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 (1st degree AV block):
-focal fibrosis
-digitalis
-ischemic heart disease
-rheumatic heart disease
-hyperkalemia

QRS DURATION: ≥120 ms

-Bundle branch blocks (QRS ≥ 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 ≥.3 mV)
- -usually largest in lead II
- -suggests Right Atrial Abnormality (RAA)(enlargement)
- -often seen in COPD

Broad, notched P-waves ≥ 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 <35
- -Ventricular hypertrophy
- -Bundle branch block

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 ≥ 35 mV
- -R in V5 or V6 ≥ 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 ≥ 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 ≥ 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 evaluation 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

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 (≥ 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)