

Practical Intro to EKGs

Reid B. Blackwelder, M.D.
 (blackwel@etsu.edu)
 Professor, Family Medicine
 East Tennessee State University



Goals

- Learn basic approach to any EKG
- Develop foundation knowledge
 - Connect with anatomy, physiology
- Create a system for practice
- Practice practical implementation
- Amaze your Friends (and your attendings)!
- Save your patients!



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

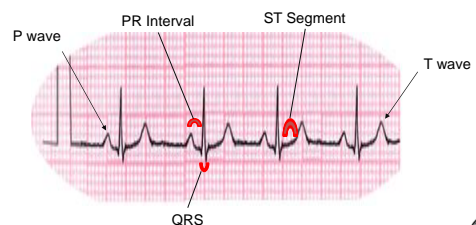


Basics – “Alphabet”

- 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



Review “Alphabet”



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



Examples of QRS Complexes



Basics - Standards

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



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)



Basics - Strip

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



Review of Boxes



“The System”

Only one of many ways to do this!

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

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!

The Basic Structure

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

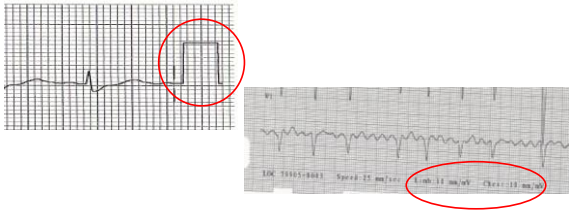
Review

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

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

Standardization Box



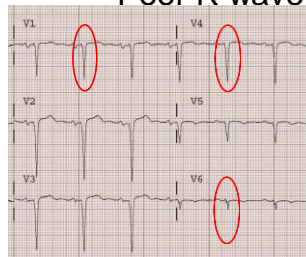
Validity

- 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

Validity

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

Poor R wave progression



- Differential Dx?

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Validity Visuals



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

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



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



Rate Calculation

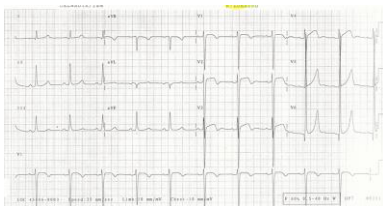


Review of Rate

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



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



Rhythm – Basic Questions

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



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”



Rhythm - Regularity

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



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...



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”



Rhythm - Sinus

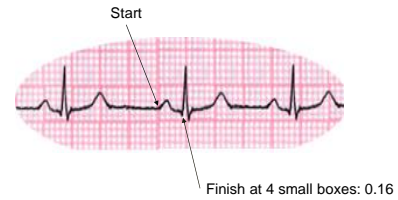
- Wide vs. Narrow QRS is clinically important
 - Covered in Handout
 - Not covered here
 - Next level after “Foundation” work



Rhythm - Intervals

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

PR Interval



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

Rhythm - Intervals

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

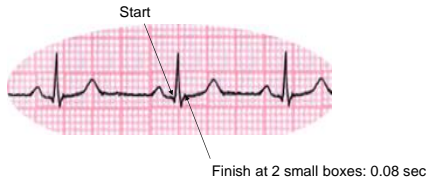
By the Way...

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

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

QRS Interval



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



Rhythm - Intervals

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

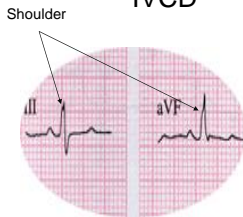
Rhythm - Intervals

Interventricular Conduction Delay

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



IVCD



Rhythm - Intervals

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

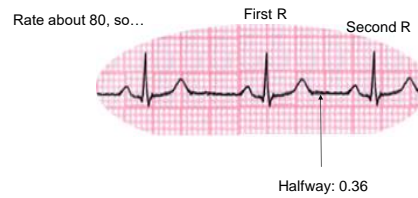


Rhythm - Intervals

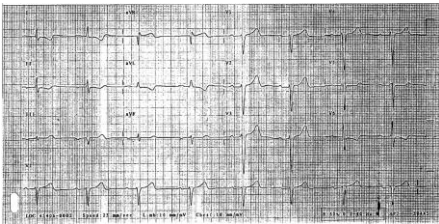
- Check QT interval
 - Start of QRS to end of T
 - Depolarization to repolarization
 - For rate between 60 - 100,
 - $QT < 1/2$ R-R interval
 - Around 0.36-0.44 sec
- Very clinically important
 - R on T phenomenon



QT Interval



Is this a sinus rhythm?



1. Yes
2. No

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Validity 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



Brain Alert!

It's getting full...



Axis

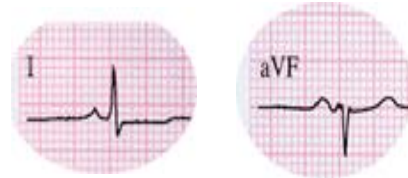
- Use I and aVF for quick scan
 - The thumb method
- Normal is + QRS in both
 - Two thumbs up
- + in I, - in aVF
 - Left Axis Deviation (LAD)



Axis

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

In which Quadrant is the Axis?



Axis

I -	I +
F -	F -
Indeterminate	LAD

I -	I +
F +	F +
RAD	Normal

Axis

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

Axis

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

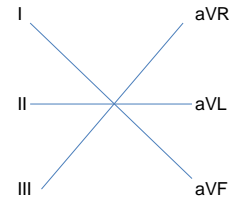
Axis

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

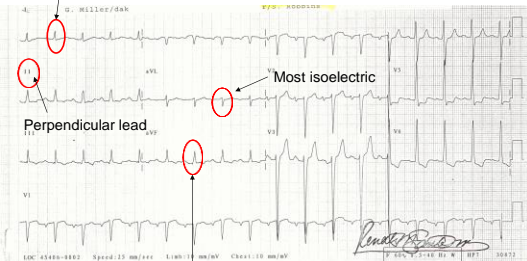
Axis

- 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

12 Lead Basic Form Perpendicular Leads – Cool Trick!



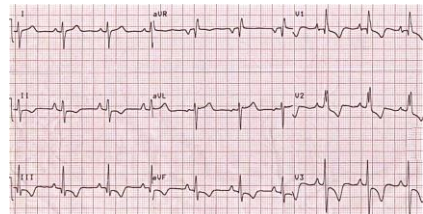
What is the Axis?



Positive in aVF



The axis is in which quadrant?



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

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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

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



Hypertrophy - Atrial

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

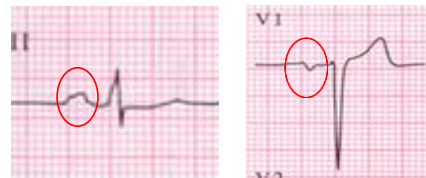
P Wave of RAA



Hypertrophy - Atrial

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

P Waves of LAA



Hypertrophy - Ventricular

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

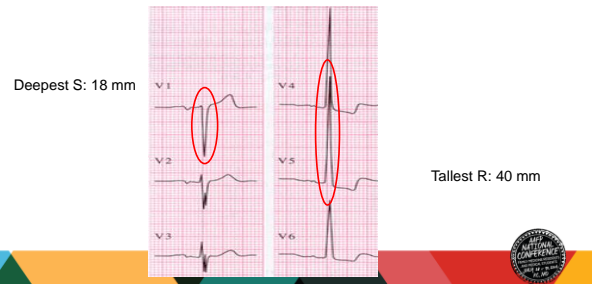
Hypertrophy - Ventricular

- 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

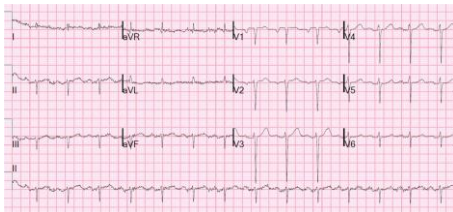
Hypertrophy - Ventricular

- 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

LVH Example



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!

Basic Cumulative Review

- Validity
- Rate
- Rhythm
- Axis
- Hypertrophy

Ischemia/Infarction

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

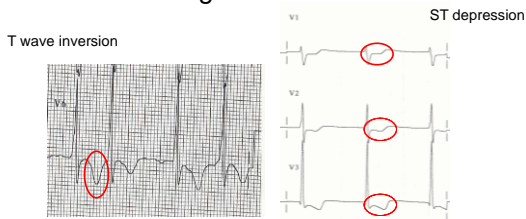
T Waves

- 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+

ST Segment Changes

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

Changes of Ischemia



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

Non Q Wave Infarction

Now called
"Non-ST Elevation MI" or
NSTEMI

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!

Dynamic Summary

- The "Dance"
- Visual demonstration

Dynamic Summary

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



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

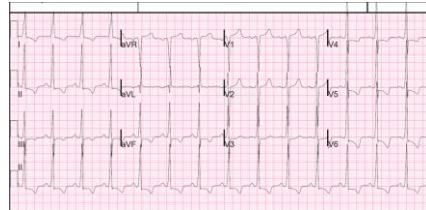
- The whole process is a continuum
- Acute Coronary Syndrome
 - Includes angina
 - Ischemia
 - Injury
 - Infarction



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

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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

That's Enough!

Now, be careful out there!

Q&A

Let your voice be heard

Evaluate workshops:

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