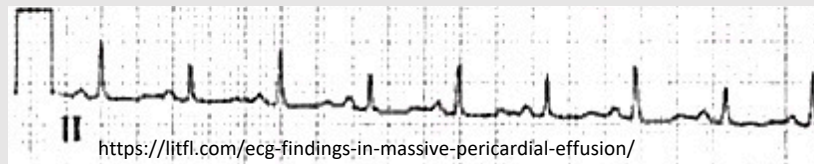


- What to look for and causes of ectopic foci of depolarization
 - PAC:** A premature QRS complex with normal to abnormal P wave due to sympathomimetics, anxiety, caffeine, hypokalemia, or hypomagnesemia
 - PJC:** QRS complex without a preceding P wave
 - PVC:** A premature, broad QRS complex due to sympathomimetics, anxiety, caffeine, hypokalemia, hypomagnesemia, dioxin toxicity, or ischemia
 - 3 more more sustained PVCs are defined as NSVT



Cardiac Tamponade

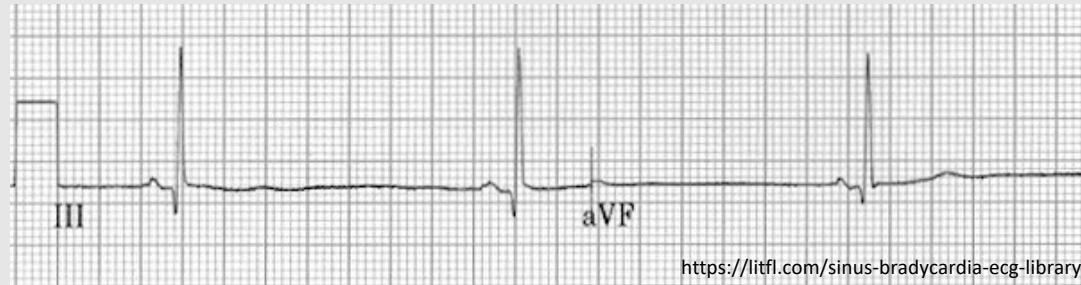
- A 45 year old with a history of Marfan's Disease presents with acute chest pain that feels "like a knife" radiating to his back. On exam, he has unequal BP of 154/92 and 132/87 in his arms and pulse of 110. Suddenly, he develops JVD, hypotension and pulsus paradoxus. Heart sounds are distant. The EKG taken at that time shows:



- Look for: Alternating QRS complex amplitude "electrical alternans"
- Causes: Aortic dissection (hypertension, smoking, collagen vascular, and syphilis), TB, metastatic tumors
- Tx: Pericardiocentesis (US guided in subxiphoid or 5th intercostal space)

Sinus Bradycardia

- *A 22 year old marathon runner presents for NCAA pre-participation physical. A screening EKG is performed showing this rhythm.*



- Look for: regular P waves rate < 60 bpm
- Causes: Think normal finding in athletes, or ischemia, increased vagal tone, antiarrhythmic drugs (AV blockers), brainstem herniation
- Tx: Atropine or a cardiac pacemaker

1st Degree AV Block + Mobitz type I (Wenckebach)

- *A 23 year old medical student from New Jersey has complaints of palpitations and joint pain following a hiking trip. He is unsure if there was a rash or tick bite history.*

- 1st Degree AV Block

- Look for: prolonged PR interval with no dropped beats



- 2nd Degree Heart Block Mobitz Type 1

- Look for: progressive, prolongation of the PR interval followed by a dropped beat



- Tx: Doesn't require treatment unless unexplained symptoms

Mobitz type II + 3rd Degree AV Block

- A 78 year old women presents for syncope and a feeling of “my heart skipping a beat” for 1 week. She has a history of MI and CHF. Vital signs are BP 133/79, pulse 61 bpm with a regular rate. On exam, irregular jugular venous wave forms “cannon-a waves” are seen.

- 2nd Degree Mobitz Type 2

- Look for: prolonged PR interval with dropped beats



- 3rd Degree or Complete Heart Block

- Look for: regular P-P interval and regular R-R interval



- Tx: Pacemaker implantation

Sick Sinus Syndrome

- *A 91 year old women presents with a 2 month history of periotic pre-syncope, dizziness, confusion, fatigue and palpitations. She has had no previous cardiac history and only takes a multivitamin. During your interview her pulse ranges from 40-120 bpm.*
 - Look for: Alternating bradycardia, tachycardia and sinus arrest
 - Causes: Often idiopathic and occurs in elderly, sarcoidosis, ischemia
 - Tx: Pacemaker



LVH Voltage Criteria

- **ESTES**

- diagnostic ≥ 5 points; probable 4 points

+ECG Criteria	Points
•Voltage Criteria (any of):R or S in limb leads ≥ 20 mm •S in V1 or V2 ≥ 30 mm •R in V5 or V6 ≥ 30 mm	3 points
•ST-T Abnormalities:Without digitalis •With digitalis	3 points 1 point
Left Atrial Enlargement in V1	3 points
Left axis deviation	2 points
QRS duration 0.09 sec	1 point
Delayed intrinsicoid deflection in V5 or V6 (>0.05 sec)	1 point

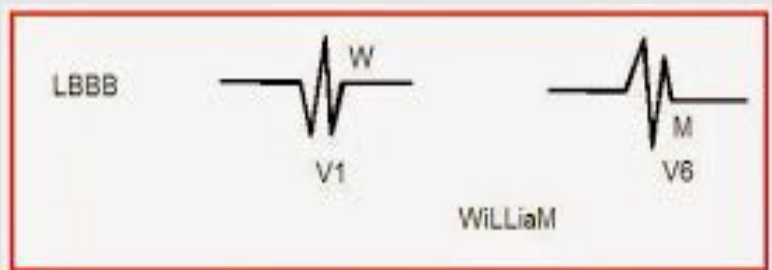
- **CORNELL** [sensitivity = 22%, specificity = 95%]
- S in V3 + R in aVL > 24 mm [men]
- S in V3 + R in aVL > 20 mm [women]
- Limb-lead voltage criteria:
 - R in aVL ≥ 11 mm *or*, if left axis deviation, R in aVL ≥ 13 mm *plus* S in III ≥ 15 mm
 - R in I + S in III > 25 mm
- Chest-lead voltage criteria:
 - S in V1 + R in V5 or V6 ≥ 35 mm



Left and Right Bundle Branches

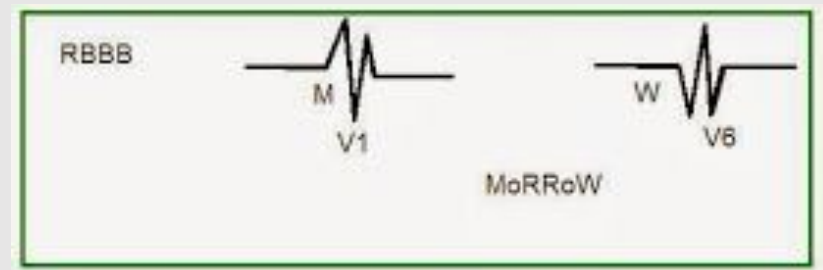
- Left BBB

- QRS duration of > 120 ms
- Dominant S wave in V1
- Broad monophasic/biphasic R wave in lateral leads (I, aVL, V5-V6)
 - Traditionally a new LBBB and chest pain is considered an ischemic equivalent
 - Prior LBBB cannot have EKG stress and use **Sgarbossa Criteria** for ACS rule out.



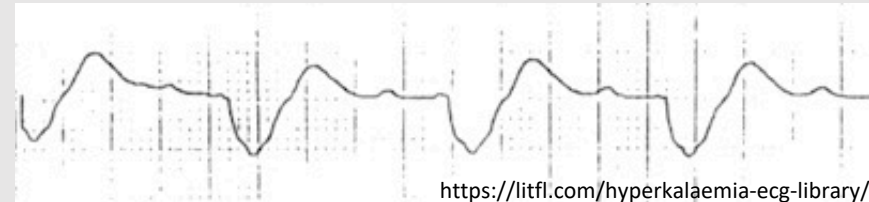
- Right BBB

- Broad QRS > 120 ms
- RSR' pattern in V1-3 ['M-shaped' QRS complex]
- Wide, slurred S wave in the lateral leads (I, aVL, V5-6)



Electrolytes and Intoxications

- *A 73 year old with renal failure presents for chest pain and palpitations after missing their last 3 dialysis appointments.*

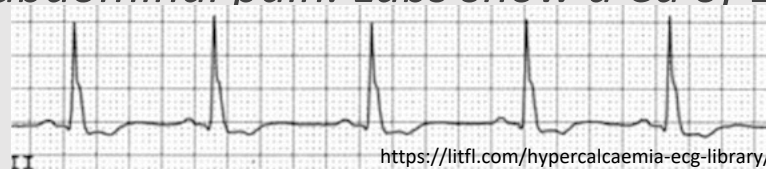


- Hyperkalemia - “peaked” T-waves, widened QRS(sinewave), short QTc and prolonged PR.
- Causes: Think crush injury, burn injury, renal failure
- Tx: IV CaGluconate, D5 and insulin, beta agonists, kayexalate, furosemide or dialysis
- *A 17 year old with a history of anorexia and diuretic use presents for inpatient rehabilitation program. She is severely malnourished and labs/ecg are performed.*
- Hypokalemia - “U wave” and long QTc
- Causes: Think
- Tx: replete K (oral>IV) and Mg

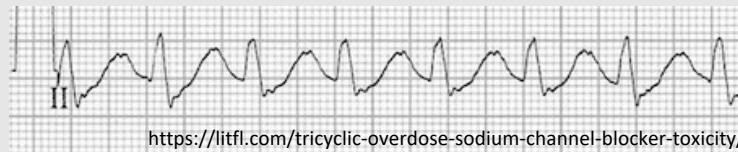


Electrolytes and Intoxications

- *A 78 year old man with metastatic lung and prostate cancer presents to the ED with an altered mental status, oliguria and abdominal pain. Labs show a Ca of 13.4. EKG is shown below.*



- Hypercalcemia- look for shortened QT, and notched, prolonging QRS
- Tx: IV Fluids 1st before loop diuretics and bisphosphonates
- *A 35 year old with atypical depression presents with seizures. His partner found a suicide note and an empty bottle of pills at home.*



- TCA overdose – look for widening QRS due to Na channel block
- Tx: Bolus NaBicarb (overcome competitive inhibition)



Prolonged QT

- A 76 year old with a history of depression and Afib is admitted to an inpatient service for pneumonia. She is treated with azithromycin and levofloxacin and she develops nausea treated with ondansetron. Overnight she develops chest discomfort and an EKG is below.*

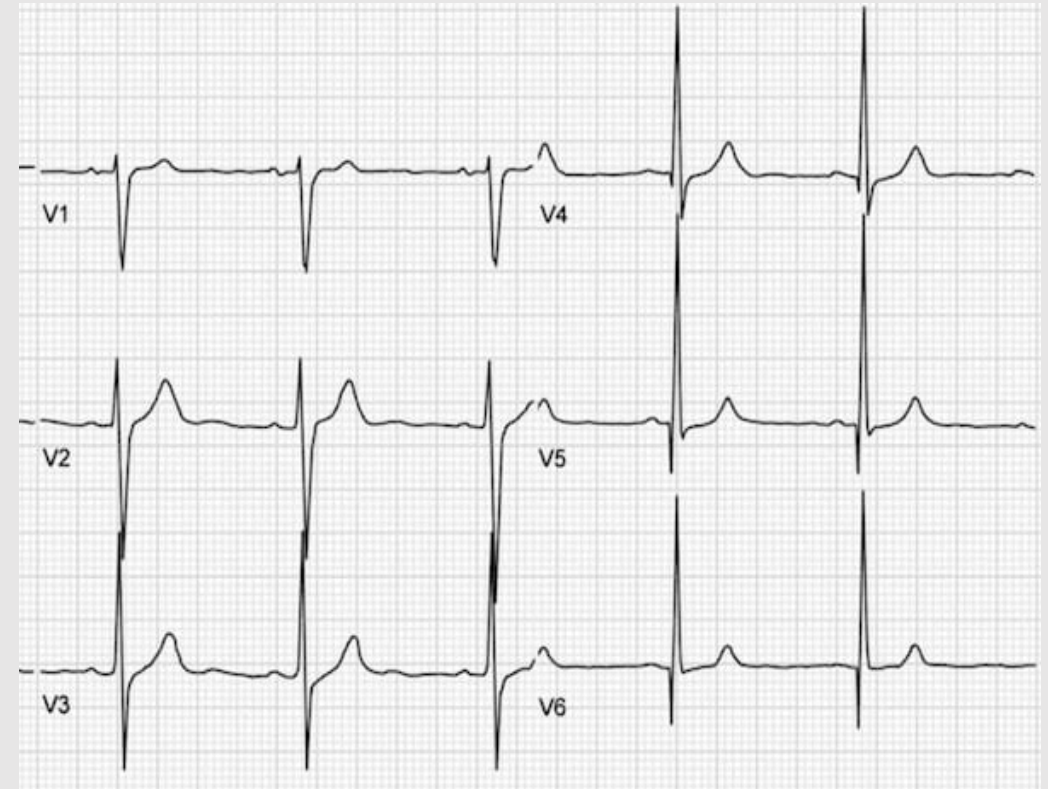


- Causes:
 - Hypokalemia, hypomagnesemia, hypocalcemia, hypothermia, **DRUGS**
- Look for:
 - QT is more than half the preceding RR interval
- Different Measures:
 - Bazett: Overcorrects above 100 bpm. Fridericia / Framingham are more accurate.



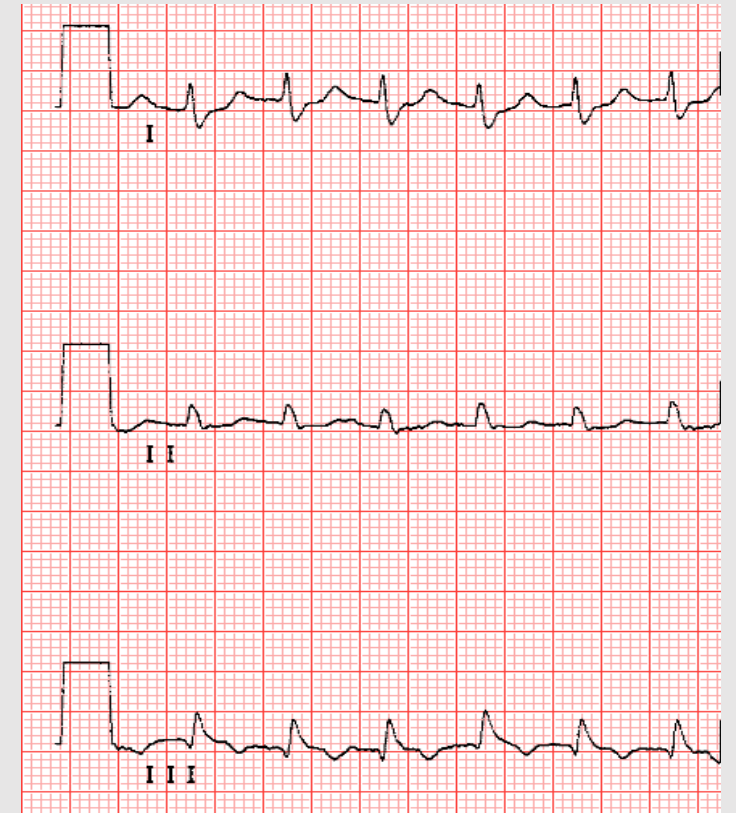
ECG Cases and Syncope: HOCM

- *A 17 year old basketball player suddenly collapses at a local AAU tournament. EMS arrives and the patient regains consciousness. In the ED the patient is well appearing. A 3/6 systolic murmur is auscultated in RUSB that decreases with hand grip. EKG shown.*
 - Caused by AD mutation in sarcomere proteins (beta-myosin heavy chain, troponin T) that causes an enlarged, obstructing septum.
 - Tx with ICD or BB
 - Look for: LVH, or deep, narrow “dagger-like” Q waves in V5-6, I, aVL and II, III or giant T-wave inversion



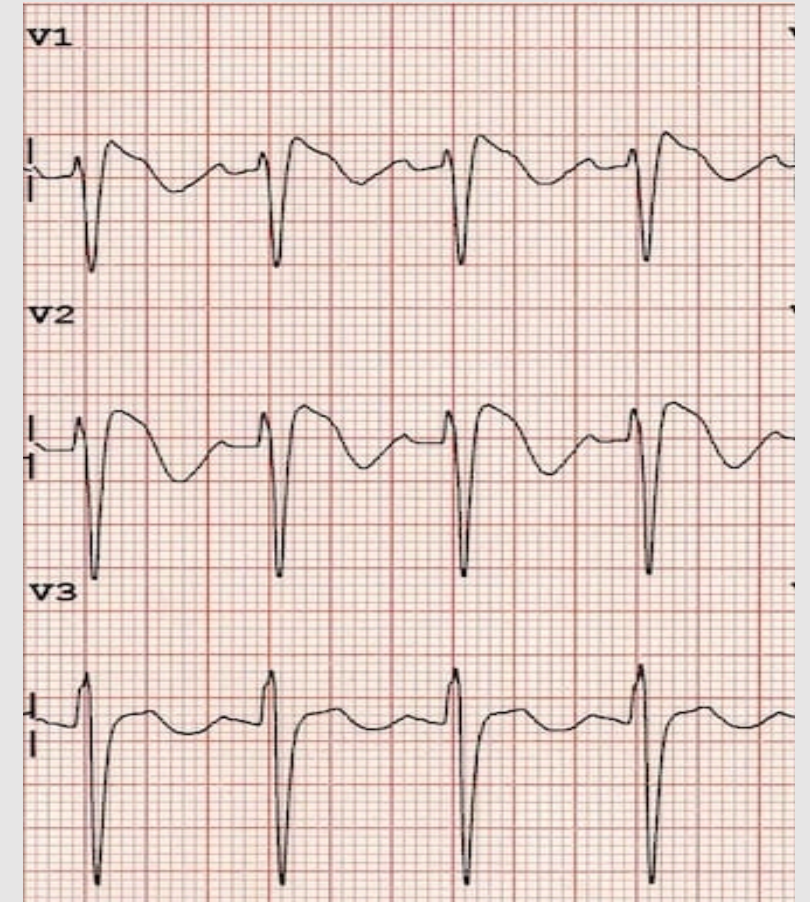
ECG Cases and Syncope: PE

- A 24 year old with a history of SLE on OCPs presents with shortness of breath, pleuritic chest pain, calf swelling and dizziness after a long distance flight.
- Look for
 - an S1Q3T3 pattern
 - a prominent S wave in lead I
 - a Q wave and inverted T wave in lead III
 - Sinus tachycardia
 - T wave inversion in leads V1 - V3
 - Right Bundle Branch Block



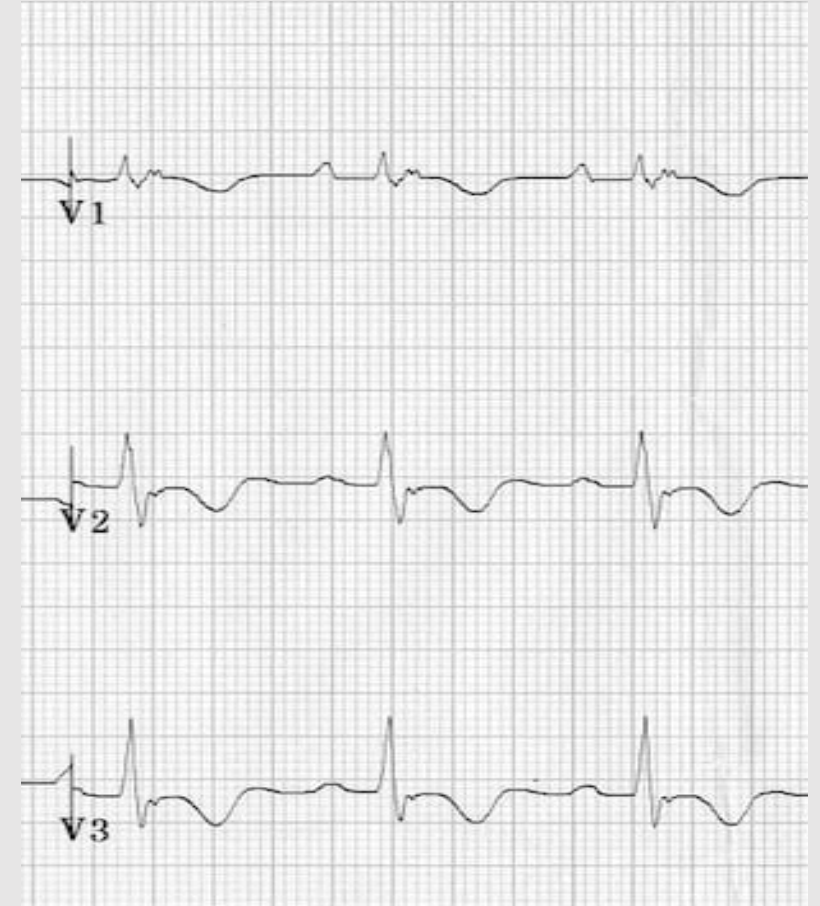
ECG Cases and Syncope: Brugada Syndrome

- *A 33 year old with sleep apnea comes into the office for a life insurance screening. His father and uncle died suddenly in their 40s. He has passed out while running but thought nothing of it. EKG shown:*
 - Causes: Genetic defects in cardiac sodium transporters
 - Treatment: ICD
 - Look for: Coved ST segment elevation $>2\text{mm}$ in >1 of V1-V3 followed by a negative T wave or $>2\text{mm}$ of saddleback shaped ST elevation



ECG Cases and Syncope: ARVC

- *A 19 soccer player on the Greek national team presents to the team doctor for palpitations ahead of the world cup. He is diagnosed with anxiety. 2 weeks later he synopsizes on the field and EKG is shown.*
 - Arrhythmogenic Right Ventricular Cardiomyopathy
 - Caused by: AD incomplete penetrance in Italian/Greek youth (3:1 men) causing fibro-fatty replacement of the right ventricular myocardium
 - Look for: epsilon wave- small positive deflection ('blip' or 'wobble') buried in the end of the QRS complex in V1-V4. T wave inversion in V1-3 and Prolonged S-wave upstroke in V1-3



Rapid Case Round



Not with that rhythm.



Case 1

- A 23 year old medical student experiences sudden onset palpitations and shortness of breath while studying for final exams. He had stayed up all night and consumed multiple cups of coffee and energy drinks. On presentation to the ED, his EKG is shown below.*



<https://litfl.com/whos-afraid-of-the-big-bad-wolff/>



Case 2

- A 67 year old gentleman with episodic dizziness and shortness of breath is placed on a Holter monitor. On analysis of his read out you see the rhythm shown below.



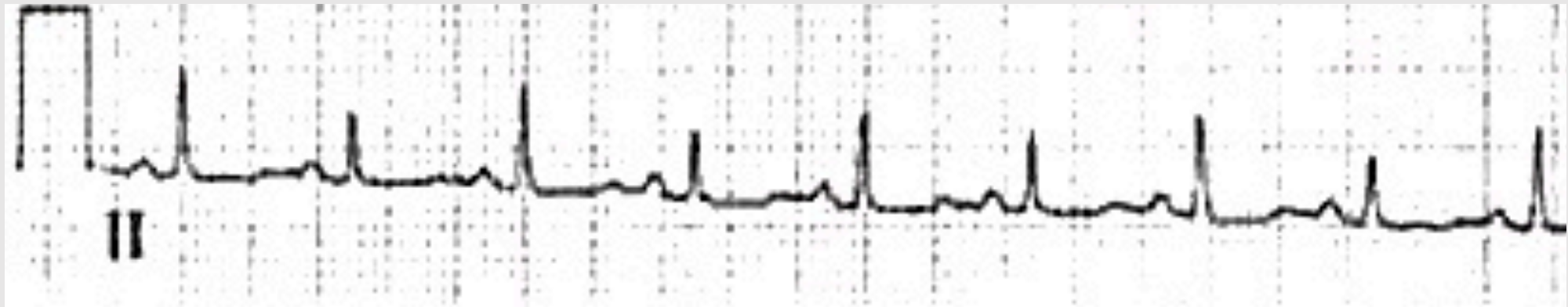
Case 3

- *A 23 year old medical student from New Jersey has complaints of palpitations and joint pain following a hiking trip. He is unsure if there was a rash or tick bite history.*



Case 4

- A 45 year old with a history of Marfan's Disease presents with acute chest pain that feels "like a knife" radiating to his back. On exam, he has unequal BP of 154/92 and 132/87 in his arms and pulse of 110. Suddenly, he develops JVD, hypotension and pulsus paradoxus. Heart sounds are distant. The EKG taken at that time shows:



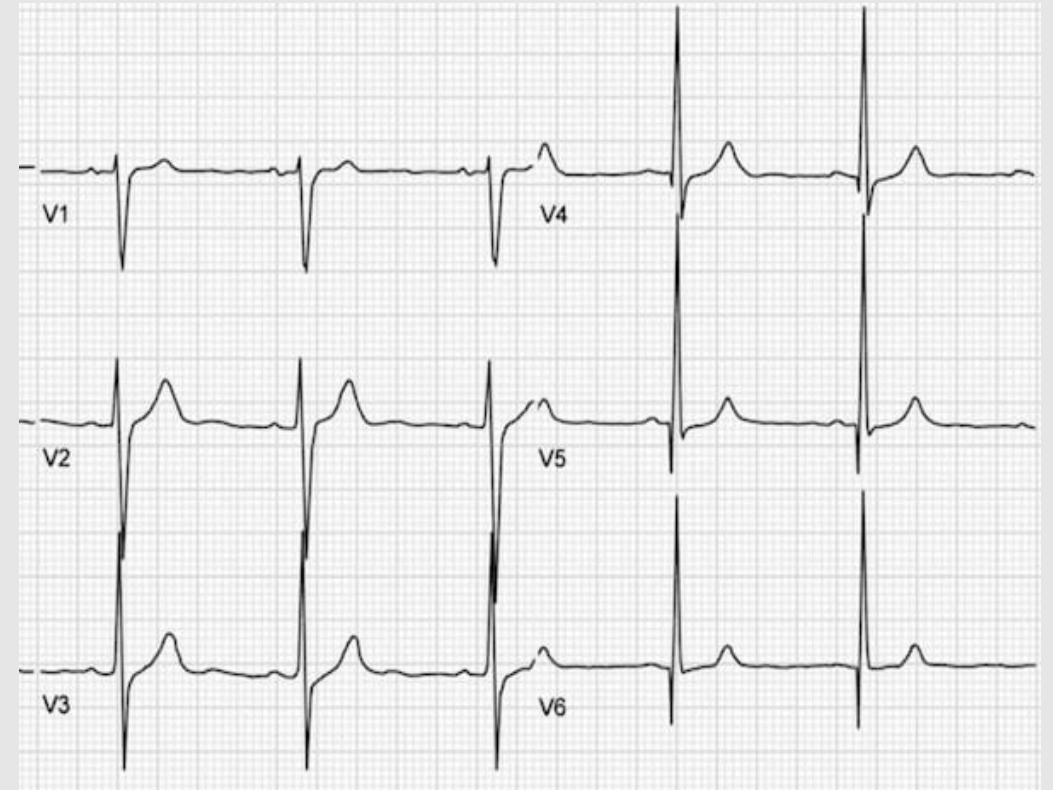
Case 5

- *A 35 year old with atypical depression presents with seizures. His partner found a suicide note and an empty bottle of pills at home.*



Case 6

- A 17 year old basketball player suddenly collapses at a local AAU tournament. EMS arrives and the patient regains consciousness. In the ED the patient is well appearing. A 3/6 systolic murmur is auscultated in RUSB that decreases with hand grip. EKG shown.*



Case 7

- *A 78 year old man with metastatic lung and prostate cancer presents to the ED with an altered mental status, oliguria and abdominal pain.. EKG is shown below.*



Case 8

- A 78 year old veteran presents to the hospital for shortness of breath. He has a 60 pack year smoking history and has a history of severe COPD requiring 5L continuous oxygen support. He is on theophylline. Pulse of 129 and irregular. On chest exam, diffuse wheezes are heard in all lung fields with prolonged respirations, a loud P2 and right heart heave.*



Case 9

- A 76 year old with a history of depression and Afib is admitted to an inpatient service for pneumonia. She is treated with azithromycin and levofloxacin and she develops nausea treated with ondansetron. Overnight she develops chest discomfort and an EKG is below.*



Case 10 Bonus 1000 points

- A 19 soccer player on the Greek national team presents to the team doctor for palpitations ahead of the world cup. He is diagnosed with anxiety. 2 weeks later he synopsizes on the field and EKG is shown.*

