

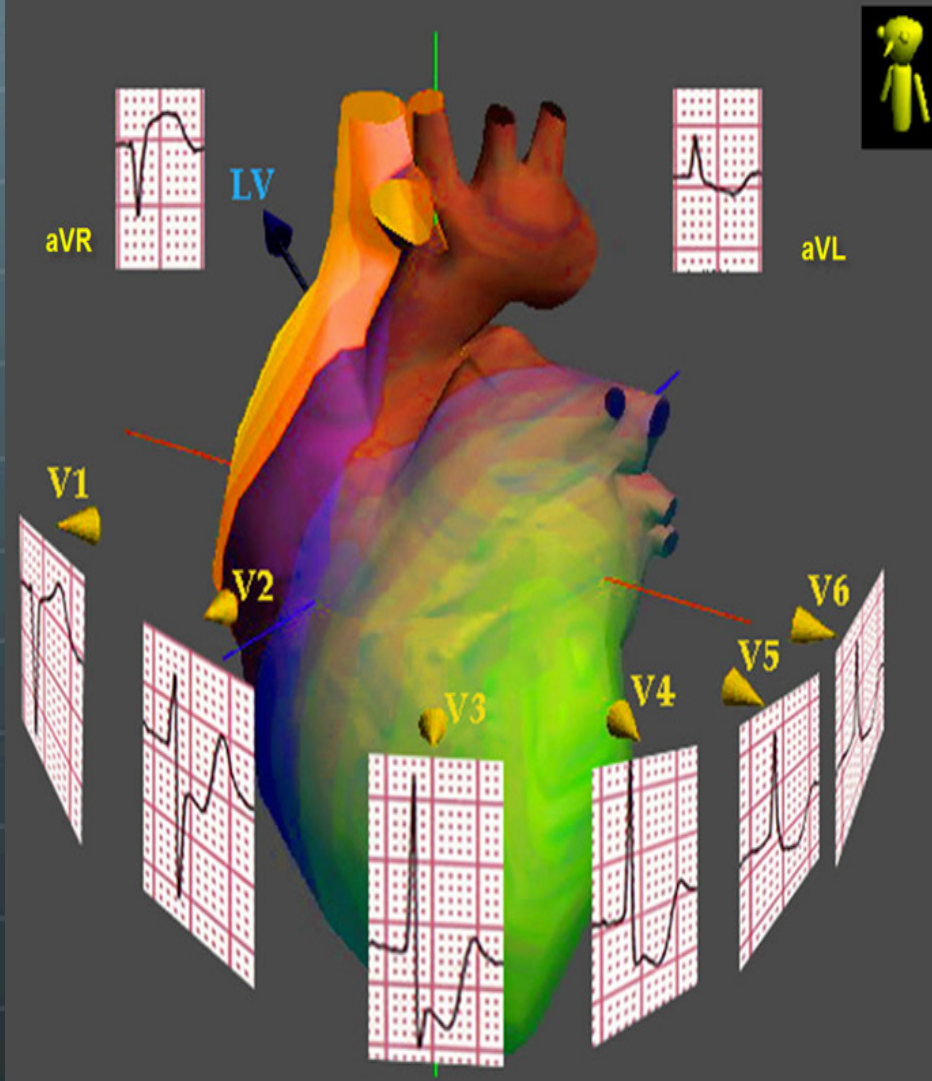
12 Lead EKG: Not Just for Chest Pain

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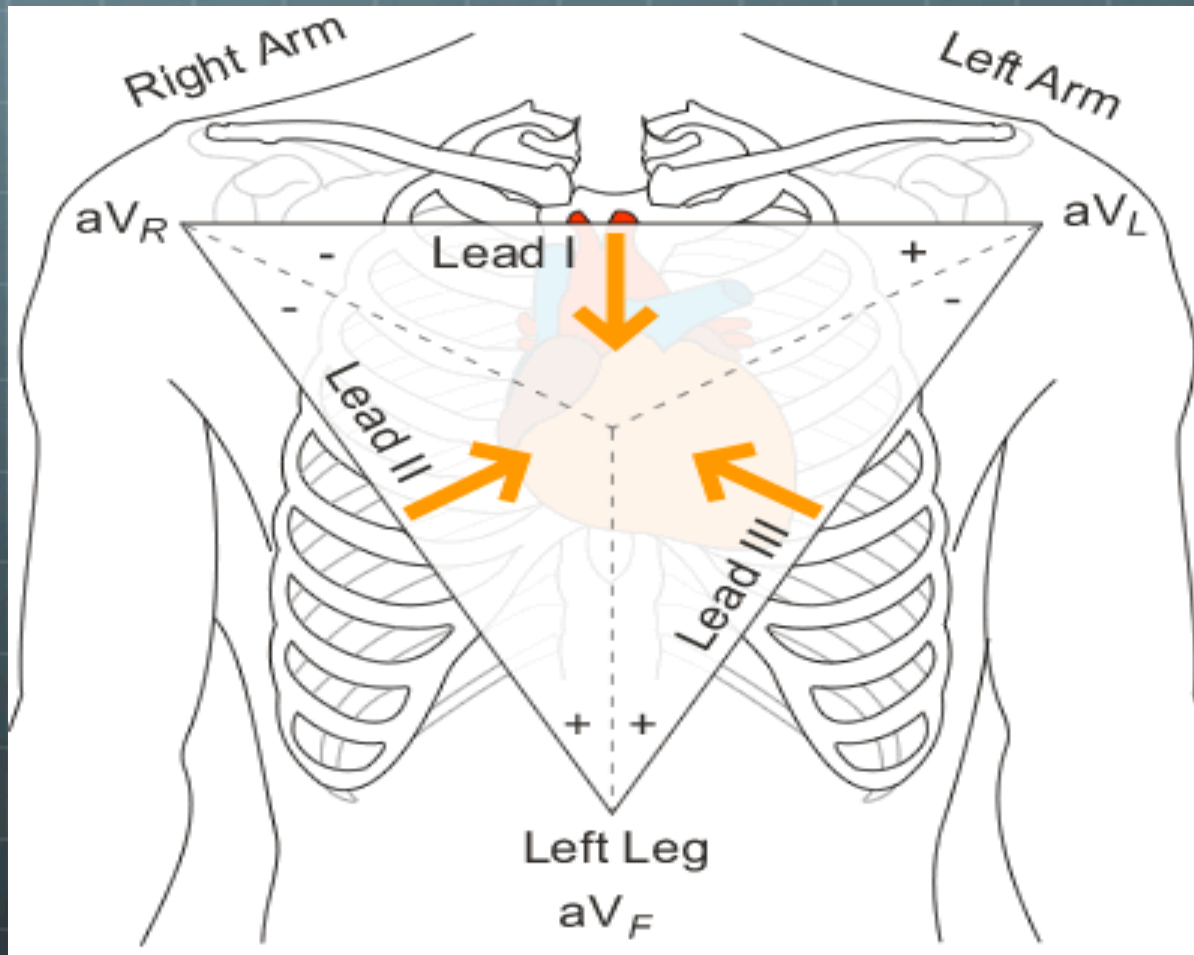
Standard EKG vs 12 Lead



4.15



BiPolar Limb Leads



Unipolar Leads

Augmented Voltage

aVR

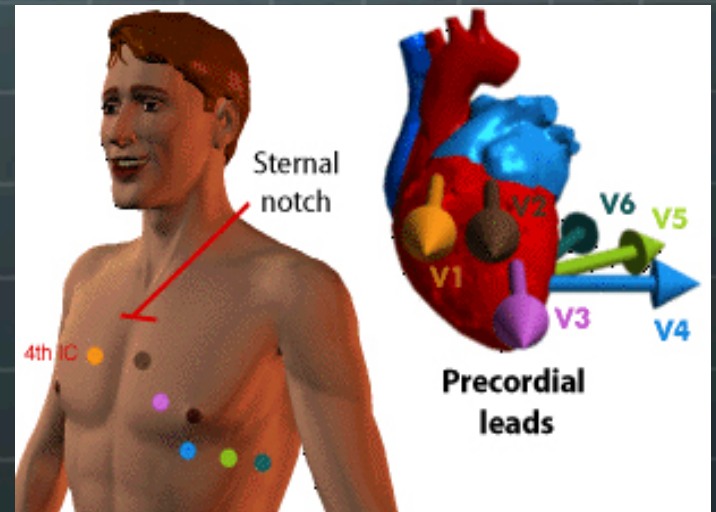
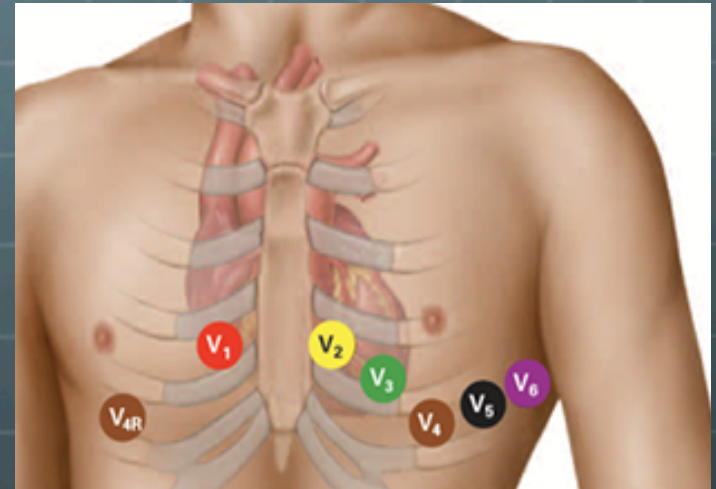
aVL

aVF

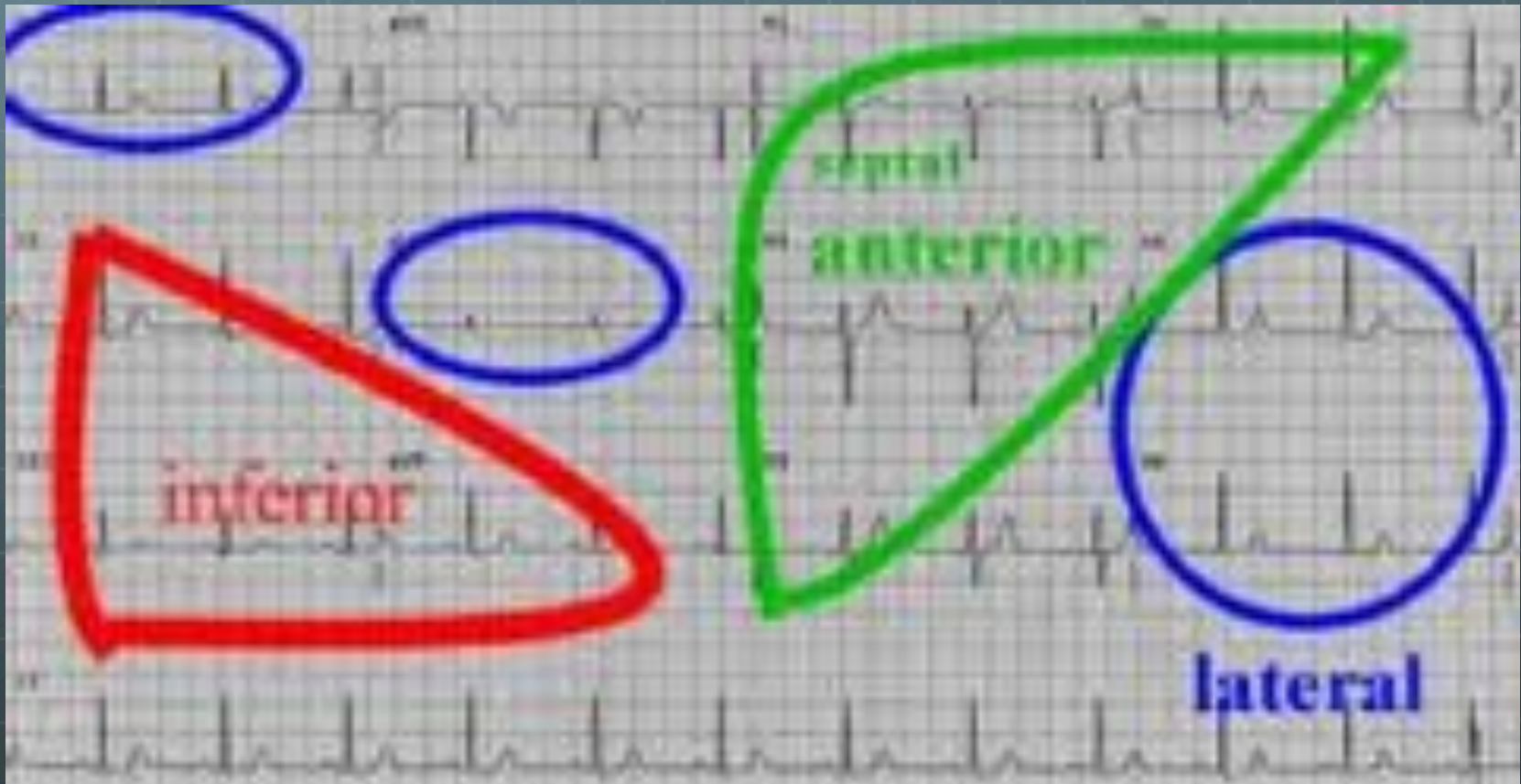


PreCordial Leads

- 🌐 Unipolar
- 🌐 Close to Heart
- 🌐 Just like other leads, all serve as cameras to view areas of the heart



Locating the MI



Lights, Camera, Action!



Inferior Wall

🌐 II, III, aVF

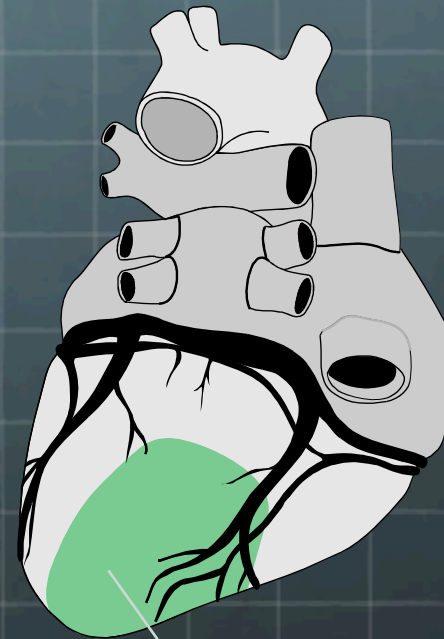
🌐 Left Leg

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



Inferior Wall

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



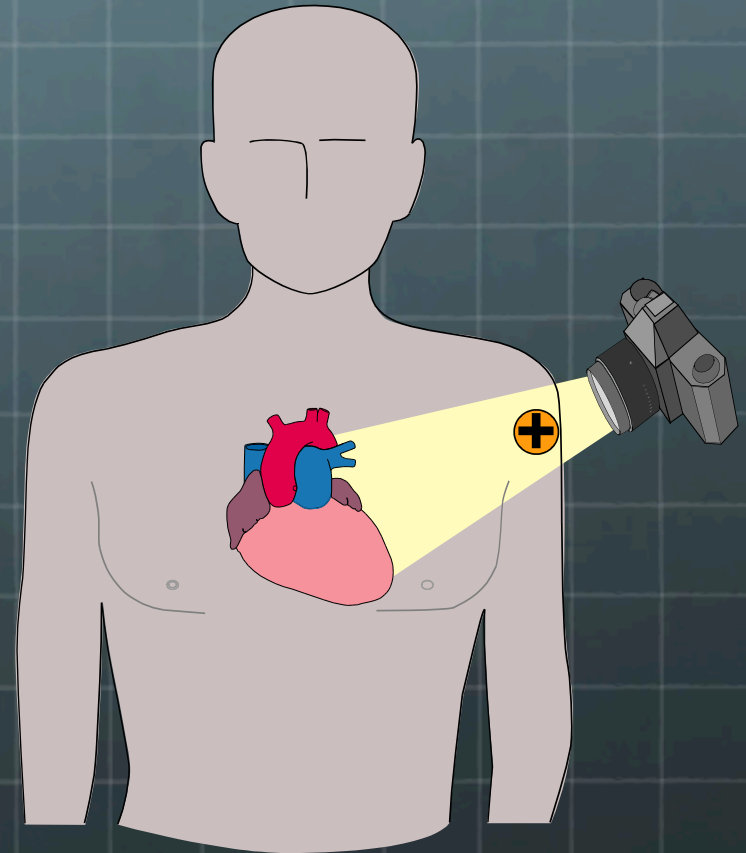
Inferior Wall

Lateral Wall

🌐 I and aVL

🌐 Left Arm

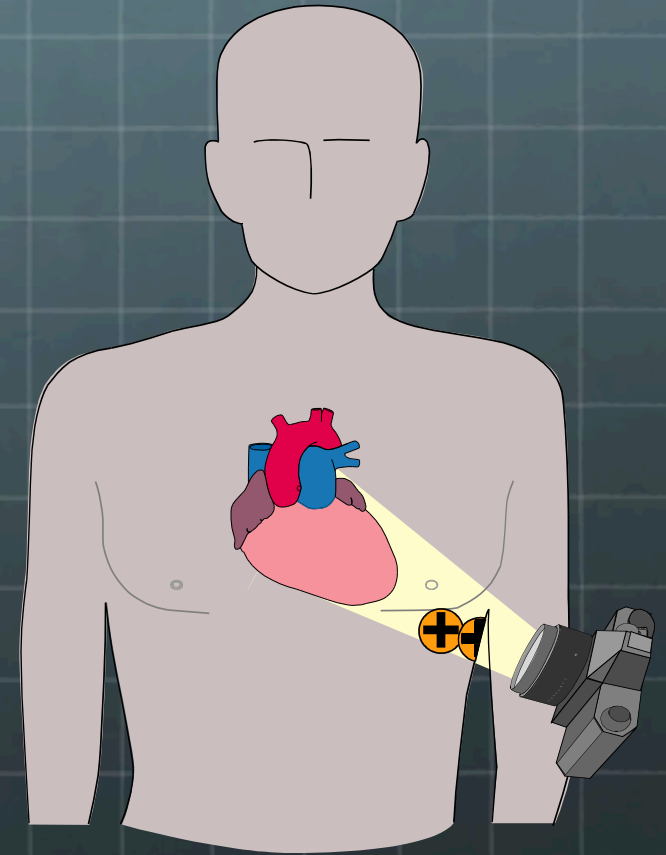
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6



Lateral Wall

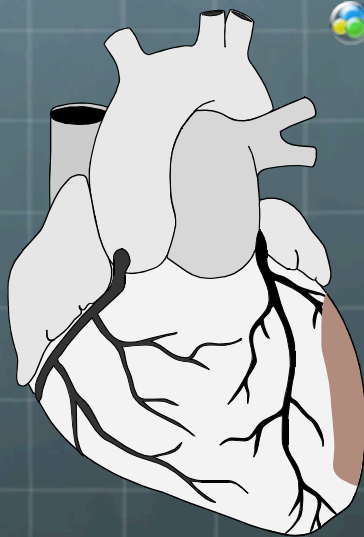
- 🌐 V5 and V6
- 🌐 Left lateral chest

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



Lateral

🌐 I, aVL, V5, V6



Lateral Wall



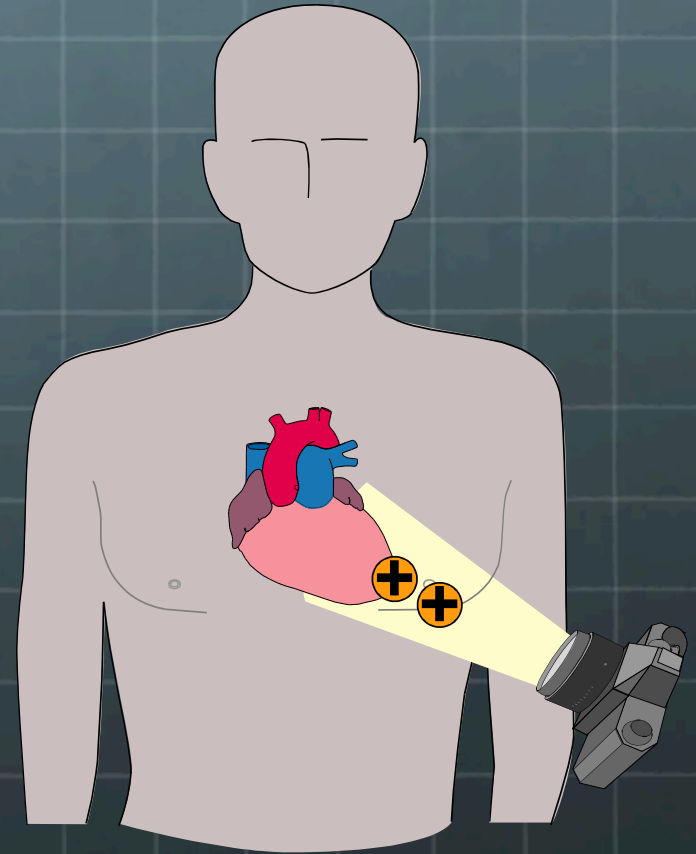
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Anterior Wall

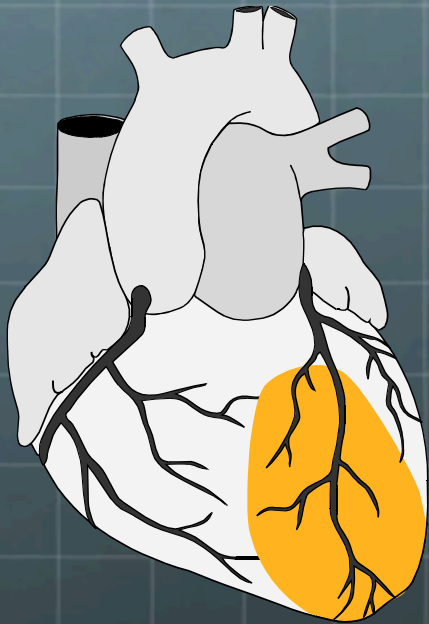
🌐 V3, V4

🌐 Left anterior chest

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



Anterior Wall



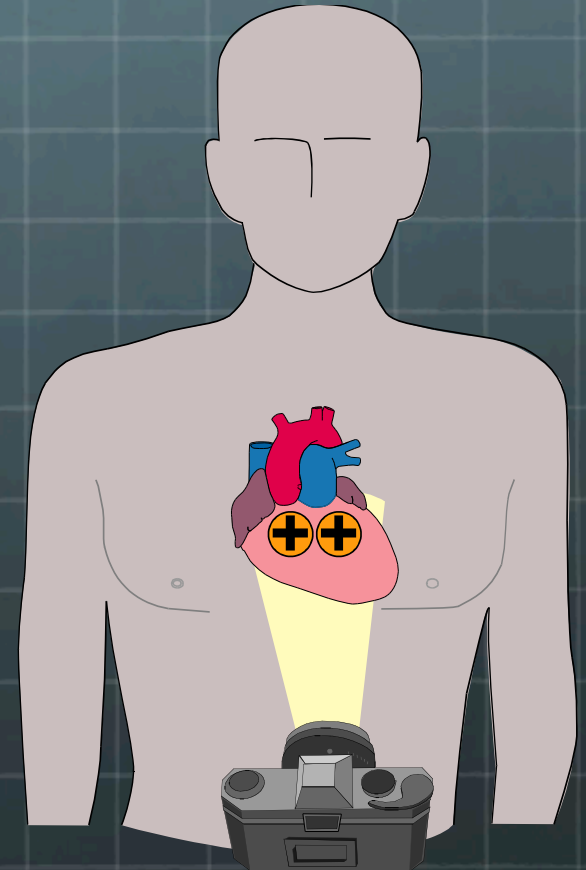
- V3, V4

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

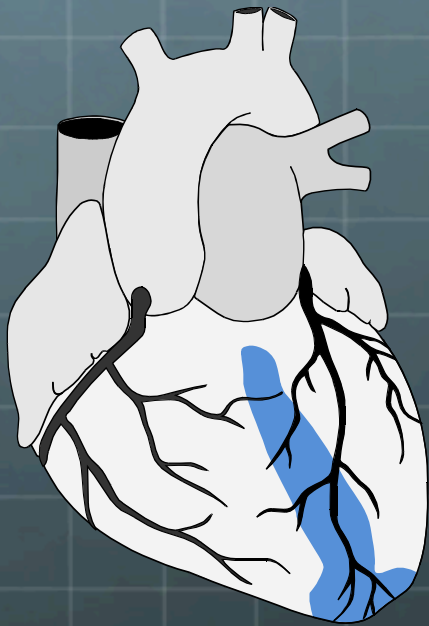
Septal Wall

- 🌐 V1, V2
- 🌐 Along sternal borders

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



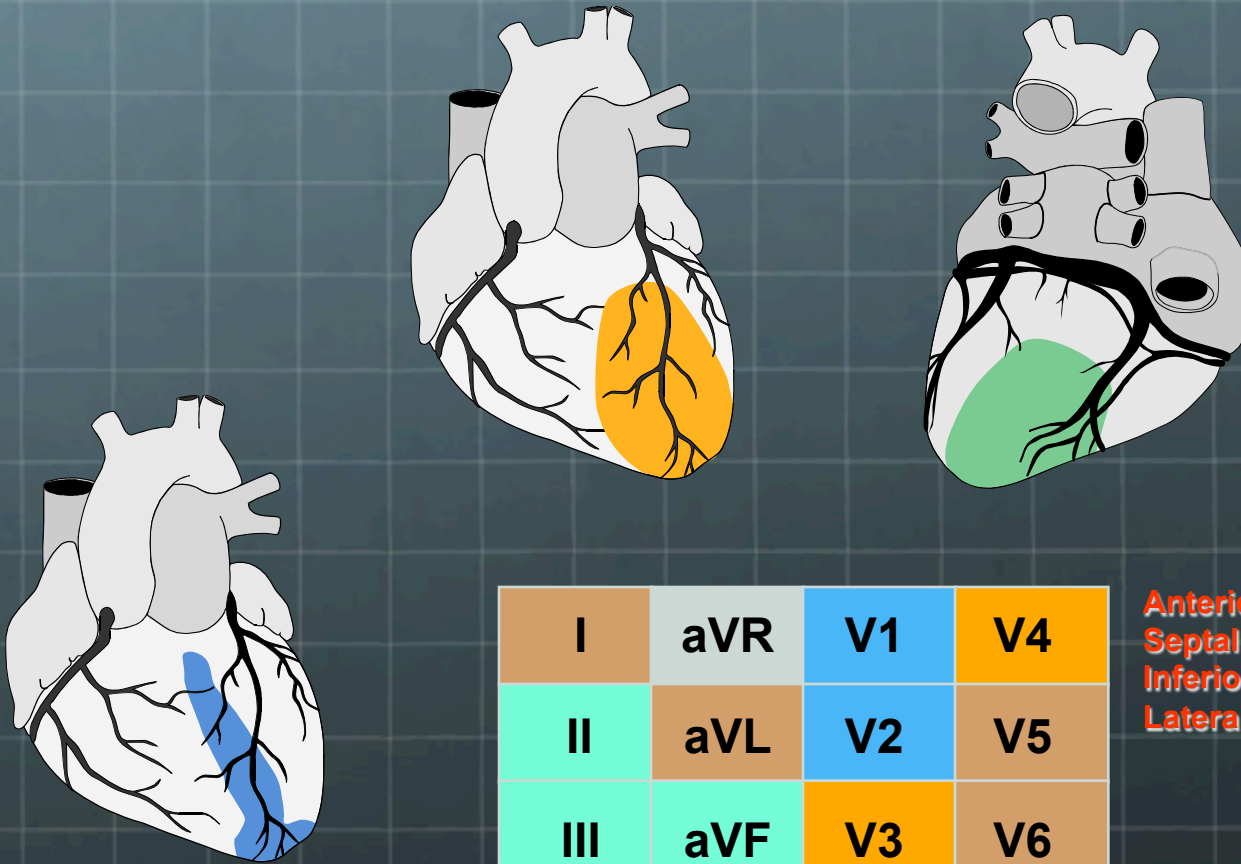
Septal



- V1, V2

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

AMI Localization



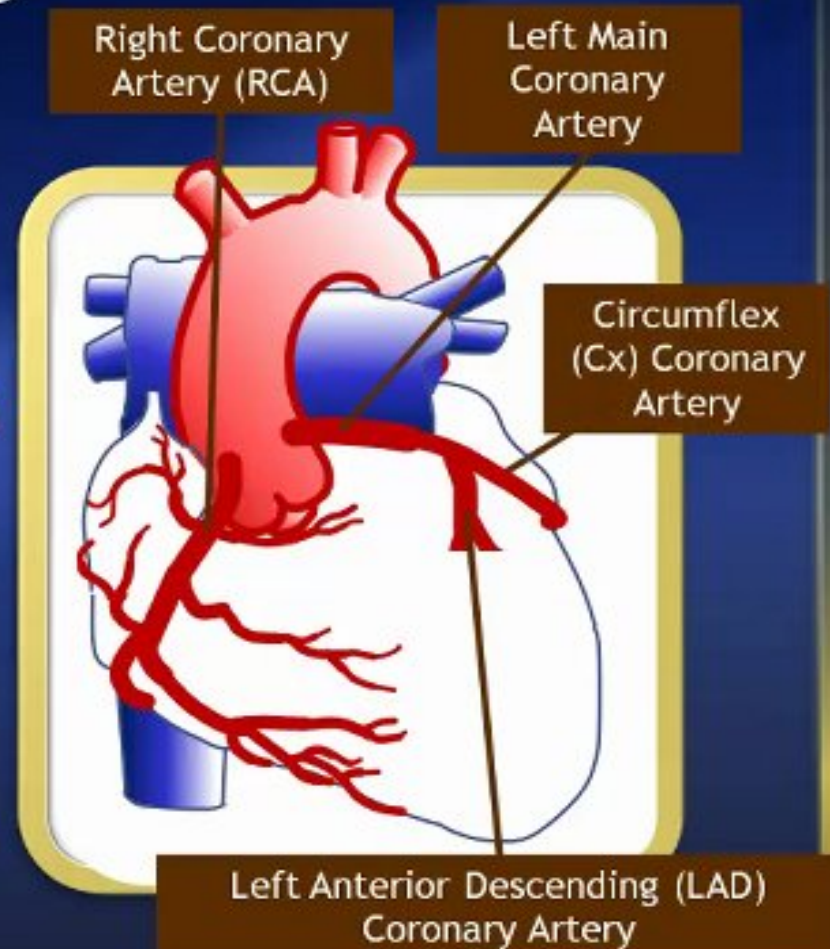
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Anterior: V3, V4
Septal: V1, V2
Inferior: II, III, AVF
Lateral: I, AVL, V5, V6

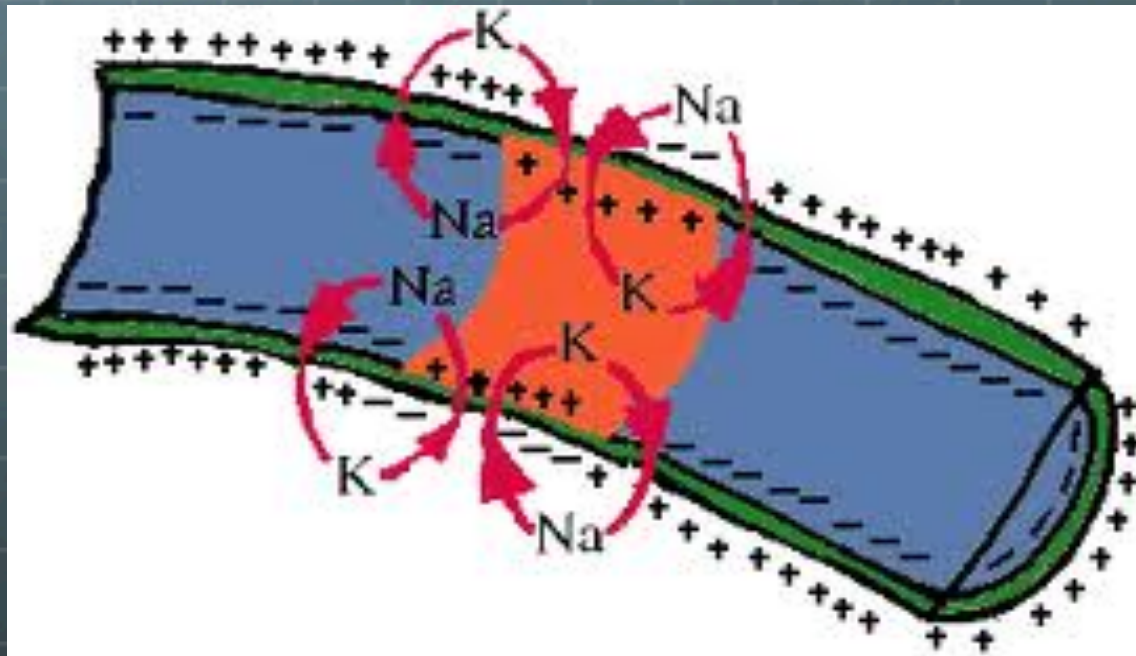
Finding the Blockage

Coronary Arteries

- **Right Coronary Artery (RCA)**
 - Inferior wall MI
 - Feeds the upper portion of the electrical system
- **Left Main**
 - Sudden death
- **Left Anterior Descending (LAD)**
 - Anterior wall MI
 - Feeds Left Ventricle
 - “The Widow-Maker”
 - Feeds the right bundle branch and portions of the left bundle branch




Electrolytes and Cells



Three Major Cations That Affect Cardiac Function



Potassium (K⁺)

-  Performs major function in cardiac depolarization and repolarization

Sodium (Na⁺)

-  Performs vital part in depolarization of myocardium

Calcium (Ca⁺⁺)

-  Performs important function in depolarization and myocardial contraction
 -  Magnesium and Chloride are also important

Movement of Ions

- Ionic difference on two sides of cell
 - **Potassium ion**
 - Concentration greater inside cell
 - **Sodium ion**
 - Concentration greater outside cell
 - **Sodium-potassium exchange pump**
 - Active transport, potassium/
sodium moved in and out of cell
through cell membrane

Movement of Ions

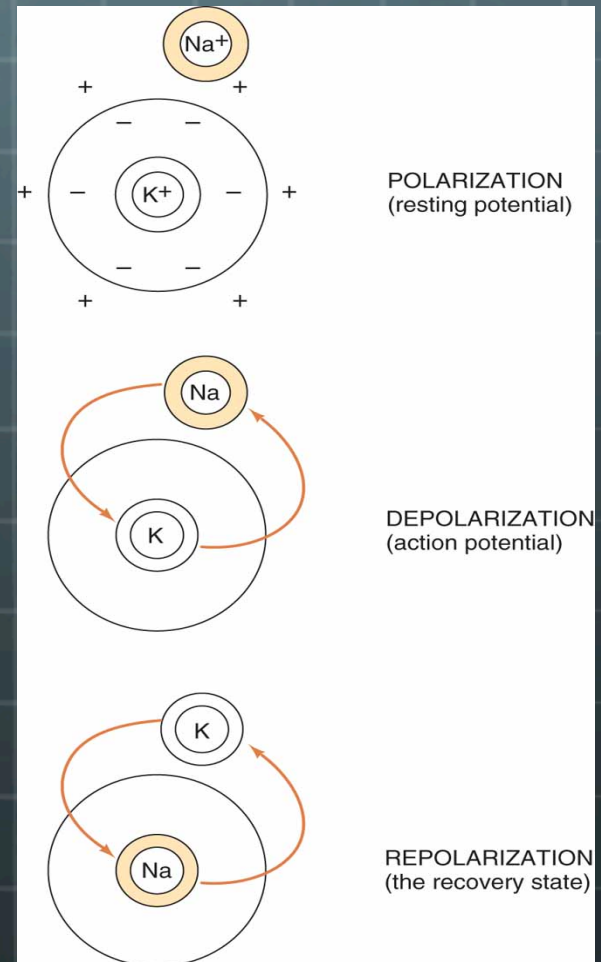
During **polarized, or resting, state** the inside of cell is electrically negative relative to outside of cell.

Cardiac Depolarization

Sodium ions rush into cell, changing interior charge to (+) after cell is stimulated

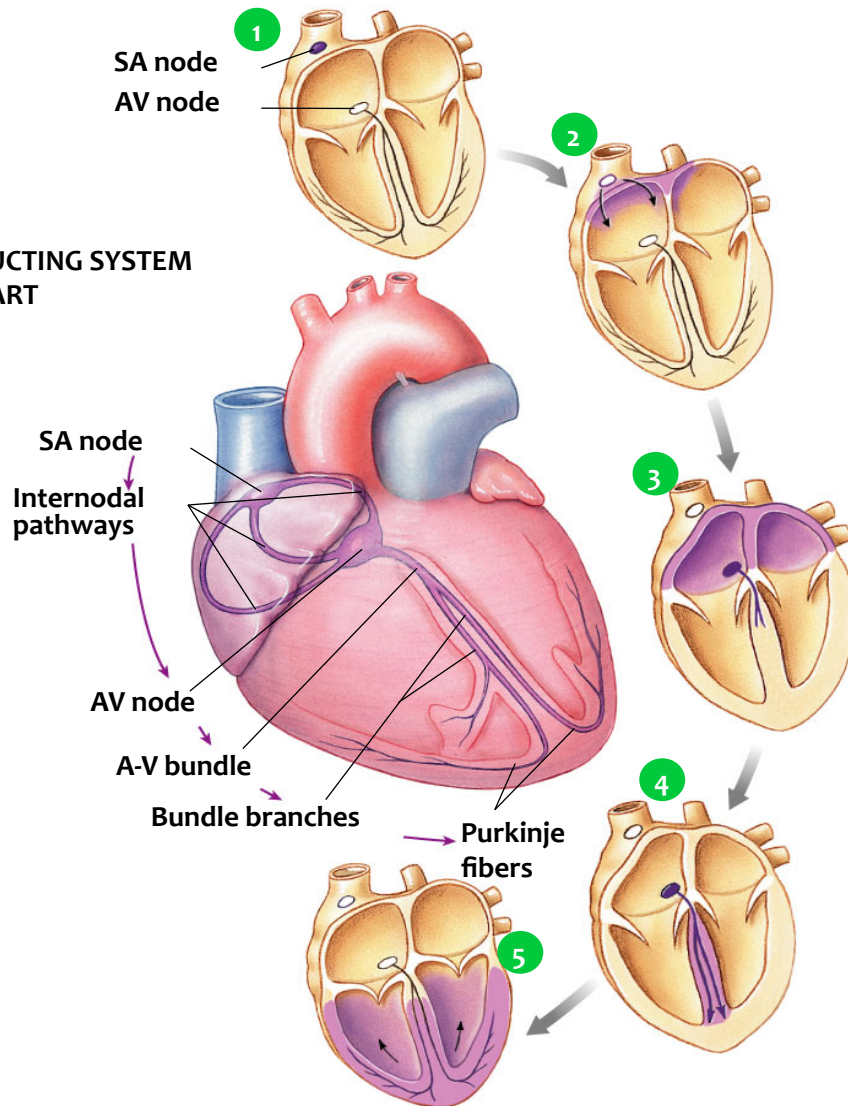
Cardiac Repolarization

Sodium ions returns to outside of cell, potassium returns to inside of cell



Depolarization and Repolarization

THE CONDUCTING SYSTEM OF THE HEART



1 SA node depolarizes.

2 Electrical activity goes rapidly to AV node via internodal pathways.

3 Depolarization spreads more slowly across atria. Conduction slows through AV node.

4 Depolarization moves rapidly through ventricular conducting system to the apex of the heart.

5 Depolarization wave spreads upward from the apex.

Basic Review

- 🌐 Electrodes act as cameras
- 🌐 The more leads we have, the more we can see
- 🌐 The Sodium-Potassium pump plays a major role in cardiac electrophysiology
- 🌐 When the inside of the cells become “more positive” than the outside, depolarization occurs

Let's look at some cases



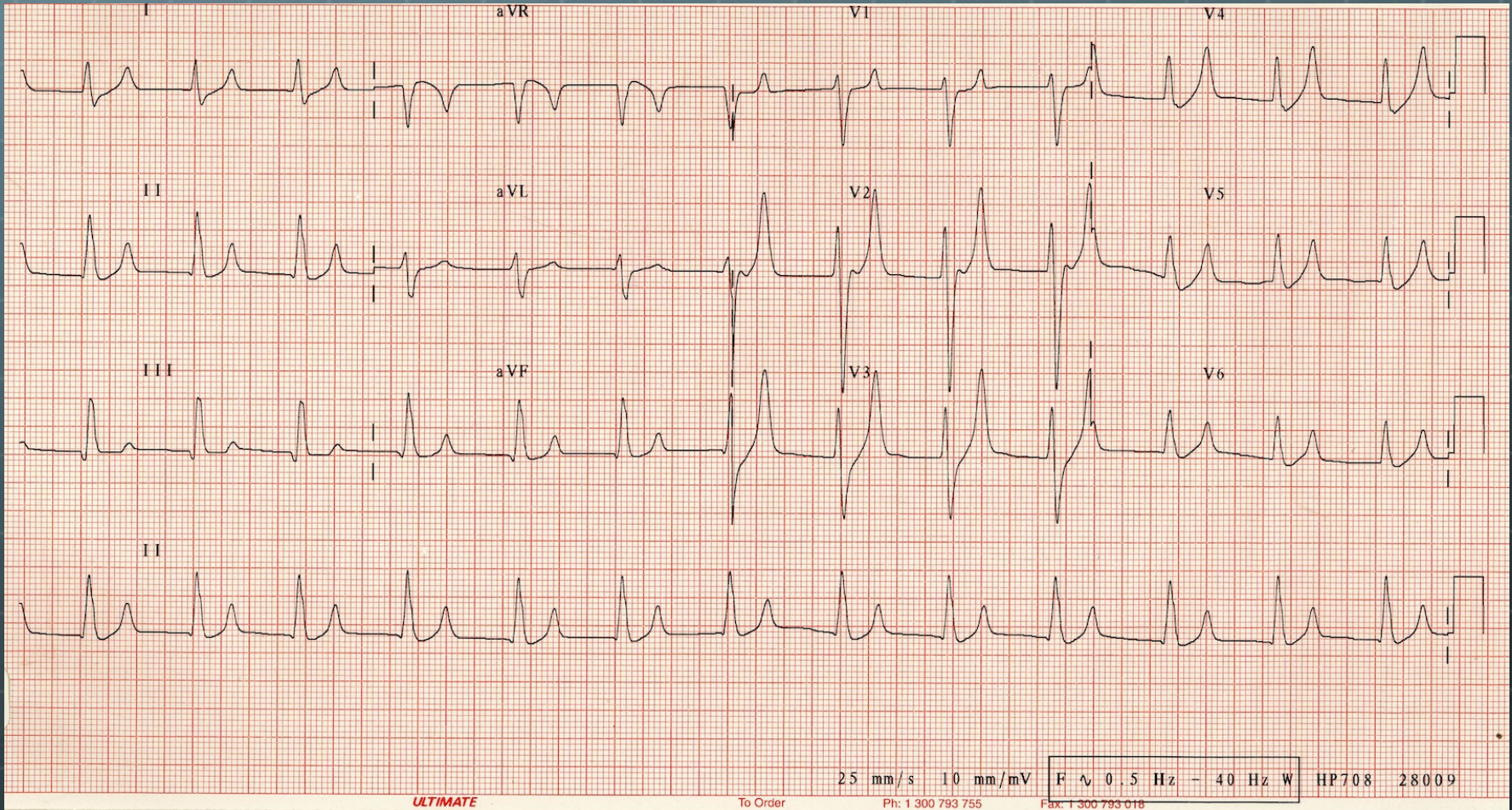
Case 1

- 30 year old male found unresponsive
- Wife states he has a history of diabetes
- Vital signs are: BP 130/86, Pulse 90, Respirations 16 with room air sat of 93%
- Glucometer reading is “HI”
- You run a 12 lead just in case it may be cardiac related and you see:



Case 1

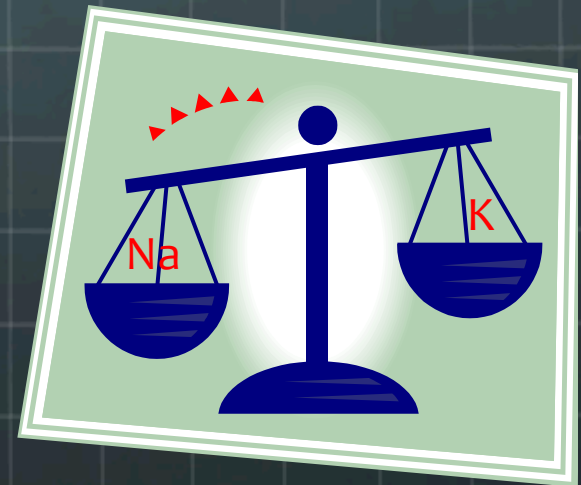
🌐 What do you notice?



Case 1

What are some possibilities that cause T wave abnormalities:

- 🌐 Electrolyte imbalances
- 🌐 Ischemia
- 🌐 CNS Events



Case 1

- 🌐 WHEN YOU SEE PEAKED, TALL, NARROW T WAVES, THINK **HYPERKALEMIA!**
- 🌐 Especially in dialysis and renal disease patients
- 🌐 We may not have lab values in the field so how will I know?
- 🌐 You won't know for sure, but you can put the puzzle together.

Case 1

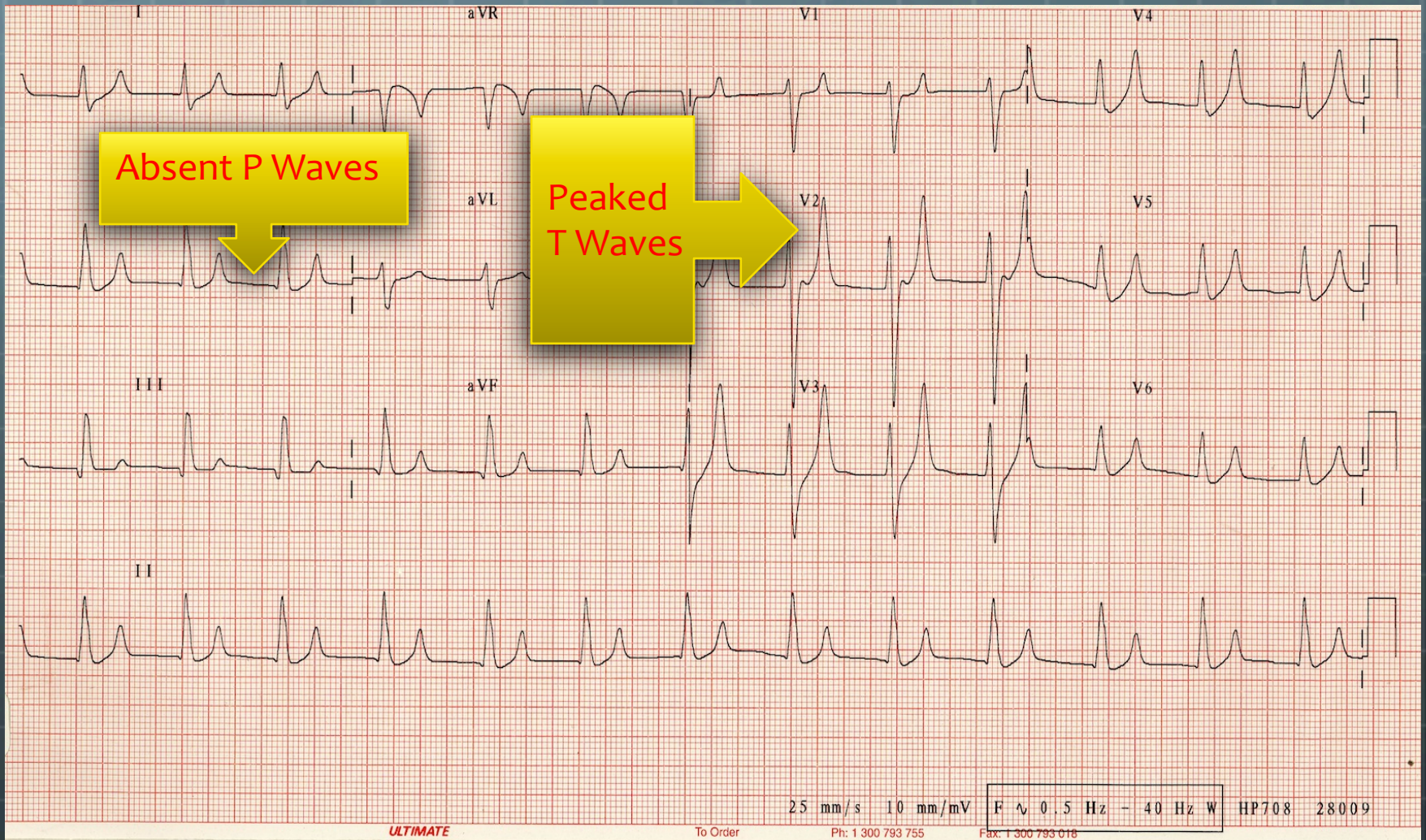
- 🌐 Treat the signs and symptoms
- 🌐 You suspect hyperkalemia and you remember that normal potassium value is 3.5-5.3 mEq/L
- 🌐 Then you remember:
 - >5.5 mEq/L= T wave abnormalities
 - >6.5 mEq/L= Intervals may widen
 - >7.0 mEq/L= P wave changes start
 - >8.8 mEq/L= P waves may disappear

Case 1

- 🌐 Are there T wave abnormalities?
- 🌐 What about P wave changes?
- 🌐 What do you think the potassium level may be?



Case 1



Case 1

- You now see V-Fib on the monitor
- How can we fix the hyperkalemia? Or can we?
 - Calcium Chloride or Calcium Gluconate
 - Sodium Bicarb
 - Albuterol
 - Insulin (with D50)
- **TREAT THE HYPERKALEMIA FIRST!** All of your code drugs may not work properly until you treat the hyperkalemia.

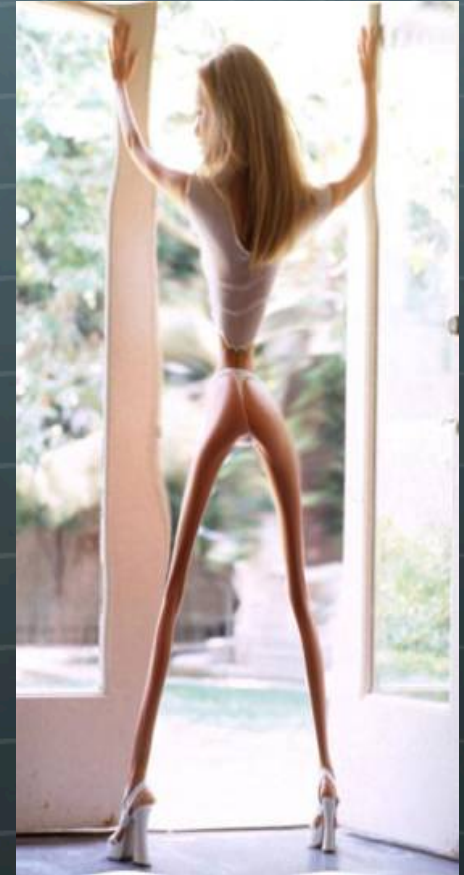


Case 1

- 🌐 You give the calcium and bicarb and you see what appears to be NSR on the monitor. You check to make sure it is not PEA and you feel a strong, bounding carotid pulse.
- 🌐 The patient is placed on dialysis at the hospital and is discharged a week later.

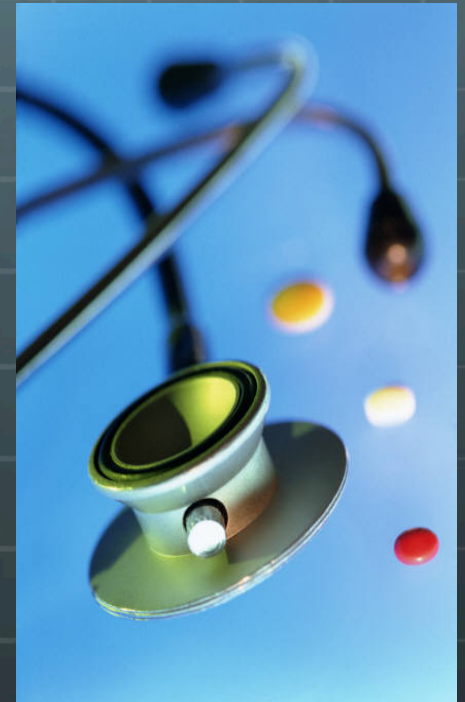
Case 2

- 🌐 You respond to the local all women's college. You find a 21 year old female complaining of vomiting.
- 🌐 Her roommate states that she has been vomiting a lot and is weak.
- 🌐 The patient appears very thin, in fact you think to yourself "she could use some biscuits and gravy".



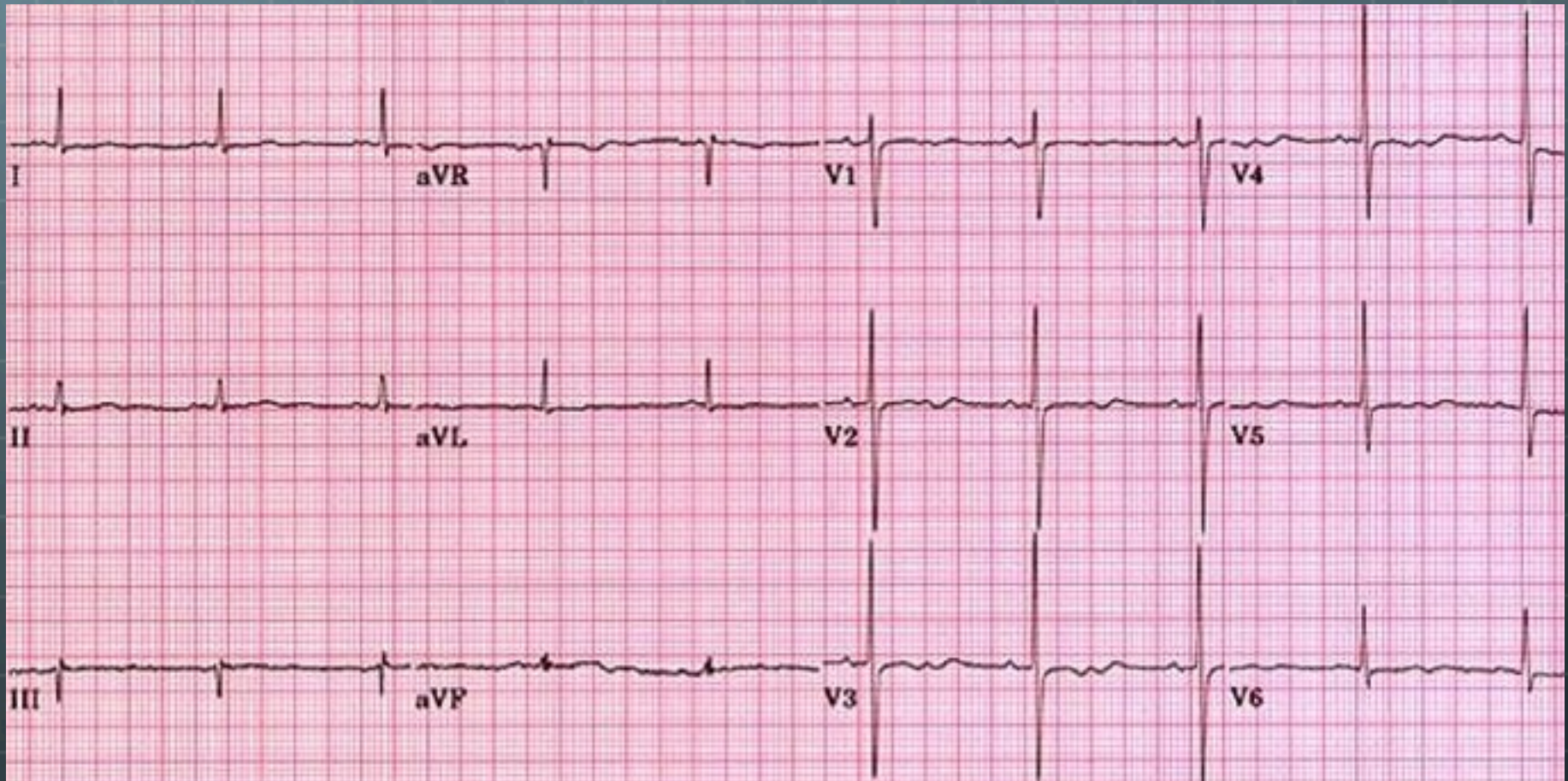
Case 2

- 🌐 Vital signs are BP 96/60, Pulse 98, respirations 20.
- 🌐 The roommate brings you the patients meds. One is BCP with the patient's name on the dispenser. The other is a pill bottle with the name blacked out. The prescription is for Lasix. The bottle is empty. You notice an empty laxative box on the floor.



Case 2

🌐 You decide to run a 12 lead and find:

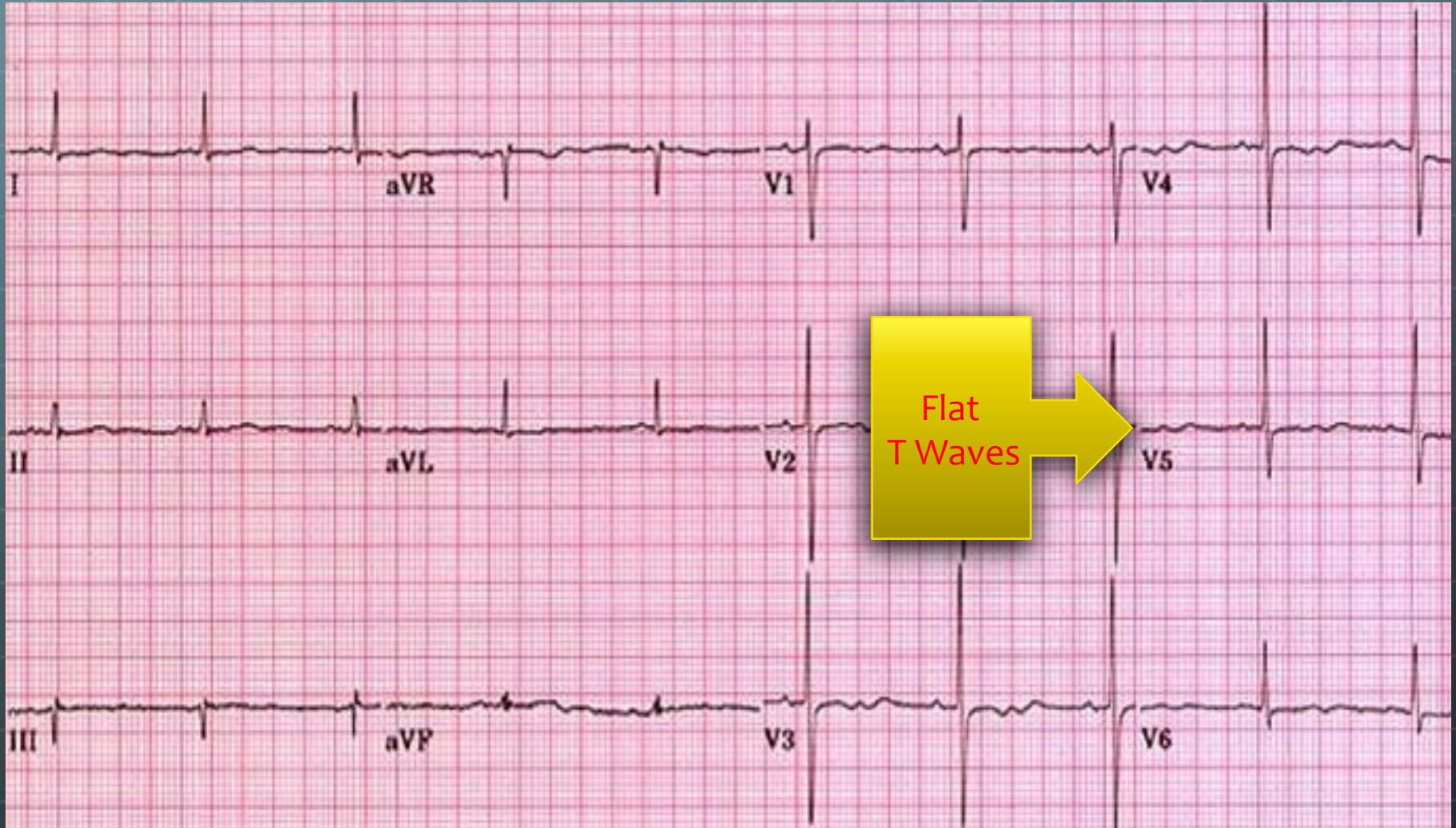


Case 2

- What did you notice?
- Ok, so there are T wave abnormalities. So you consider:
 - Electrolyte imbalance
 - Ischemia
 - CNS event.



Case 2



Case 2

- 🌐 She is awake and oriented, her sat is 97% so you're thinking electrolyte imbalance.
- 🌐 And since peaked T waves are found in hyperkalemia, flat or depressed T waves must mean...
- 🌐 **HYPOKALEMIA!**
- 🌐 You provide supportive measures and transport to the ED.

Case 2

- 🌐 Her potassium was 1.9
- 🌐 Putting the pieces together, why do you think it was so low?
- 🌐 Anorexia and Bulimia are more common than you think.
- 🌐 Most of your patients with eating disorders will be young females

Case 2

- 🌐 Don't forget about the elderly who may be anorexic unintentionally
- 🌐 Eating disorders contribute significantly to electrolyte imbalances
- 🌐 Laxatives and diuretics are used by many people with eating disorders.
- 🌐 And who takes these types of things daily...the elderly.

Case 3

- 🌐 You are dispatched to a 66 y/o female with sudden onset of slurred speech and weakness.
- 🌐 What are you thinking en route?
- 🌐 On the way to the call, another call comes in for a 38 year old female unresponsive. Another unit is closer to the first call, so you take this one.

Case 3

- 🌐 You dread this call. You go to this address frequently. The mother is always calling for non emergency reasons for her kids. She is a known drug and alcohol abuser.
- 🌐 You arrive to find the patient lying in bed. She is unresponsive, has deep, snoring respirations at a rate of 14.



Case 3

- 🌐 Her 12 year old tells you that her mother has been doing well since she met “John”. She has stopped drinking and no longer uses drugs. The child seems genuinely excited about her mother’s improvement; she keeps telling you about the skiing trip John took them on a few days ago.
- 🌐 Her mother’s only complaint was a headache earlier; she had taken a nap, but never woke up.



Case 3

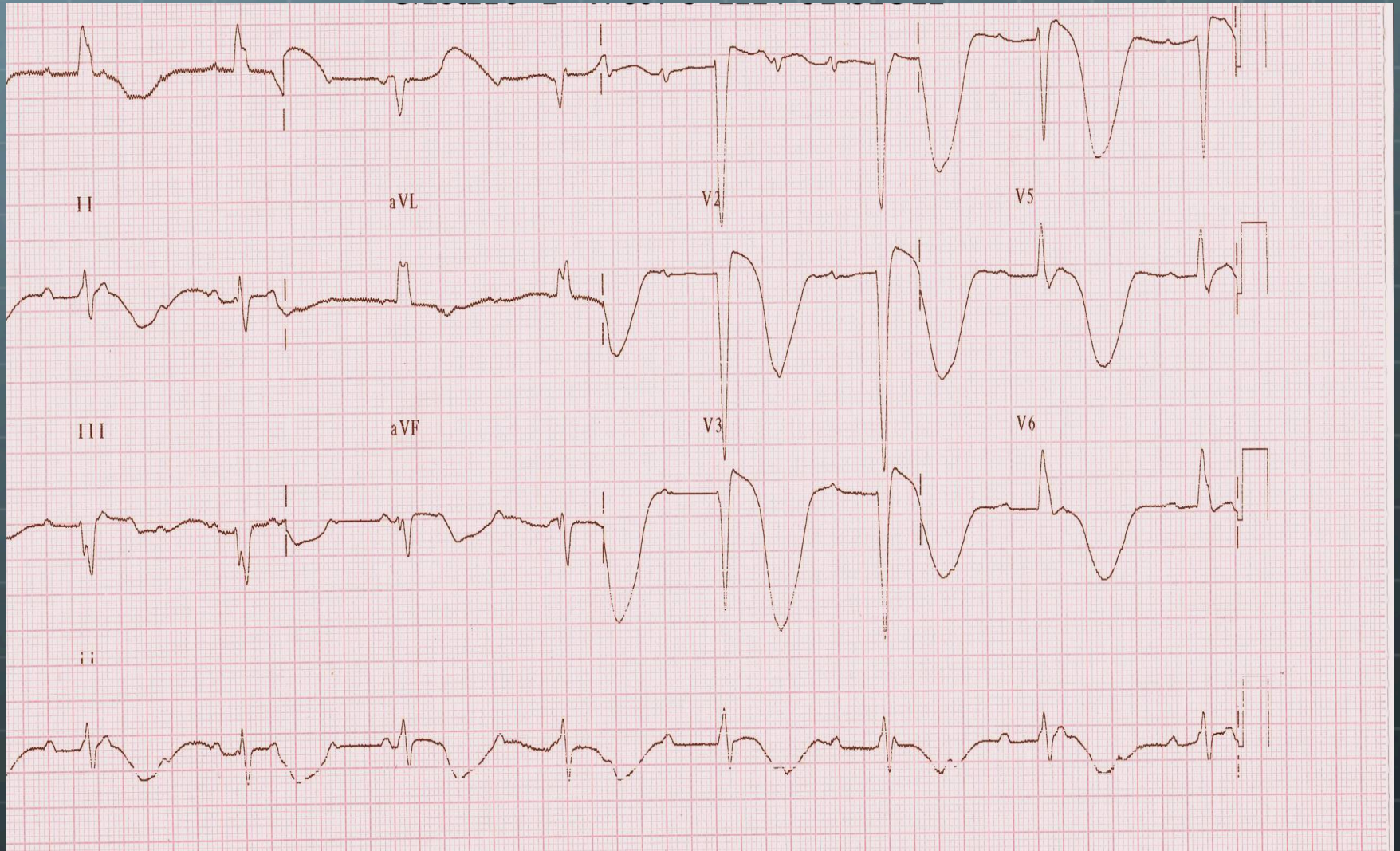
🌐 Patient's BP is 167/100, Pulse is 68. Glucometer reading is 129. O2 sat is 93% room air.

🌐 Whatcha thinking now?

🌐 Now you're on track, how 'bout a good ol' EKG.



Case 3



Case 3

🌐 Yep, those T waves sure don't look good. What are the 3 things we should consider?

🌐 Electrolyte imbalance

🌐 Ischemia

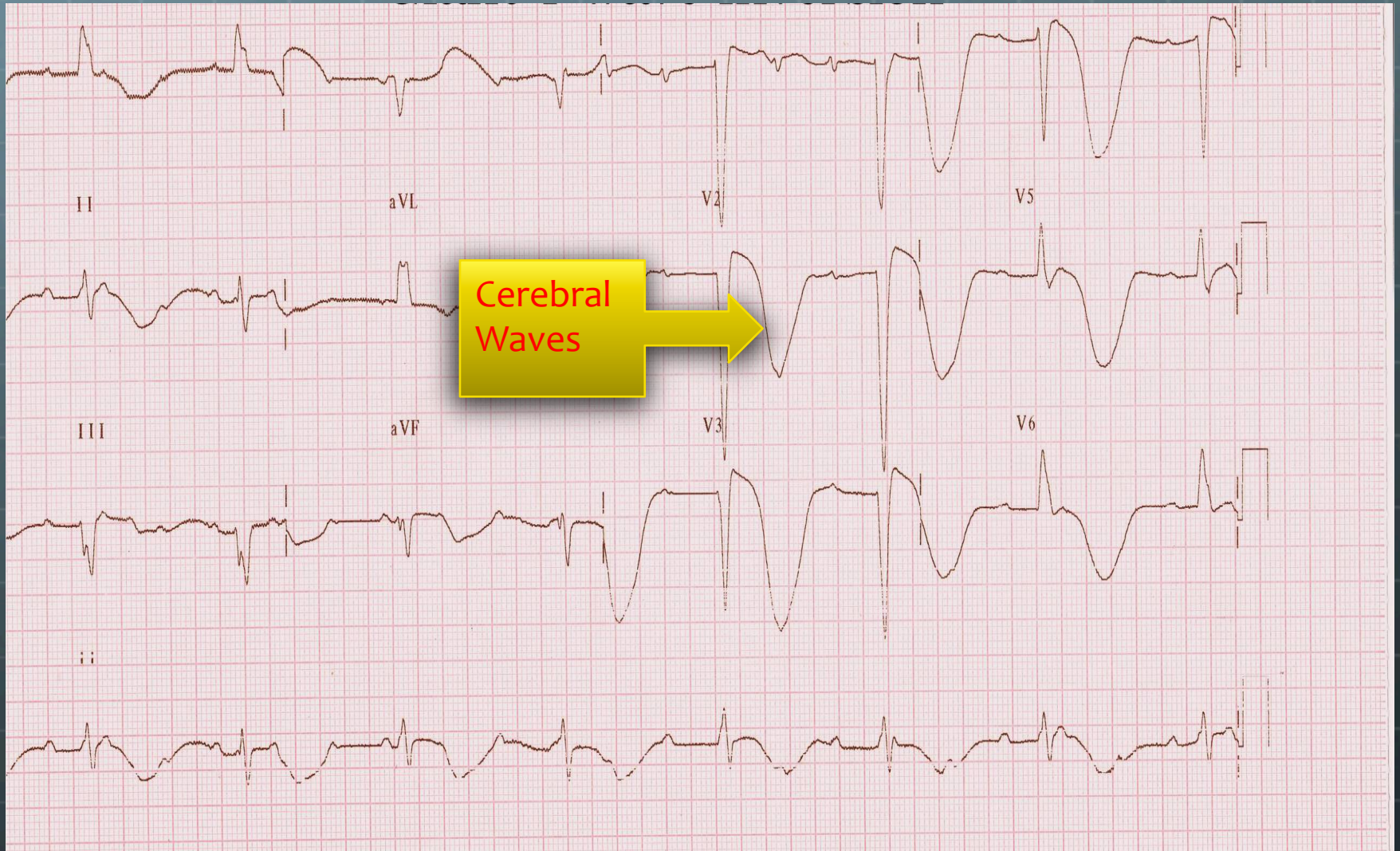
🌐 CNS event

Case 3

- 🌐 As you place her on O₂ and place her on the stretcher, her 6 year old son comes in and asks, “Did mommy fall again?”
- 🌐 You question this and find out that during the skiing trip, the patient took a hard fall that “knocked her out” for a couple of seconds.



Case 3



Case 3

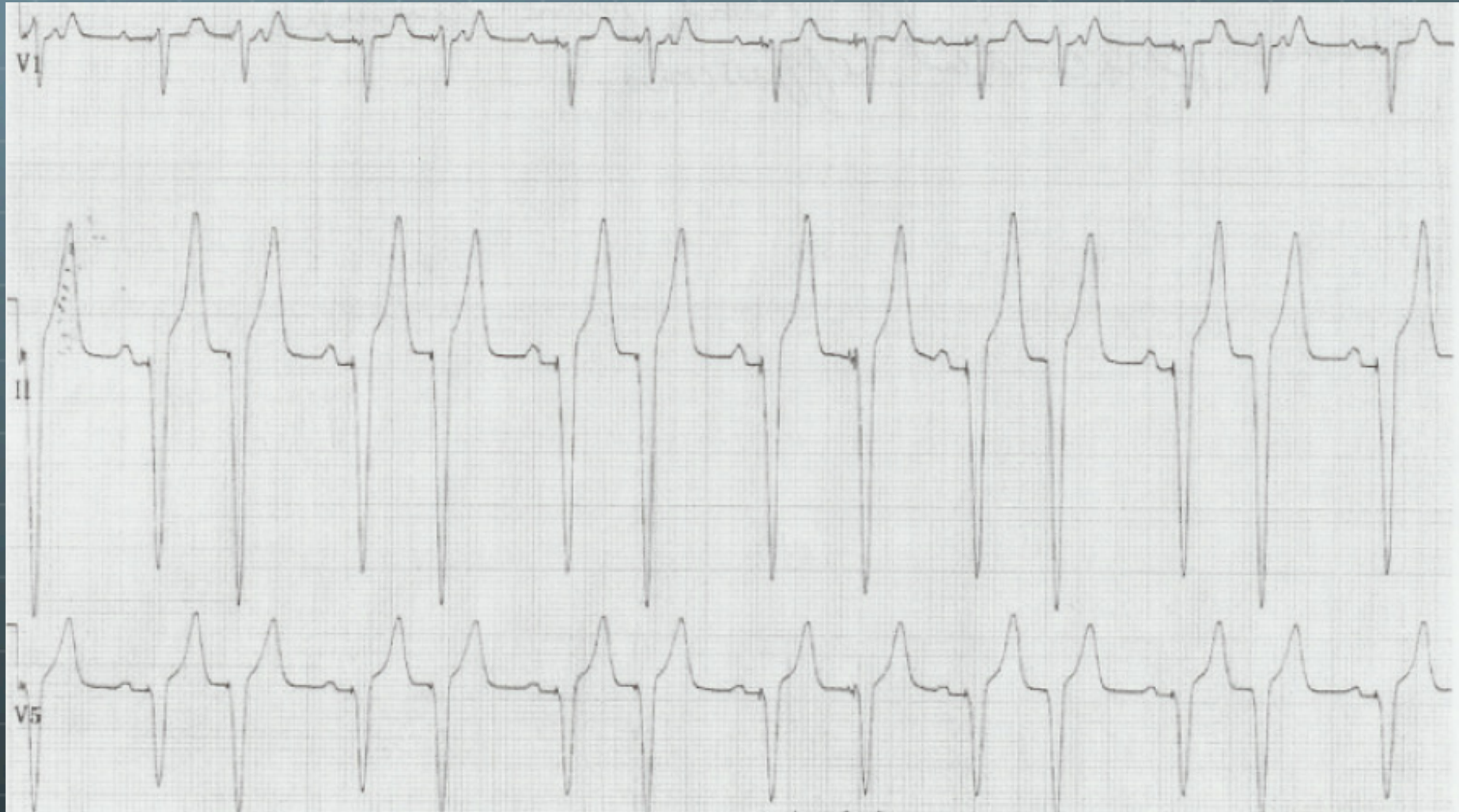
- 🌐 The patient is diagnosed with a subdural bleed; dies 2 days later.
- 🌐 Why do CNS events cause deep, inverted T waves?
- 🌐 Nobody knows, they just do!

Case 4

- 70 y/o female complaining of being lightheaded
- Her only medical history is having a pacemaker implanted a week ago because her heart was “beating too slow”.
- Vital signs: BP 80/50, Pulse 120, respirations 24. O₂ sat 88% room air.



Case 4

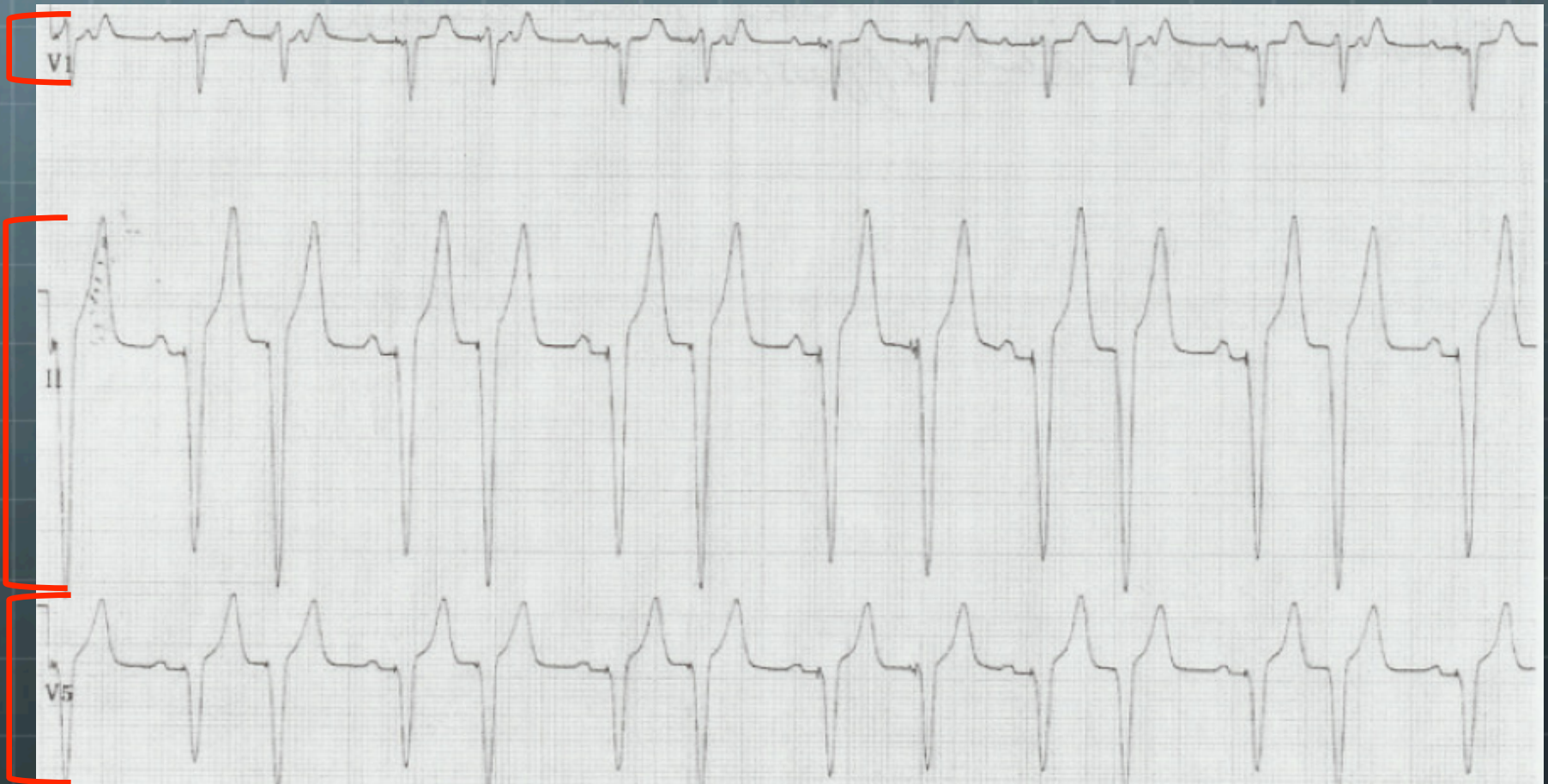


Case 4

- 🌐 Any ideas yet?
- 🌐 What are we going to do for this patient?
- 🌐 You recheck vitals and find: BP 60/40, Pulse 130, and respirations 24.
- 🌐 JVD Noted
- 🌐 BP was 80/50, now 60/40...hmmm

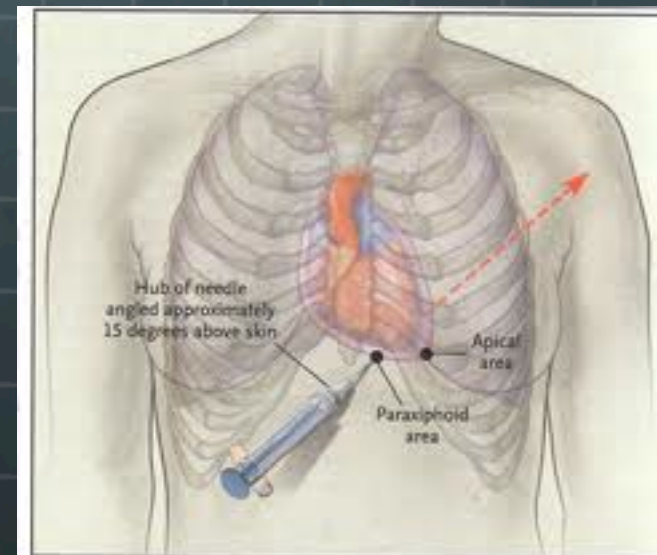
Case 4

So the differences in size of the leads helps confirm cardiac tamponade.



Case 4

- 🌐 These alternans vary due to the positional change of the fluid-filled, enlarged heart.
- 🌐 When the pacemaker was implanted, the pericardium was injured causing tamponade.
- 🌐 Pericardiocentesis anyone?



Case 5

- 🌐 You respond to a 48 year old male that has “passed out”.
- 🌐 Upon arrival, the patient is A&O x 4. He is sitting in the chair, is pale, cool and moist. He complains of a little chest pain with some dyspnea.
- 🌐 He tells you that he has been working around the house today. He states, “since I fell a couple of weeks ago, I haven’t been able to do much. I guess I overdid it today.”

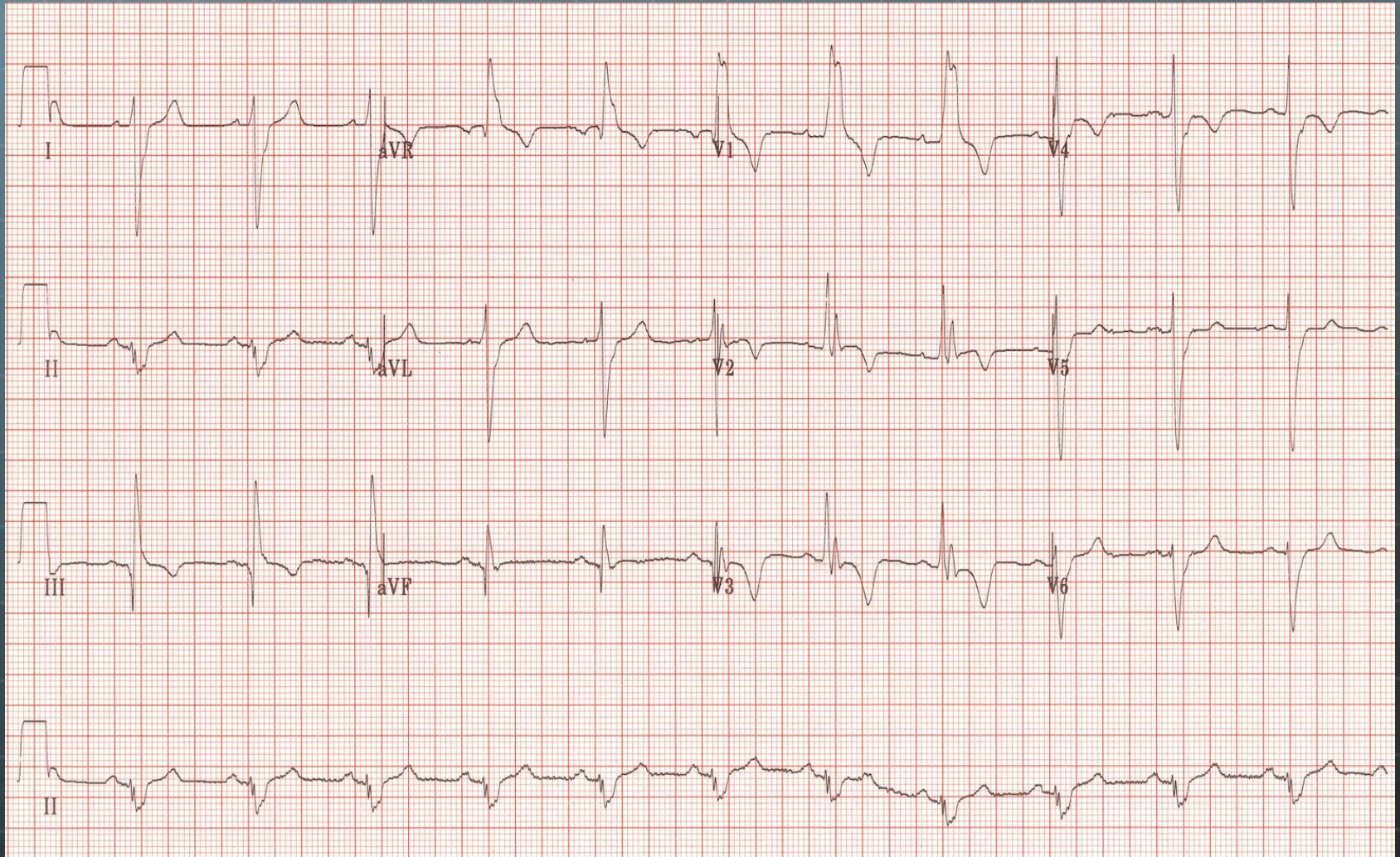


Case 5

- 🌐 Vital signs: BP 80/50, Pulse 112, respirations 24. O2 sat is 90% on room air.
- 🌐 What do you want to do?
- 🌐 After putting him on O2 and while your partner sets up the IV, you place him on the monitor and find...

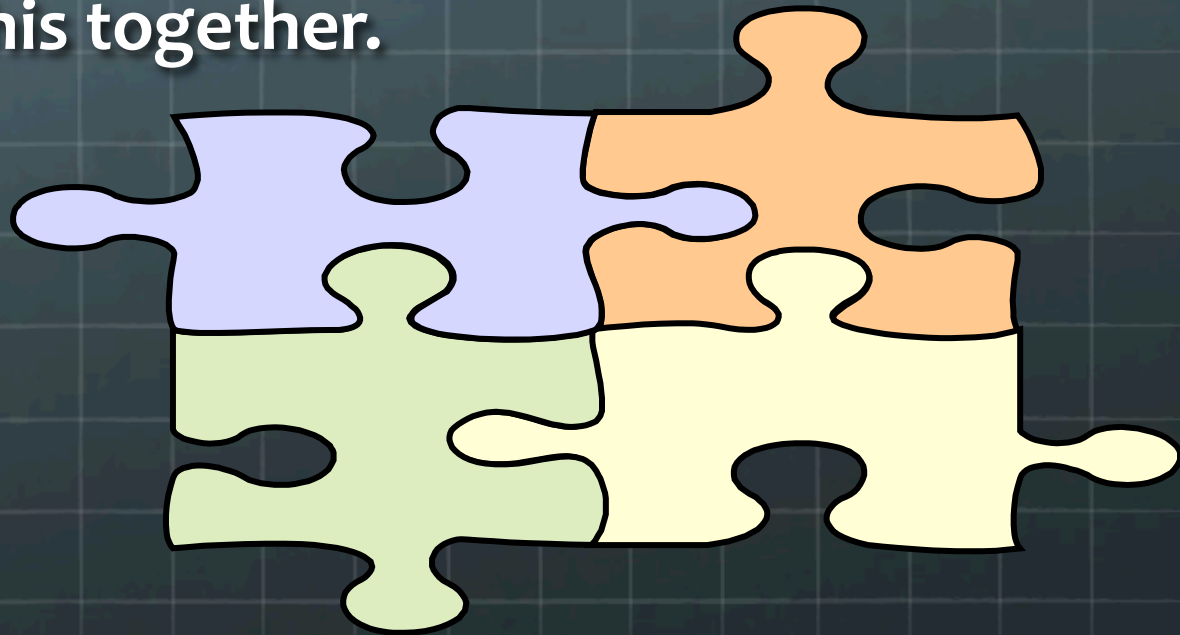


Case 5



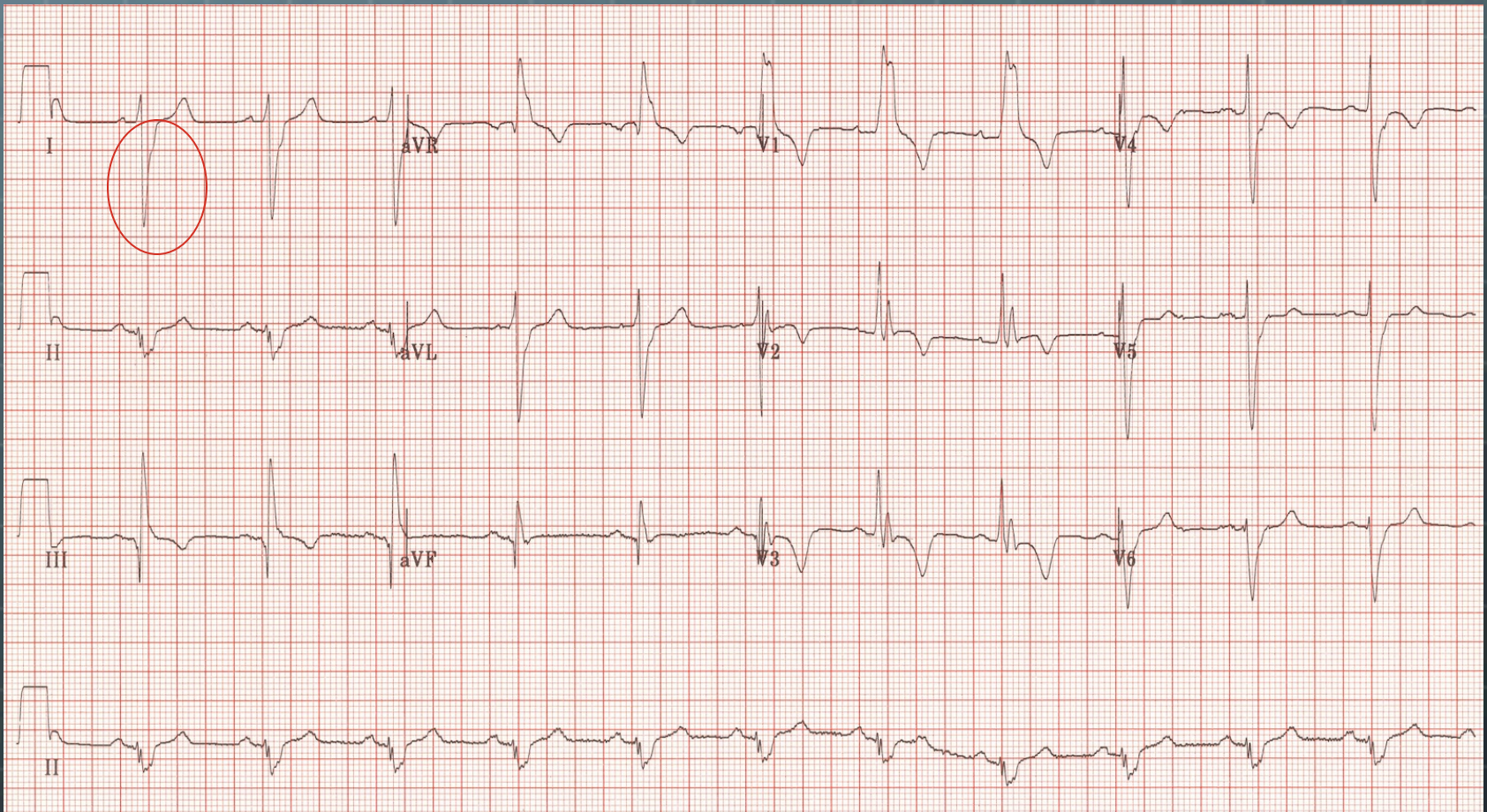
Case 5

- 🌐 Now, this one is a bit more tricky
- 🌐 We are looking for S1Q3T3.
- 🌐 Let's look at this together.



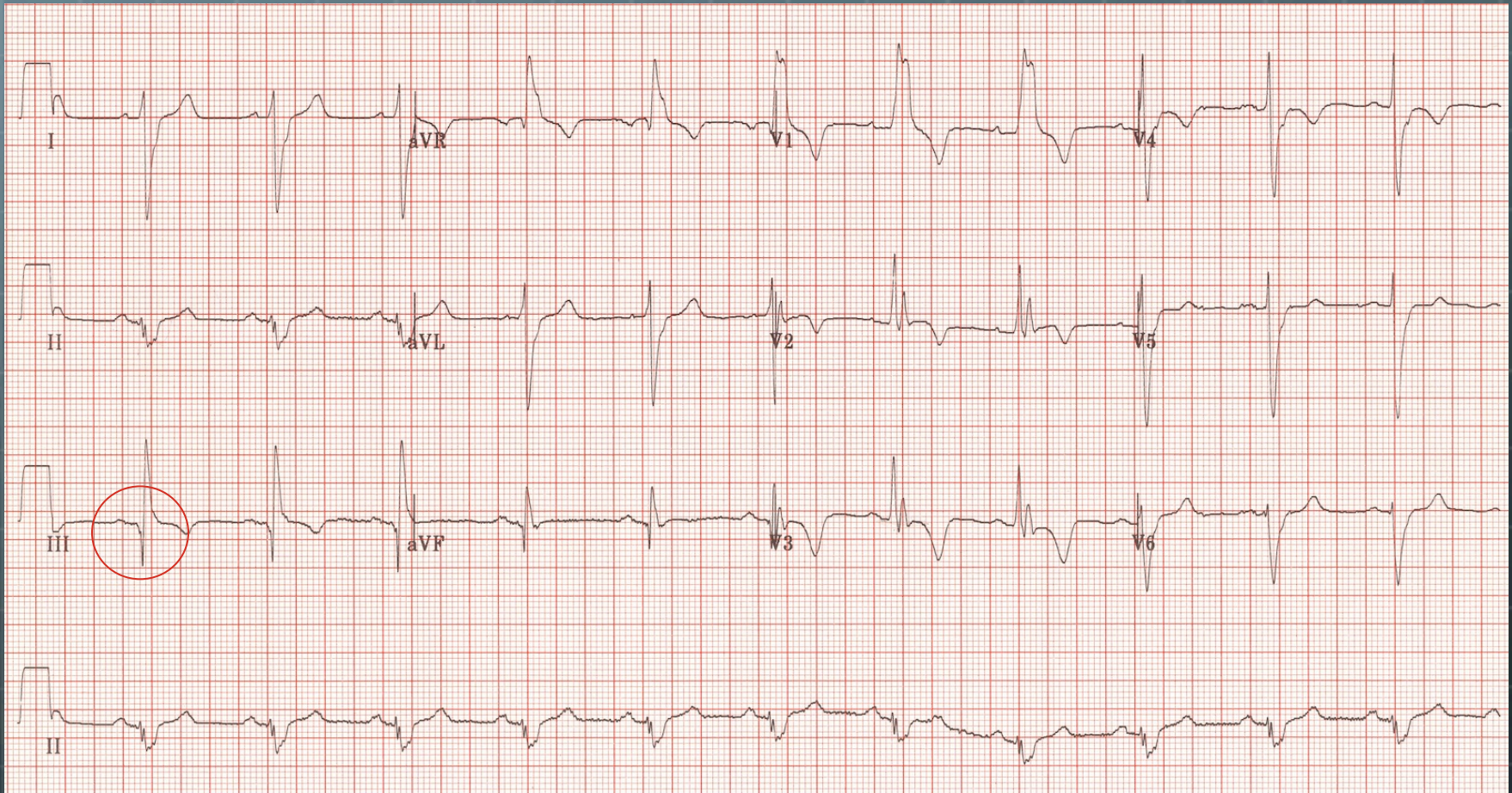
Case 5

 Do you see an S wave in lead I?



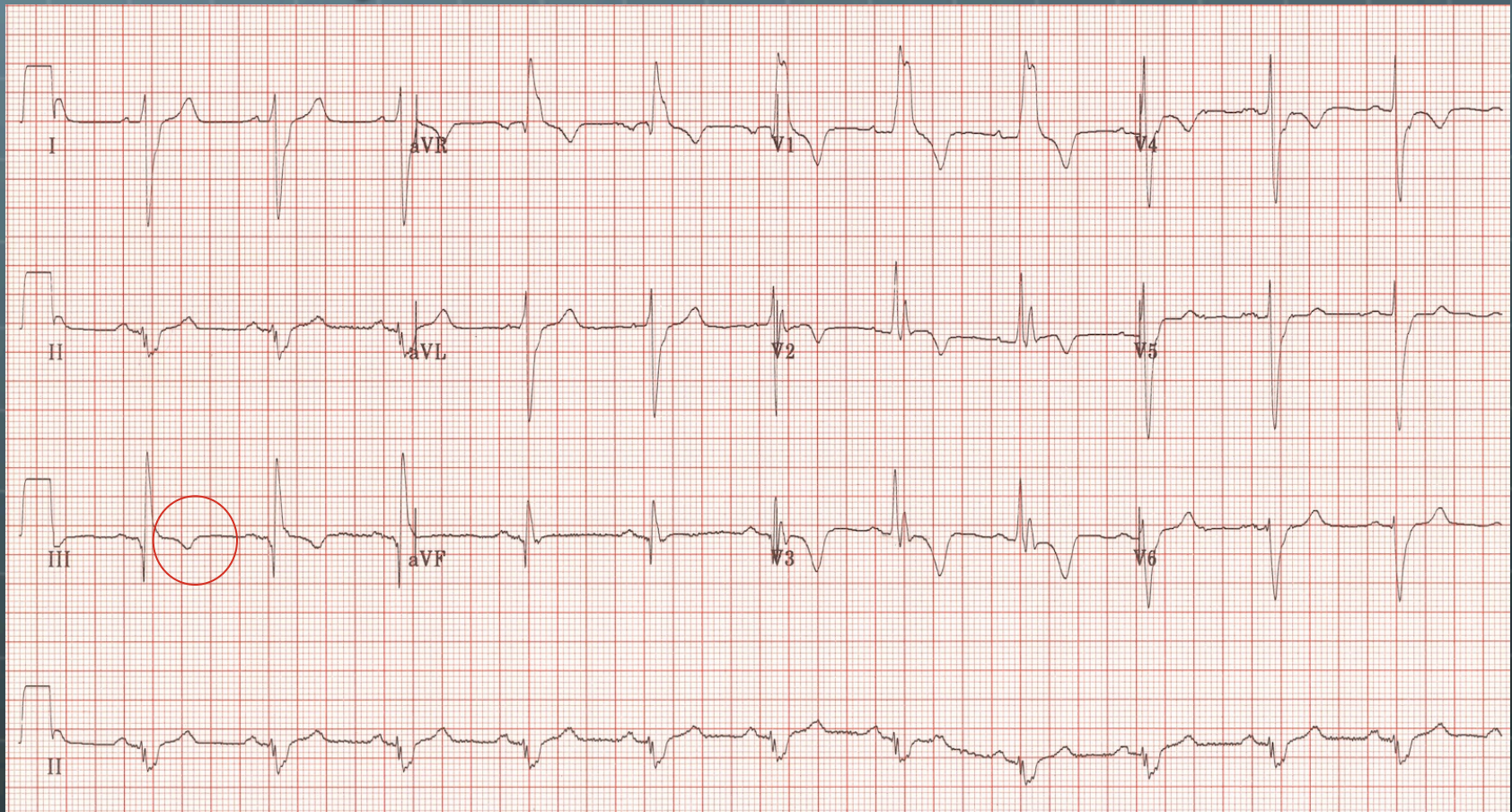
Case 5

🌐 Do you see a Q wave in lead III?



Case 5

🌐 What do you notice about the T waves in lead III?



Case 5

- So we have S1Q3T3 which can be indicative of a P.E.
- Some studies have shown this to be the case in 75%-90% of patient studied. Most say it is rare and only found in 15%-20% of cases.
- This strain pattern may be seen in any situation that causes strain on the right ventricle.
- And the last case is....

Case 6

- 🌐 You are watching your soaps at the station when a van flies into the parking lot at mach 10.
- 🌐 A middle-aged woman exits the driver's seat and runs toward the door. You meet her and she yells, "Something's wrong with my husband."



Case 6

- 🌐 You go to the passenger side to find a 63 year old male complaining of light-headedness, nausea, diaphoresis and upper abdominal pain.
- 🌐 He states he was mowing grass when his s/s started.
- 🌐 He is loaded onto the stretcher and placed in the unit.



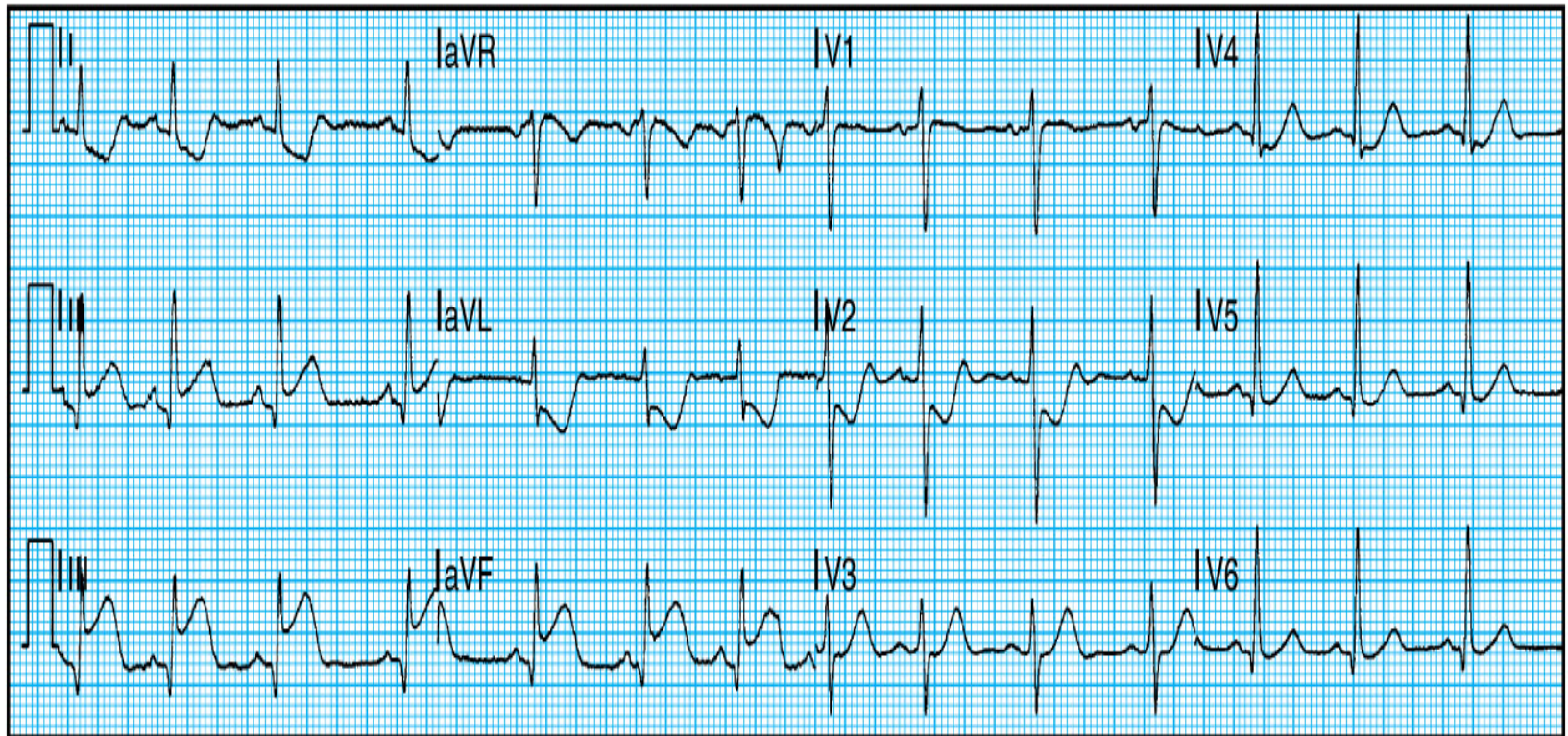
Case 6

- 🌐 **Vital Signs: BP 90/P, Pulse 96, Respirations 20. O2 sat is 95% room air. Lung sounds are clear bilaterally in all fields. You notice JVD. He has no peripheral edema.**
- 🌐 **He has no history, but states his father died at age 50 of a heart attack.**

Case 6

🌐 You apply a 12 lead and find:

PR 0.140s QRS 0.088s
QT/QTc 0.358s/0.426s
P-QRS-T Axes 55° 61° 102°



Case 6

- Let's piece this puzzle together.
- AHA Recommended Treatment:
- M**orphine
- O**xygen
- N**itro
- A**spirin
- So we give the aspirin and place him on O₂.



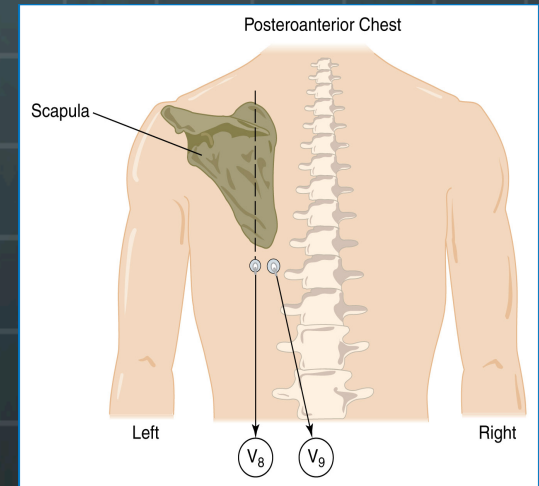
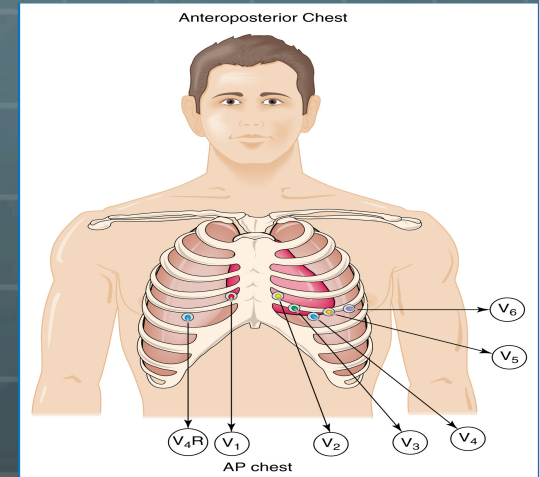
Case 6

- 🌐 We have hypotension, dry lungs and JVD. What are we thinking?
- 🌐 We should ALWAYS think right side with inferior MI.
- 🌐 RVI occurs about 50% of the time in inferior MI's. So then we go to our checklist for RVI.



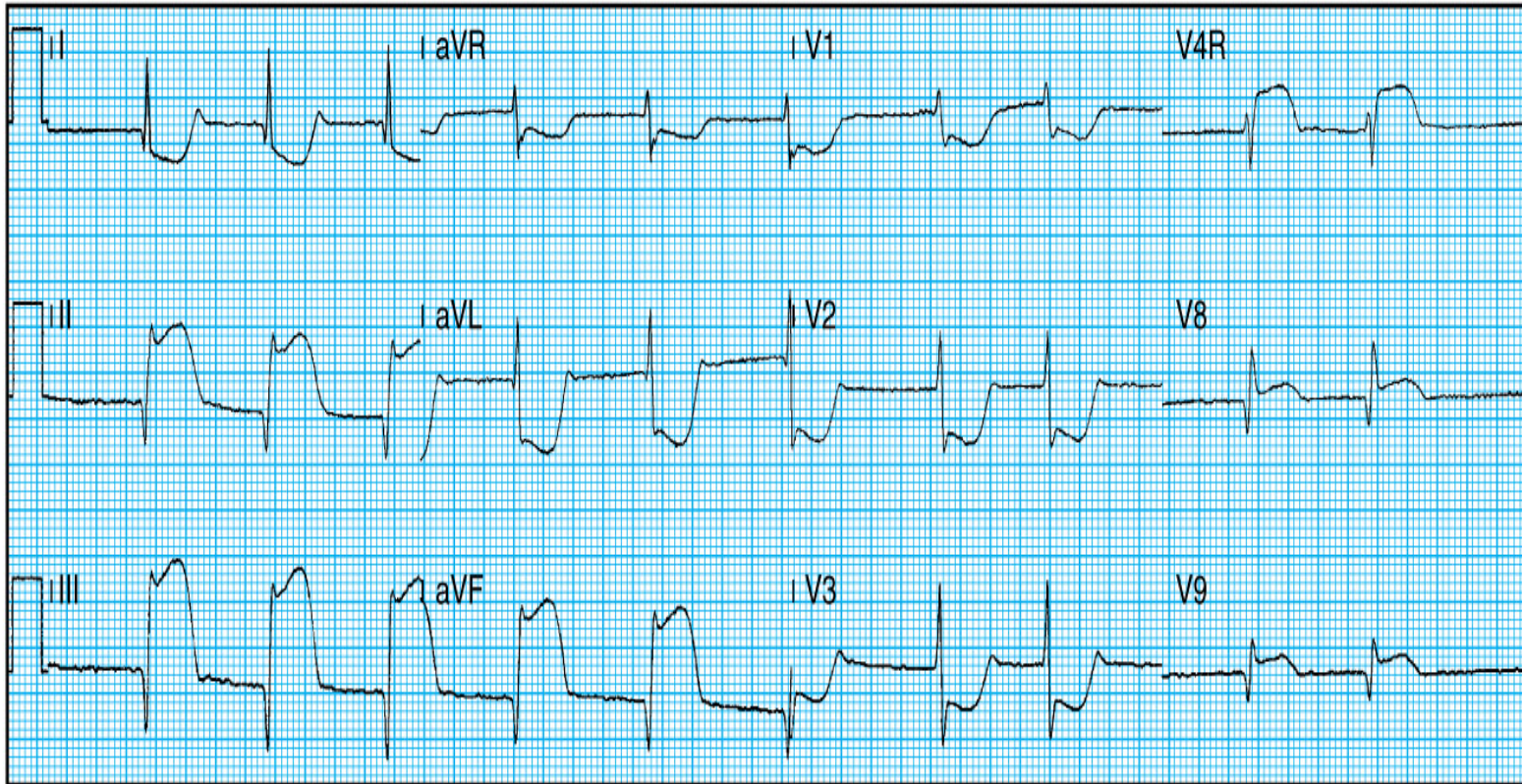
Case 6

- It would be nice to have the new 15 lead monitors but... we don't!
- Then we remember that you can “make” a 15 lead monitor from a 12 lead.
- We take V4 and move it to the right side (5th intercostal space). Then we move V5 and V6 to the left back.



15 Lead EKG

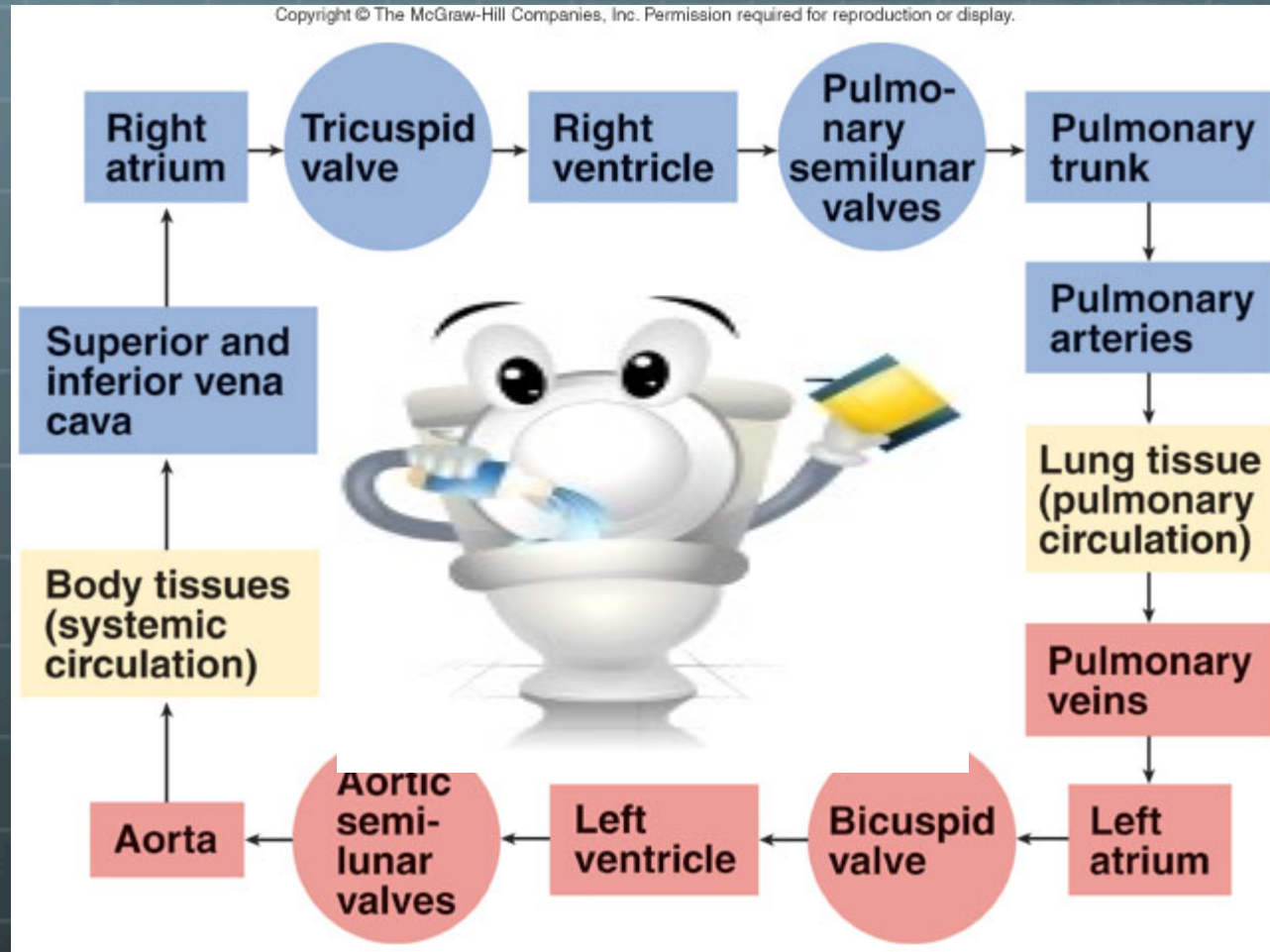
HR: 56 P-QRS-T axes: 999 53 105
PR Int: 0 QRS Dur: 88 QT/QTc: 432/444



Blood Flow

Be mindful of venous return

Nitrates, morphine, beta blockers and diuretics decrease venous return.



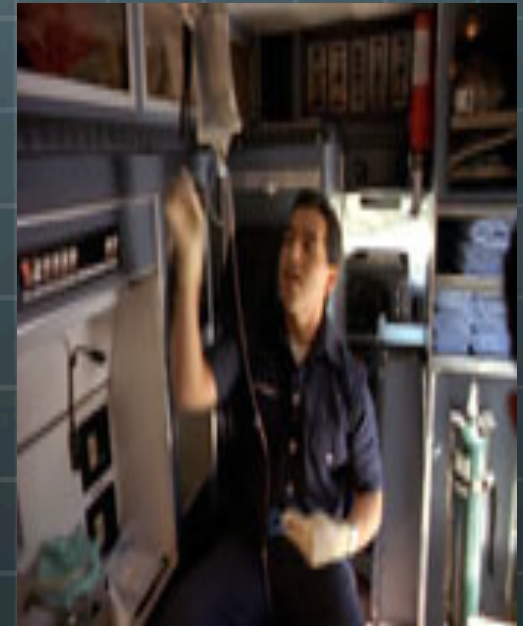
Let's Review:

- 🌐 Electrolyte imbalance can pose a serious threat to your patient.
- 🌐 If potassium is too high or too low, it is important to get the cellular shift going.
- 🌐 Be very mindful of this with dialysis patients and those with end stage renal disease



Let's Review:

- 🌐 CNS events can cause deep T waves
 - 🌐 Aka “Cerebral Waves”
- 🌐 Don't assume your patient has a condition, put the puzzle together
- 🌐 Alternans are caused fluid in the pericardium
 - 🌐 Keep this in mind for trauma, recent heart surgery and chest pain



Let's Review:

- S1Q3T3 MAY be indicative of a pulmonary embolism
- Only hospital tests such as x-rays, MRIs and blood test can truly diagnose a P.E. RVI occurs 97% of the time in inferior MIs.
- If it looks like “dry CHF” consider RVI
 - Consider RVI in ALL INFERIOR MIs
 - Use you right side leads to confirm

Let's Review:

- 🌐 RVI occurs about 50% of the time in inferior MIs.
- 🌐 If it looks like “dry CHF” consider RVI
- 🌐 Consider RVI in ALL INFERIOR MIs
- 🌐 Use you right side leads to confirm



Let's Review:

- 🌐 ALWAYS TREAT THE PATIENT!
- 🌐 12 lead is a useful tool
- 🌐 A 12 year old with a wrist fracture probably won't benefit from a 12 lead
- 🌐 Use common sense

**Common Sense
Is Not So Common...**

QUESTIONS?

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References

Holtz, N.E. & Garcia, T.B., 12-Lead ECG: The Art of Interpretation, Jones and Bartlett Publishers, Massachusetts, 2001.

www.ncemi.org/ekgotw/datafiles

Brady Publishing

AMR