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FAMILY MEDICINE **RESIDENTS** + MEDICAL **STUDENTS**

# Practical Intro to EKGs

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## Basics - Physiology

- The heartbeat creates many cellular depolarizations
- When going toward positive leads, get
  - Positive deflections
- When going away from positive leads, get
  - Negative deflections
- EKG is a summation measurement of many cellular events

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## Basics – "Alphabet"

- The first upward deflection is the P wave
  - It represents atrial depolarization
- The PR Interval is the time between atrial and ventricular depolarization
- The QRS complex represents ventricular depolarization
- The ST segment is next
- The T wave represents ventricular repolarization

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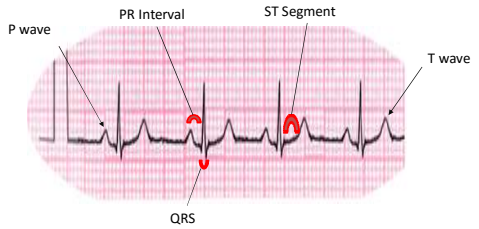
## Review "Alphabet"

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## QRS Nomenclature

- Upward deflection is an R wave
  - A second positive deflection is given a prime designation - RSR'
- A downward deflection preceding an R is a Q wave
- A downward deflection that follows an R is an S wave
- If only negative deflection is present it is a QS complex
- Ventricular depolarization is called "QRS"
  - Although not all parts may be present

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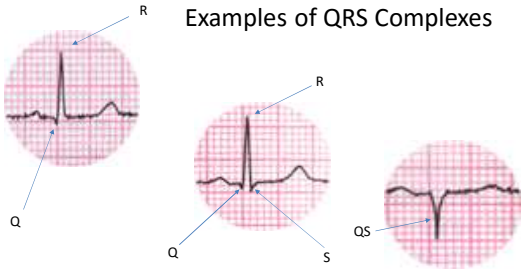
## Examples of QRS Complexes

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## Basics - Standards

- **Three limb leads**
  - **I, II, III**
- **Three augmented limb leads**
  - **aVR, aVL, aVF**
- **Six chest leads**
  - **V 1 - V 6**

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## Basics – Standard Form

| | | | |
|---|---|---|---|
| I | aVR | V 1 | V 4 |
| II | aVL | V 2 | V 5 |
| III | aVF | V3 | V 6 |

Rhythm strip (II or V 1, usually – the atrial leads)

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## Basics - Strip

- **Big box =**
  - **200 msec (0.2 sec)**
  - **5 small boxes**
- **Little box =**
  - **40 msec (0.04 sec)**
  - **Also 1 mm**

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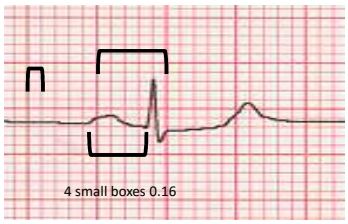
## Review of Boxes

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## "The System"

Only one of many ways to do this!

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## Caveats

- Difficult to do in groups
  - Everyone is at a different level
- Lots of material in a compressed session
  - Your brain will "get full" before we finish!
  - The handout is more complete than you need

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## Caveats

- We will not cover "Cool Arrhythmias"
- Remembering criteria is not expected
  - Or even encouraged until you're ready
- Shoot for "Normal" vs. "Not Normal"
  - The only pattern to learn is "Normal"!
- You have everything in the handout
- Keep Calm and Carry On!

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## The Basic Structure

- **Validity**
- **Rate**
- **Rhythm**
- **Axis**
- **Hypertrophy**
- **Ischemia/Infarction**

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## Review

- **Validity**
- **Rate**
- **Rhythm**
- **Axis**
- **Hypertrophy**
- **Ischemia/Infarction**

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## Validity

- Clinical context for test, right patient, etc
  - When handed an EKG, ask …
  - "Why was this done?" and
  - "How is the patient?"
- Look for voltage standardization curve
  - Two big boxes tall, or 10 mm/mV
  - Is also at the bottom of the strip

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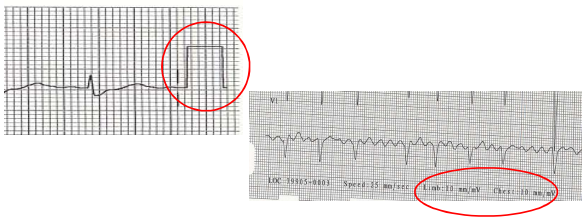
## Standardization Box



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## Validity

- QRS in Lead I should be opposite that in AVR
  - And QRS is + in Lead I
- R-wave should progress in chest (V) leads such that by V4 the R-wave is most prominent
  - Represents the left ventricle
- Review an old EKG

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## Validity

- An "issue" noted in validity does not necessarily mean the tracing is invalid
- Any abnormalities should generate "Differential Diagnoses"

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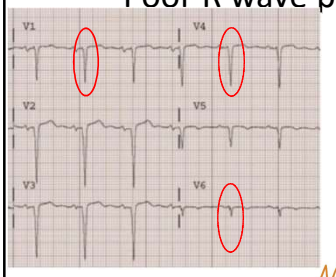
## Poor R wave progression




- Differential Dx?

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## Validity Visuals


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## Review of Validity

- **Name, clinical context**
- **Standardization box**
- **QRS in I and aVR generally opposite**
- **R wave progresses in chest leads**
- **Compare with old EKG**

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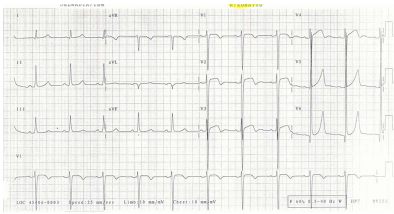
## Poll Question: The heart rate is closest to:



1. 150
2. 100
3. 75
4. 60
5. 50

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## Rate

- Normal rate 60-100
  - <60 bradycardia
  - >100 tachycardia
- Basic pacing rates:
  - Atria 80/min
  - Junctional 60/min
  - Ventricular 40/min
  - But a rate does NOT determine pacer

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## Rate

- Rate=300/# of large boxes between R-waves, or
- Memorize:
  - 300, 150, 100, 75, 60, 50, 43, 37
  - Count at each large box after first R

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## Rate Calculation


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## Review of Rate

- 300
- 150
- 100
- 75
- 60
- 50
- 43
- 37

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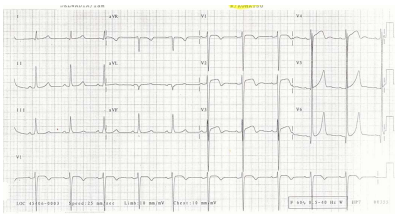
## The heart rate is closest to:



1. 150
2. 100
3. 75
4. 60
5. 50

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## Cumulative Review

- **Validity**
  - Context
  - Standardization box
  - I and aVR
  - R wave progression
  - Old EKG
- **Rate**
  - 300, 150, 100, 75, 60, 50, 43, 37

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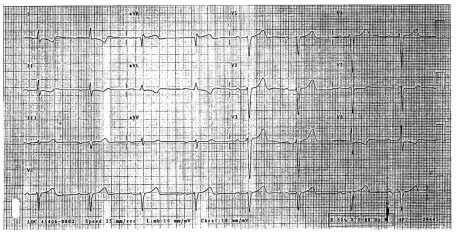
## Poll Question: Is this a sinus rhythm?



1. Yes
2. No

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## Rhythm – Basic Questions

- Is it REGULAR?
- Is it SINUS?
- What are the INTERVALS?
  - PR
  - QRS
  - QT

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## Rate & Rhythm

- Truly done as "Gestalt"
  - Learning steps so you will usually
  - Implement by steps (with pauses)
  - How to cut your time in half!
- Look at rhythm strip for both
- Trust your eyes for "not normal"

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## Rhythm - Regularity

- Regular (usually "Fairly regular")
- Regularly irregular
  - Group or pattern beating
  - Predictable
- Irregularly irregular
  - Chaotic
  - Unpredictable

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## Rhythm - Sinus

- Often hear: P before QRS, QRS after P
  - This really means an atrial relationship to ventricles
  - What are the Atrial leads?
- For SINUS rhythm must also have…

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## Rhythm - Sinus

- A positive P wave in II
- A pacer from the SA node (sinus) should always be positive if
  - Leads placed correctly and
  - No dextrocardia
- The why is a "Pearl"

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## Rhythm - Sinus

- Wide vs. Narrow QRS is clinically important
  - Covered in Handout
  - Not covered here
  - Next level after "Foundation" work

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## Rhythm - Intervals

- Check PR interval
  - Start of P to start of QRS
  - Normal is 0.12-0.20 sec
  - 3 –5 small boxes

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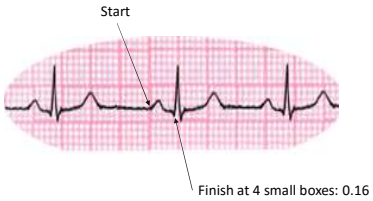
## PR Interval

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## Rhythm - Intervals

- First degree AV block, PR > .20
- Second degree AV block
  - Mobitz type I (Wenkebach)
  - Mobitz type II
- Third degree AV block
- PR interval can also be too fast
  - Accessory pathway
  - WPW, LGL, etc

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## Rhythm - Intervals

- Really cool stuff!!
- We won't talk about it
- Get the basics down before taking on weird rhythms

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## By the Way…

- First
  - Validity
- Second
  - Rate
- Third
  - Rhythm

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## Rhythm - Intervals

- Check QRS width
  - Start of complex to end
  - Normal 0.10- 0.12
    - 2 ½ to 3 small boxes
- Look at QRS morphology, too
  - Should be crisp, single line

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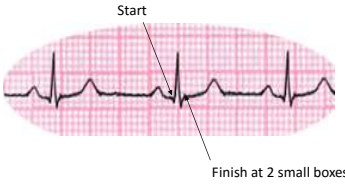
## QRS Interval

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## Rhythm - Intervals

- If QRS is wide, then
  - By definition a Bundle Branch Block
  - RSR`
    - in V 1, V 2 is RBBB
    - in V 5, V 6 is LBBB


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## Rhythm - Intervals

- If RSR` present, or
- QRS is "slurred" or has "shoulder", but
- Interval not wide or prolonged…

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## Rhythm - Intervals

<u>Interventricular Conduction Delay</u>

- IVCD, or
- "Early BBB", or
- "Incomplete BBB"
- Clinical Relevance?

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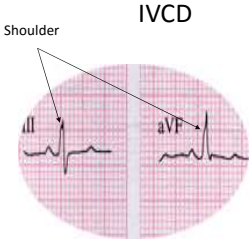
## IVCD

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## Rhythm - Intervals

- Handout has more on
  - BBB
  - IVCD
  - Hemiblocks
- Not foundation material

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## Rhythm - Intervals

- Check QT interval
  - Start of QRS to end of T
  - Depolarization to repolarization
  - For rate between 60 - 100,
  - QT < 1/2 R-R interval
  - Around 0.36-0.44 sec
- Very clinically important
  - R on T phenomenon

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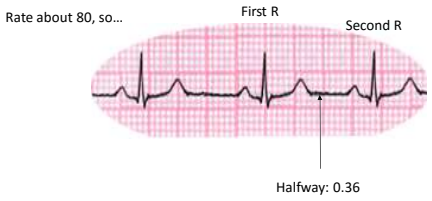
## QT Interval

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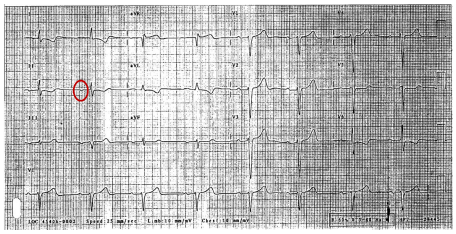
## Is this a sinus rhythm?



1. Yes
2. No

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## Cumulative Review

- Validity
  - Context
  - Standardization box
  - I and aVR
  - R wave progression
  - Old EKG
- Rate
  - 300, 150, 100, 75, 60, 50, 43, 37
- Rhythm
  - Regular or not
  - Sinus or not
  - Intervals

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## Brain Alert!

It's getting full…

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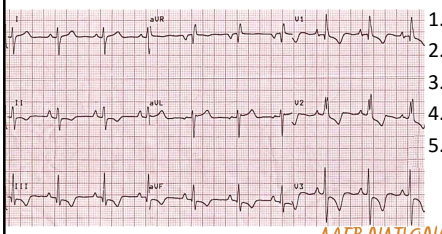
## Poll Question: The axis is in which quadrant?



1. Normal
2. LAD
3. RAD
4. Indeterminate
5. Not sure

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## Axis

- Use I and aVF for quick scan
  - The thumb method
- Normal is + QRS in both
  - Two thumbs up
- + in I, - in aVF
  - Left Axis Deviation (LAD)

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## Axis

- - in I, + in aVF
  - Right Axis Deviation (RAD)
- - in I, - in aVF
  - Really not normal!
  - Differential?

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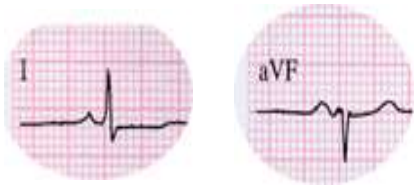
## In which Quadrant is the Axis?

I + F –
LAD

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## Axis

| | |
|---|---|
| I – | I + |
| F – | F – |
| Indeterminate | LAD |
| I – | I + |
| F + | F + |
| RAD | Normal |

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## Axis

- Main goal now is to identify normal axis or not
- But work to be more specific with respect to degree of axis
- Why?

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## Axis

- Normal: 0 to+90 degrees
- Leftward (or LAD) 0 to -29
- LAD: -30 or more degrees
- RAD: > or = +90 degrees

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## Axis

- Strive to give degree measurement
- Look for isoelectric lead
  - As much + as – deflection
  - The axis is perpendicular to it

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## Axis

- Perpendicular leads without the graph
- Use the 12 lead structure (all leads in 30°)
  - I and aVF
    - Degrees 0 and 90
  - II and aVL
    - Degrees 60 and -30
  - III and aVR
    - Degrees 120 and 30

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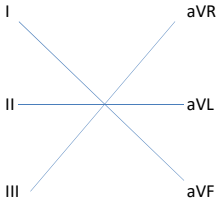
## 12 Lead Basic Form
## Perpendicular Leads – Cool Trick!

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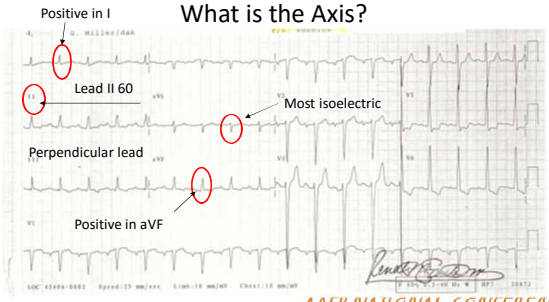
## What is the Axis?

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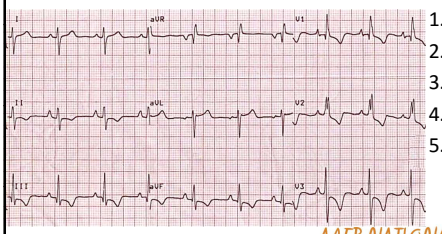
## The axis is in which quadrant?



1. Normal
2. LAD
3. RAD
4. Indeterminate
5. Not sure

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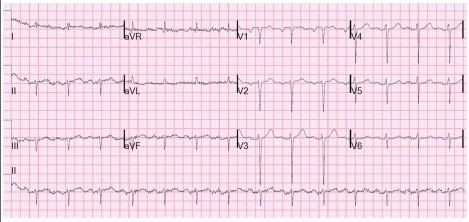
Poll Question: What hypertrophy is suggested in V1?




1. None
2. LAE
3. RAE
4. LVH
5. RVH

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## Hypertrophy

- Atrial
  - Must have sinus rhythm!
  - Look at P wave in leads II and V 1
- Ventricular (Many criteria exist)
  - Cannot do with a BBB
  - Look at QRS in chest leads

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## Hypertrophy - Atrial

- Normal P wave
  - Smooth in morphology
  - < 2 ½ small boxes high and wide (II)
  - In V 1
    - Can be all positive
    - Can be symmetrically biphasic
- Left atrium has a little more muscle
  - Determines time of conduction

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## Hypertrophy - Atrial

- RAA
  - Lead II:
    - Tall P-wave (>2.5 mm)
    - "P-pulmonale"
  - V 1:
    - Large tall P
- Tall in both!

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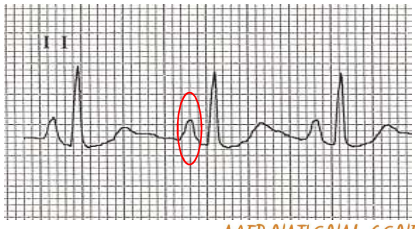
## P Wave of RAA

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## Hypertrophy - Atrial

- LAA
  - Lead II:
    - P-wave with notching
    - "P-mitrale"
  - V1:
    - Mainly or purely negative P-wave

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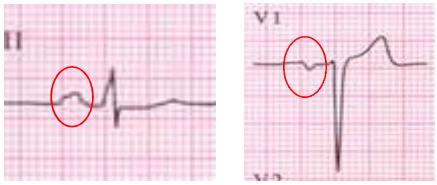
## P Waves of LAA

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## Hypertrophy - Ventricular

- Multiple criteria exist
- Included in handout
- Trust your eyes for size

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## Hypertrophy - Ventricular

- RVH
  - Found in validity evaluation
  - "Big" R wave in V 1 (6-7 mm)
    - Normal pattern: No R in V1
  - "Deep" S wave in V 6 (6-7 mm)
    - Normal pattern: No S in V6
  - Included in differential of RAD

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## Hypertrophy - Ventricular

- LVH
  - Suggested in first scan of EKG
  - One method (Sokolow) is to
    - Look at biggest R in V 5 or V 6, plus
    - Biggest S in V 1 or V2
    - LVH suggested if > 35mm in adult

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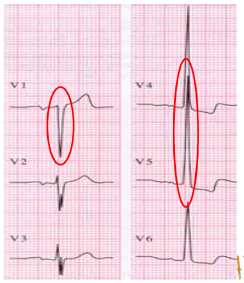
## LVH Example

Deepest S: 18 mm




Tallest R: 40 mm

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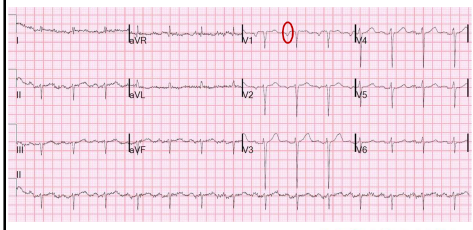
## What hypertrophy is suggested in V1?




1. None
2. LAE
3. RAE
4. LVH
5. RVH

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## Major Brain Default

Overload imminent!
Abort!

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## Basic Cumulative Review

- **Validity**
- **Rate**
- **Rhythm**
- **Axis**
- **Hypertrophy**

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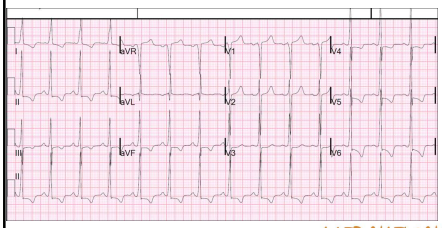
## Poll Question: This EKG suggests




1. Normal
2. Anterior MI
3. Lateral MI
4. Septal ischemia
5. Inferolateral ischemia

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## Ischemia/Infarction

- Check all leads for:
  - Q waves
  - ST segment changes
  - T wave changes
- Look in groups of leads

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## T Waves

- Usually QRS and T are upright together
- T waves should be upright in V 2-6
  - Can be normally inverted in V 1
- T wave inversion is first sign of ischemia
- Peaked T wave is first sign of acute injury or high K+

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## ST Segment Changes

- Differential for ST Depression
  - Ischemia
  - Subendocardial infarct
  - "Strain" from hypertrophy
  - Drug effect
    - Digoxin

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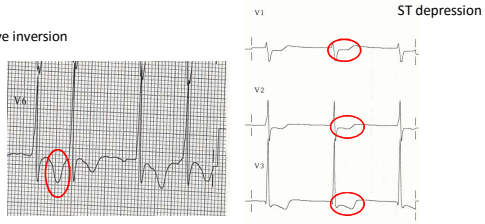
## Changes of Ischemia

T wave inversion

ST depression

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## ST Segment Changes

- Elevation is Acute injury
- If no Q waves then non-Q wave infarction
- If associated with Q waves
  - Likely transmural infarct
  - Much less common now - thrombolytics

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## Non Q Wave Infarction

Now called
"Non-ST Elevation MI" or
NSTEMI

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## Summary of Changes

- Repolarization most sensitive part of cycle
  - T wave changes are first
- ST segment follows T wave
- Q waves can be bad, but also normal!

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## Dynamic Summary

- The "Dance"
- Visual demonstration

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## Dynamic Summary

- Ischemia:
  - T wave inversion, pulls
  - ST segment down (depression)
  - If continues, then …

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## Dynamic Summary

- Injury:
  - T wave peaks (hyperacute T wave), which pulls
  - ST segment up (elevation)
    - Represents Cardiac muscle at risk
  - If injury continues, then…



## Dynamic Summary

- T wave inverts again (tombstoning)
- If continues, then…
- Infarction



## Dynamic Summary

- Infarction:
  - Q wave appears (irrev cell death)
  - If continues…
  - Q wave enlarges and ST seg returns to baseline
- T wave inversion is the last thing to return to "normal"



## Dynamic Summary

- The whole process is a continuum
- Acute Coronary Syndrome
  - Includes angina
  - Ischemia
  - Injury
  - Infarction

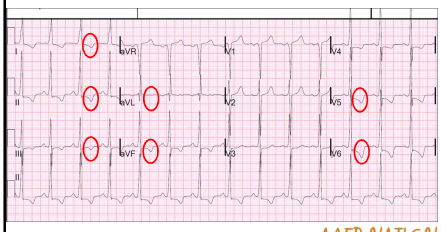


## Q/ST changes in Lead Groups (Artery)

- Septal (LAD):
  - Changes in V1-V2
- Anterior (LAD):
  - V3-V4
- Lateral (Circumflex):
  - I, aVL, V5-V6
- Inferior (RCA or Circumflex):
  - II, III, aVF
- Posterior (RCA):Large R with ST depression V1, V2



## This EKG suggests




1. Normal
2. Anterior MI
3. Lateral MI
4. Septal ischemia
5. Inferolateral ischemia

Captain, she's gonna blow!

Not to worry
You now know this stuff



## Summary

- Validity
  - Context
  - Standardization box
  - I and aVR
  - R wave progression
  - Compare with old EKG



## Summary

- Rate
  - 300
  - 150
  - 100
  - 75
  - 60
  - 50
  - 43
  - 37



## Summary

- Rhythm
  - Regular or not
  - Sinus or not
  - Intervals evaluated
    - PR
    - QRS
    - QT



## Summary

- Axis
  - I and aVF
  - Normal Quadrant or Not (Axis Deviation)
  - Isoelectric lead next to get degree of axis
  - Work to give degree measurement!



## Summary

- Hypertrophy
  - Atrial
    - Look at P wave in leads II and V 1
  - Ventricular
    - Many criteria exist

## Summary

- Ischemia
  - T wave inversion
  - ST segment depressed
- Injury
  - Peaked T wave (maybe)
  - ST segment elevated (maybe)
- Cell death
  - Q wave forms

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## That's Enough!

Now, be careful out there!

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# Q&A

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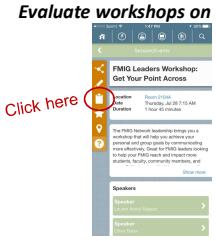
## Let your voice be heard!

***Evaluate workshops on the NC app***

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