

## READING AN EKG

RATE: 300 / (# Large squares from R to R)

RHYTHM:

Is every QRS preceded by P-wave?

Is the rhythm regular?

MEAN QRS VECTOR:

Normal: -30 to +90 (degrees)

LAD: < -30

RAD: > +90

P-WAVE VECTOR: +30 to +60

T-WAVE VECTOR: Within 45° of QRS

INTERVALS (normal): ms

(Note: 1 small square = 40 ms)

PR interval: 120-200 ms

QRS duration: <120 ms

QT interval: Varies with HR

RATE	INTERVAL
125	< 250 ms
75	< 350 ms
45	< 450 ms

QRS NOMENCLATURE

Q-wave = first negative deflection before positive

R-wave = any positive deflection

S-wave = first negative after positive

NORMAL EKG: Typically

P-waves upright in I, II, V2-V6

T-waves upright in I, II, V3-V6

Inverted in aVR

Variable in III, aVL, aVF, V1, V2

Small Q-wave normal in I, aVL

Deep Q-wave (QS) normal in aVR, and  
occasionally seen in III, V1, V2

## BASIC EKG ABNORMALITIES

**PR INTERVAL:**

< 120 ms:

-normal in tachycardia

-junctional (nodal) rhythm

-"pre-excitation":

Wolff- Parkinson-White syndrome

("delta-waves" prolong the QRS)

> 200 ms (1<sup>st</sup> degree AV block):

-focal fibrosis

-digitalis

-ischemic heart disease

-rheumatic heart disease

-hyperkalemia

**QRS DURATION:  $\geq 120$  ms**

- Bundle branch blocks (QRS  $\geq 120$  ms)
- Intraventricular conduction delay (IVCD)
- LVH
- Hyperkalemia
- Procainamide, quinidine
- Wolf-Parkinson-White syndrome
- Ventricular based rhythms

**QT INTERVAL:**

## Long QT:

- drugs:
  - cardiac depressants (i.e., amiodarone, sotalol, quinidine..)
  - tricyclic antidepressants
  - antimicrobials (floxacin's, azoles, erythromycin)
  - antipsychotics (haloperidol and others)
  - others (cisapride, sumatriptan, zolmitriptan, methadone)
- ischemic heart disease
- hypokalemia, hypocalcemia, alkalosis
- bundle branch block
- stroke, coma
- ventricular hypertrophy

## Shortened QT:

- hypercalcemia
- digitalis

**P-WAVE ABNORMALITIES:**Tall peaked P-waves (amplitude  $\geq 3$  mV)

- usually largest in lead II
- suggests Right Atrial Abnormality (RAA)(enlargement)
- often seen in COPD

Broad, notched P-waves  $\geq 120$  ms

- suggests Left Atrial Abnormality (LAA) (enlargement)
- often seen in Mitral Valve Disease

## Biphasic P-wave in lead VI

- may be normal
- initial deflection > terminal deflection  
suggests RAA
- terminal deflection > initial deflection  
suggests LAA

**QRS COMPLEX:**

## Low Amplitude

- Obesity
- COPD
- Effusions -- pleural or pericardial
- Old age -- especially after MI's
- Hypothyroidism
- Pneumothorax
- Primary cardiomyopathy

## Tall QRS -Normal for age &lt;35

- Ventricular hypertrophy
- Bundle branch block -2-

**Poor R-wave progression**

- lead placement
- clockwise rotation (normal variant)
- anteroseptal MI
- LVH, RVH
- LBBB, LAFB, IVCD
- COPD

Q-waves (see MYOCARDIAL INFARCTION)

- must be > 40 ms and/or at least 1/4 the amplitude of the R-wave to be significant

**ST SEGMENT:**

Elevated ST segment

- acute MI (usually focal)
- pericarditis (diffuse)
- ventricular aneurysm (persistent and focal), left ventricular hypertrophy
- atypical angina (Prinzmetal's), Bundle branch blocks
- benign early repolarization (may be normal variant)

Depressed ST segment

- ischemia/angina pectoris
- digitalis ("scooped out" ST's)
- Ventricular hypertrophy-if down sloping called "strain"
- bundle branch blocks (non-specific ST-T wave changes)
- hypokalemia/hypomagnesaemia

**T-WAVE CHANGES:**

Tall peaked T-waves (5 small boxes in limb leads or 10 small boxes in chest leads)

- hyperkalemia (pinched bottom or rocket ship)
- hyperacute MI (maybe seen early in Acute phase)
- normal variant in young

Inverted T-waves

- anything causing ST-depression
- digitalis
- pericarditis-begins upright and flips
- normal variant-persistent juvenile pattern in 10% blacks and children

U-Waves

- from repolarization of papillary muscle
- seen most in precordial leads
- hypokalemia/hypomagnesaemia
- most often normal variant

**LEFT AXIS DEVIATION:** (-30 or >)

- LVH
- Left anterior fascicular block
- LBBB
- Inferior MI

**RIGHT AXIS DEVIATION:** (+90 or >)

- MI (lateral)
- RVH
- RBBB
- Left posterior fascicular block (rare)
- COPD
- Acute PE

## COMMON CRITERIA FOR EKG DIAGNOSES

### RIGHT ATRIAL HYPERTROPHY

- "Peaked" P-waves  $> 2.5$  mV in II, III, or aVF
- Biphasic P-wave in lead VI with positive  $>$  negative

### LEFT ATRIAL HYPERTROPHY

- Long P-wave  $> 120$  ms in any lead (primarily in lead II)
- Biphasic P-wave in lead VI with negative  $>$  positive
- Double peaked P-wave in I, II, aVL, V4-V6

### LEFT VENTRICULAR HYPERTROPHY (criteria not valid if patient is younger than 35 years old)

- Axis  $> -15$  degrees (nonspecific)
- S in VI or V2 + R in V5 or V6  $\geq 35$  mV
- R in V5 or V6  $\geq 26$  mV
- R in aVL  $> 12$  mm
- "Strain": ST depression, often with flipped T's in I, II, aVL, V5, V6

### RIGHT VENTRICULAR HYPERTROPHY

- R  $>$  S in V1 and S  $>$  R in V6
- Axis  $> +110$  degrees
- "Strain": ST depression, often with flipped T's in V1-V4

### RIGHT BUNDLE BRANCH BLOCK (RBBB)

- Prolonged QRS  $\geq 120$  ms
- Axis normal or rightward
  - (if left axis deviation present, then must have both RBBB and left anterior fascicular block)
- rSR' pattern in V1, V2 "mutant rabbit ears"
- Terminal (last 40 ms) S-wave in V5, V6
- ST depression and T-wave inversion in V1, V2

### LEFT BUNDLE BRANCH BLOCK (LBBB)

- Prolonged QRS  $\geq 120$  ms
- Axis normal or leftward
- Poor R-wave progression. May have rS or large Q wave in V1, V2, V3, and V4
- Terminal QRS forces (last 40 ms) positive in V5 and V6 (pure positive QRS complex in V6)
- T-wave inversion, ST depression & elevation in most leads. (Often exaggerated)

### LEFT ANTERIOR FASCICULAR BLOCK (Hemiblock)

- Axis more negative than  $-45$  degrees
- No other cause of axis deviation present
- Normal QRS duration (100 – 110 ms)
- Small Q in I, small R in III (q1r3 pattern)

### LEFT POSTERIOR FASCICULAR BLOCK (Hemiblock)

- Axis more positive than  $+110$  degrees
- No other cause of axis deviation present
- Normal QRS duration
- Small Q in III, small R in I (r1q3 pattern)

## MYOCARDIAL INFARCTION

### Progression of changes

Acute: presence of ST-elevation

Age indeterminate: ST-segment has normalized

### Old terminology:

-hyperacute (min-hrs): ST elevation and high "peaked" T-waves

-acute MI (hrs): ST drops but still elevated, T-wave inversion

-Q-waves develop in hours to days if present

-recent MI (weeks-months): ST returns baseline, T-waves inverted for months to years, and Q-waves remain

-old MI (months-years): Q-waves

### Significant Q waves: (must meet one of two criteria)

1) Q wave must be 1/4 the size of the R wave to be considered significant

or

2) Q wave is 40 ms wide (one small box) or greater to be considered significant

### Definitions of STEMI (Transmural, Q-wave) Infarctions

-septal	V1 -V2
-anterior	V2 -V3, V4
-anteroseptal	V1 - V3, V4
-high lateral	I, aVL
-anterolateral	V5 - V6, I, aVL
-extensive anterior	V1 - V5, V6
-inferior	II, III, aVF
-inferolateral	II, III, aVF, V5 - V6
-posterior	R-wave V1 - V2 with ST depression
-right ventricular	rV3 -rV4 with ST depression

### NOTE:

-EKG changes in only 80% with MI

-Inferior MI's commonly result in a BBB

-Q-waves disappear in 20% of patients who had MI

## BRUGADA SYNDROME

-High incidence in Southeast Asia and Japanese populations

-Mean age of onset, 41. Much more common in men

-ECG finding: Coved ST segment elevation >2mm in V1-V3 followed by negative T wave

-Must correlate with clinical findings

## De WINTER'S T WAVES

-Proposed STEMI-equivalent, 2% of LAD occlusions will present with this finding

-Precordial junctional ST segment depression at the j-point (1-3mm) in leads V1-V6

-Tall, peaked, symmetric T waves in the precordial leads

-Lead a-VR shows slight ST segment elevation in most cases (>0.5 mm)

## PERICARDITIS

-Diffuse ST elevation (except aVR)

-No reciprocal ST depression

-As pericarditis subsides, ST returns to baseline and T-waves invert

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## WOLFF-PARKINSON-WHITE SYNDROME (WPW)

-Is considered the Great Mimic. Tends to mimic many other ECG conditions. Is uncommon (2

per 1000) but occurs frequently enough to cause problems for the unwary.

- Short PR interval (< 120 ms)
- QRS widening ( $\geq$  120 ms)
- Presence of delta waves (in multiple leads, best seen in precordial leads)
- Patients with WPW are highly susceptible to certain cardiac arrhythmias. If suspect WPW, do not use digoxin, verapamil or diltiazem.

## DIGITALIS

-Digitalis effect: (the degree of changes has no consistent relation to the amount of digitalis admin.)

- "scooped" out ST depression
- biphasic T-wave (may show decreased amplitude)
- shortening of QT
- prolonged PR

Digitalis toxicity:

- all the above, plus
  - excitatory effects: Digitalis toxicity is known to be capable of producing almost all types of cardiac arrhythmias, except atrial flutter and BBB. (i.e., PVC's, PAT with block), V-Tach, V-Fib, etc.)
  - suppressant effects:
    - sinus bradycardia, SA block, AV blocks

## HYPERKALEMIA

- K < 7.5 mEq/L:
  - decreased amplitude of P-waves
  - wide QRS (Intraventricular conduction defect)
  - Tall, narrow, and peaked T-waves
- K > 7.5 mEq/L:
  - Absence of P-waves
  - "sine wave" R-S-T pattern (sinoventricular rhythm)

## HYPOKALEMIA

- ST depression. Decreased T-wave amplitude (or inversion),
- Prominent U-waves and P-waves
- Prolongation of the QRS duration
- Prolonged QT interval

## HYPERCALCEMIA

- Short QT interval (short ST)

## HYPOCALCEMIA

- Prolonged QT interval (long ST)

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