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: Left axis dev: Anterior HB; Right axis dev: Posterior 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)

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

**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!