Approach to EKG Reading
Reid B. Blackwelder, M.D. (blackwel@etsu.edu)
Professor and Interim Chair, Family Medicine, ETSU

EKG INTERPRETATION

1) **Validity**

Clinical context for test, right patient

Look for voltage standardization curve of two big boxes tall

In general:

Lead I should be opposite of AVR (in a normal EKG)

R-wave should progress in chest leads (V leads) such that by V4 the R-wave is most prominent (represents left ventricle)

Compare with an old EKG

A question of validity does not necessarily mean the tracing is invalid

All abnormalities generate "Differential Diagnoses"

Nomenclature of QRS

First downward deflection is a Q wave

First upward deflection is an R wave

A downward deflection that follows an R is an S wave if it goes below the baseline

Large deflections are denoted by capital letters; smaller ones (< 3mm) by lower-case letters

A second positive deflection is given a prime designation, a third a double prime, etc

If only a negative deflection is present it is termed a QS complex

II) **Rate**

Know: Big box = 200 msec (0.2 sec)

Little box = 40 msec (0.04 sec) [also 1 mm]

Memorize: 300, 150, 100, 75, 60, 50, 43, 37

(or know that Rate=300/# of large boxes between R-waves)

(or count beats in 6 second strip and multiply by 10)

Normal rate 60-100; <60 bradycardia, >100 tachycardia

Basic pacing rates: Atria 80/min, junction 60/min, vent 40/min

III) **Rhythm**

Basic rhythm of strip (use rhythm strip if available):

Is it Regular? Regular

Fairly regular

Regularly irregular (group or pattern beating)

Irregularly irregular (chaotic, unpredictable)

Is it Sinus?   If yes, the P wave in II should always be positive if leads placed correctly and no dextrocardia

P waves present and associated with QRS (P before QRS, QRS after P)

Sinus rhythms: narrow QRS

Supraventricular rhythms: narrow QRS

Atrial Fibrillation: no P-waves, irregularly irregular

Atrial Flutter: Atria depolarize at 300/min with ventricular response in usually 2:1 (150/min), or 4:1 (75/min) pattern; odd ratios uncommon. Always suspect with ventricular rate 150/min

AVNRT: rate 150-240 without obvious signs of atrial activity

Multifocal atrial tachycardia: multifocal P-waves with
irregularly irregular rate
Junctional rhythm: no or inverted P-wave with rate of 40-60
Premature atrial contraction (PAC): PQRS occurs before
regular sinus beat; P-wave different; pause follows
Ventricular rhythms: widened QRS
PVC: followed by a pause
V-Tach: tachycardia with rate >120/min
Defined as three or more PVCs in a row
Non-sustained (<30 sec) or Sustained (run persists)
V-Fib: disorganized firing of ventricle with no recognizable
wave forms
Idioventricular: one vent. pacemaker fires at 20-40
Accelerated idioventricular rhythm: single focus at 40-119
A wide complex tachycardia is V. Tach until proven otherwise
Factors pointing toward V Tach
Absent RS complex in precordial leads
AV dissociation
V6 R/S ratio < 1
What are the Intervals?
Check PR interval(normal 0.12-0.20): start of P to start of QRS
First degree AV block, PR > .20
Second degree AV block
Mobitz type I (Wenkebach): PR gradually increases until QRS lost
Mobitz type II: PR constant, QRS lost
Third degree AV block: complete disassociation of P-wave and QRS
Check QRS width (normal 0.10- 0.12): start of complex to end
Look for interventricular conduction delay (IVCD) (may be called
early or incomplete BBB)
RSR' is marker - duration determines BBB (QRS > 0.12)
RSR' location determines which bundle involved:
V1 V2 —> RBBB
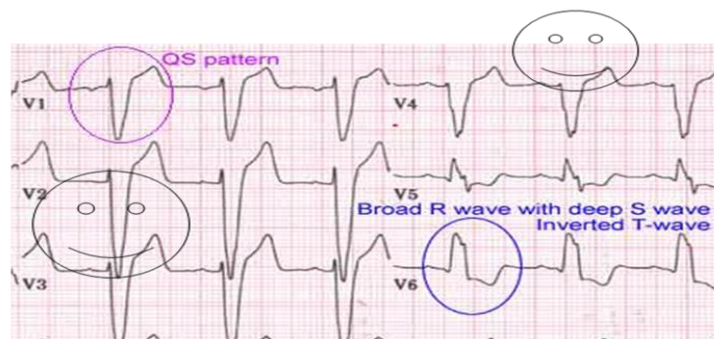V5 V6 —> LBBB
Caveats: BBB makes ventricular hypertrophy criteria invalid
LBBB makes ischemia hard to identify as the ST and T
wave changes imitate changes of ischemia

LBBB ST Changes - Expected

Hemiblock: anterior or posterior fascicle of LBB may be individually

involved. Suspect when axis deviation present
(**LARP**: **L**eft axis dev: **A**nterior HB; **R**ight axis dev: **P**osterior HB)
Anterior hemiblock —> LAD (esp if extreme) & Q1S3
Posterior hemiblock —> RAD with S1Q3
Check QT interval (for rate < 100, QT < 1/2 R-R interval):
start of QRS to end of T (roughly QTc of <0.45)

IV)   **Axis**

Use **I and aVF for quick scan** (normal is + QRS in both)
Then look for most isoelectric limb lead; axis is perpendicular to it
Main goal is to identify normal axis or not, but it can help to be more
specific with respect to degree of axis

Normal: -29 to+89 degrees
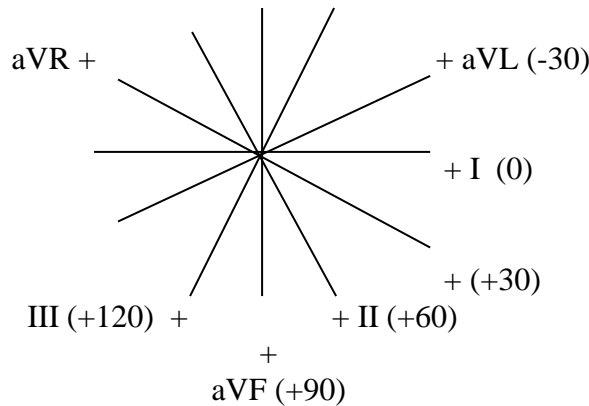[Leftward (or LAD) 0 to -29]
LAD: < or = -30 degrees
RAD: > or = +90 degrees
Quick Hint: can diagnose pathologic/significant LAD by looking at Lead II:
If QRS deflection negative, then LAD (and probably LAHB)

aVR +   + aVL (-30)

                                        + I (0)

                                    + (+30)
III (+120) +   + II (+60)
                +
            aVF (+90)

V)   **Hypertrophy**

Atrial Hypertrophy

Look at P-wave in Lead II and V1:
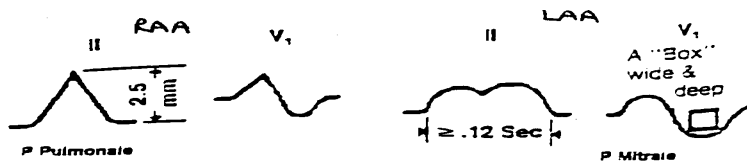RAA: Lead II: Tall P-wave (>2.5 mm) is P-pulmonale
V1: large diphasic P with tall initial component
LAA   Lead II: P-wave duration > 0.12 with notched P-wave
in I, aVL or II is P-mitrale
V1: large diphasic or purely negative P-wave with
wide and deep (one box both ways) terminal
component

Ventricular Hypertrophy

LVH (voltage criteria)
>   Sum of deepest S in V1-2 + tallest R in V5-6 >/= 35 mm
>   **Cornell Criteria**
>>   **R in aVL + S in V3**
>>   **>28 in men, >20 in women**
>>   **Very Specific**
>   S in V1-2 or R in V5-6 > 25 mm
>   R wave in aVL >/= 12 mm
>   R or S wave in any limb lead >/= 20 mm
>   R in I + S in III > 25 mm
>   Often associated LAD
>   Often with left-lead "strain" pattern - asymmetric T-wave
>>   changes in I, aVL, V5-6

RVH
>   R > S in V1 but R decreases from V1 to V6 (R/S > 1)
>   Deep S wave in V5, V6 (R/S < 1)
>   R in V1 or S in V6 > 7 mm
>   RAD with wide QRS (> .12)
>   Often associated RAA

VI)   **Infarction/ Ischemia (Acute Coronary Syndrome)**
Check all leads for:
>   **Q waves** (significant Q > .04 wide, or >/= 1/3 amplitude of QRS)
>>   Look for associated ST segment changes to determine if
>>   acute; signify tissue death. Irreversible
>   **ST segment** changes
>>   **Elevation** —> acute injury
>>>   if associated with Q waves —> recent infarct
>>>   if no Q waves —> non-Q wave infarction
>>>   Now called Non-ST Elevation MI (NSTEMI)
>>   **Depression** —> ischemia, subendocardial infarct or drug
>>>   effect
>   **T wave inversion** —> ischemia
>>   Usually QRS and T are upright together
>>   T waves should be upright in V 2-6
>>   Usually occurs in same leads as acute changes
Dynamic summary from ischemia to infarction:
Ischemia:
>   T wave inversion, pulls
>   ST seg down (depression); if continues, then
Injury:
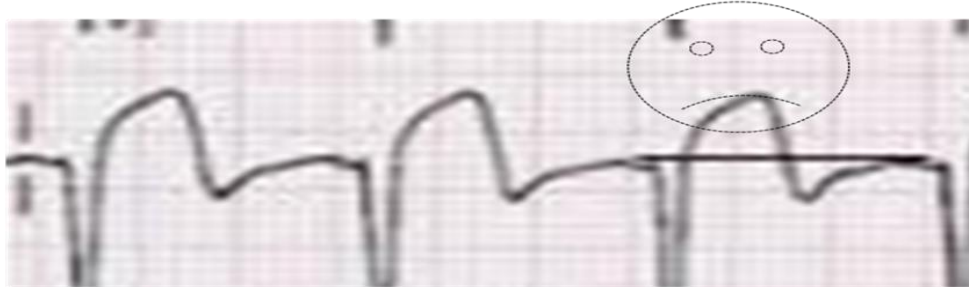>   T wave peaks (hyperacute T wave), which pulls
>   ST seg up (elevation); if injury continues, then
>   T wave inverts again; if continues, then

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"
(days/weeks/months later)

ST Elevation MI – "Frowny Face"

Early Repolarization – "Smiley Face"

Location

Septal (LAD):	Q/ST changes in V1—> V2
Anterior (LAD):	Q/ST changes in V3 —> V4
Inferior (RCA or Cx):	Q/ST changes in II, III, aVF
Posterior (RCA):	Large R with ST depression V1, V2
Lateral (Circumflex):	Q/ST changes in I, aVL, V5-6

VII)   Summary
Recognize that part of the process is a system as well as pattern reading
Relying solely on this will lead to incomplete or inaccurate interpretations
The only pattern to really recognize is a normal one!
If you see something jump out - fine
But then read the EKG completely!
To really stay good at EKGs, you must read them regularly!
Good luck and have fun!