EKG INTERPRETATION

RATE

Most common: 300-150-100-75-60-50-43-37-33-30
Mathematical method: 300/ # large boxes between R waves
Six second method: # R-R intervals in 30 large boxes x 10
Ten second method: # R-R intervals in 50 large boxes x 6 (Std ECG)

RHYTHM AND INTERVALS

1. Check for the longest strip, usually II:
   a. regular
   b. regularly irregular,
   c. irregularly irregular
2. Check for P before each QRS and QRS after P
3. Check PR interval, QRS, QT interval

AXIS (Normal -30 to 90 degrees)

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>Cardiac Axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Positive</td>
<td>Normal (0 to +90 degrees)</td>
</tr>
<tr>
<td>Negative/Isoelectric</td>
<td>Positive</td>
<td>Right axis deviation (+90 to +180)</td>
</tr>
<tr>
<td>Positive</td>
<td>Negative/Isolectric</td>
<td>Left axis deviation (-30 to +180)</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>Indeterminate (-90 to -180)</td>
</tr>
</tbody>
</table>

Positive means more above baseline than below baseline
Negative means more below baseline than above baseline

Left axis deviation: LVH, left anterior fascicular block, inferior MI
Right axis deviation: RVH, left posterior fascicular block, lateral MI

[Diagram of ECG axes with annotations]
HYPERTOPHY

1. LVH:    a. larger S in V1 or V2 + larger R in V5 or V6 ≥ 35 mm (7 large boxes)
          b. R in aVL ≥ 10 mm (2 large boxes)
2. RVH:    R > S in V1
3. Atrial (to be observed in II and V1):
   - RAE(H): Tall Peaked P in II, also III, aVF (> 2.5 mm in height). V1 has increase in
     the initial positive deflection and a square 1mm x 1mm could fit within that portion of the
     P wave
   - LAE(H): Biphasic Notched wide P in II (> 3 mm width). V1 has increase in the
     terminal negative deflection and a square 1mm x 1mm could fit within that portion of the
     P wave.

HEART DAMAGE

1. Ischemia  ST Depression >1mm horizontal or down sloping, 60-80 ms after QRS
             Symmetrical T wave inversion or flattening
             T waves are usually upright in I, II, V2-V6, inverted aVR
2. Injury    Acute damage: elevation of ST segments
3. Infarct   Q waves. To be pathologic: wide at least 0.04 seg (1 mm) or if the
             amplitude is 1/3 or greater of the entire QRS in the same lead
             Q in III needs to be 1/3 of QRS complex; Q in III, aVF should be
             accompanied by Q in II to be significant.
             Small Qs may be normal in I, aVL, V5, V6 and aVR

LOCATION OF HEART DAMAGE USING 12 LEAD EKG

Anterior    Q in V3, V4
Anteroseptal Q in V1, V2
Inferior    Q in II, III, aVF
Lateral     Q in I, aVL, V5, V6
Posterior   Tall R in V1, V2
HEART BLOCKS

<table>
<thead>
<tr>
<th>1° AV</th>
<th>2° AV</th>
<th>3° AV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° AV</td>
<td>Mobitz I</td>
<td>Mobitz II</td>
</tr>
<tr>
<td>Number P-QRS</td>
<td>Equal</td>
<td>P&gt;QRS</td>
</tr>
<tr>
<td>P-R interval</td>
<td>≥ 0.20</td>
<td>Progressive prolongation and a QRS is dropped</td>
</tr>
<tr>
<td>R-R interval</td>
<td>Regular</td>
<td>Irregular with progressive shortening</td>
</tr>
</tbody>
</table>

BUNDLE BRANCH BLOCK

Right
- RR’ Seen in V1; S in I (rabbit ears in V1, V2)
- Complete (QRSD> 0.12 sec.) or incomplete (QRSD< 0.12 sec)

Left
- Deep S (QS or rS) in V1 or V2; Tall R in V5, V6 (rabbit ears) V5 and V6
- Wide QRS complex (wide, notched R wave, no Q wave in V6)
- Complete (QRSD> 0.12 sec.) or incomplete (QRSD< 0.12 sec)
- If new onset, assume MI unless enzyme and clinical proves otherwise
The sinoatrial (SA) node initiates depolarization. The impulse is propagated by atrioventricular (AV) node and spreads throughout ventricles via His-Purkinje system.

The EKG is recorded on standard paper at 25 mm/s. Paper is divided: large squares: 5 mm wide = 0.2 sec. Five small squares = large square, each small square: 1 mm wide = 0.04 sec.

The electrical activity is measured in milivolts. Machines calibrated: amplitude of 1 mV = 1 cm = 2 large squares: 0.1 mV = 1 mm = 1 small square.

The direction of deflection depends on whether electrical impulse is traveling towards or away from a detecting electrode.

By convention, traveling towards electrode produces upright ("positive") deflection, whereas impulse moving away from electrode produces a downward ("negative") deflection. When wave of depolarization at right angles to lead, an equiphasic deflection produced.
Six chest leads (V1 to V6) "view" the heart in the horizontal plane: six limb leads (I, II, III, aVR, aVL, and aVF), view the heart in the vertical plane. The 12 leads = standard EKG.

Anatomical relationships: leads II, III, and aVF view the inferior surface of the heart; leads V1 to V4 view the anterior surface; leads I, aVL, V5, and V6 view the lateral surface; and leads V1 and aVR look through the right atrium directly into the cavity of the left ventricle.

The term tachycardia is used to describe a heart rate greater than 100 beats/min. A bradycardia is defined as a rate less than 60 beats/min (or <50 beats/min during sleep).

One large square = 0.2 seconds; five large squares = 1 second and 300 = 1 minute. At standard rate of 25 mm/s, heart rate = number of large squares between two consecutive R waves, divided into 300 number of small squares between two consecutive R waves divided into 1500.

When using a rate ruler, use correct scale according to paper speed (25 or 50 mm/s); count correct numbers of beats (for example, two or three); and restrict to regular rhythms.

When irregular rhythm, rate calculated from rhythm strip. One second = 2.5 cm of trace. Heart rate / minute = the number of R waves in 10 seconds (namely, 25 cm of recording paper) and multiplying by 6.

A prolonged recording from one lead is used to provide a rhythm strip. Lead II, which usually gives good view of P wave, commonly used to record the rhythm strip.

**Cardinal features of sinus rhythm**

- The P wave is upright in leads I and II
- Each P wave is usually followed by a QRS complex
- The heart rate is 60-99 beats/min
Normal findings in healthy individuals

- Tall R waves
- Prominent U waves
- ST segment elevation (high-take off, benign early repolarisation)
- Exaggerated sinus arrhythmia
- Sinus bradycardia
- Wandering atrial pacemaker
- Wenckebach phenomenon
- Junctional rhythm
- 1st degree heart block

**Axis**

Cardiac axis refers to mean direction of the wave of ventricular depolarization in the vertical plane, measured from zero reference point. The zero reference = same viewpoint as lead I. An axis above line is negative number, and axis below line is positive number. The normal range for cardiac axis is between $-30^\circ$ and $90^\circ$. An axis $<-30^\circ$ is termed left axis deviation, whereas an axis $>90^\circ$ is termed right axis deviation.

To calculate cardiac axis, the simplest method is inspection of leads I, II, and III.

**Conditions for which determination of the axis is helpful in diagnosis**

- Conduction defects—for example, left anterior hemiblock
- Ventricular enlargement—for example, right ventricular hypertrophy
- Broad complex tachycardia—for example, bizarre axis suggestive of ventricular origin
- Congenital heart disease—for example, atrial septal defects
- Pre-excited conduction—for example, Wolff-Parkinson-White syndrome
- Pulmonary embolus
A more accurate estimate of axis achieved if all six limb leads examined. The direction of current flow is towards leads with a positive deflection, away from leads with a negative deflection, and at 90° to a lead with an equiphasic QRS complex.

The axis is determined as follows:
- Choose the limb lead closest to being equiphasic. The axis lies about 90° to right or left of this lead
- Inspect QRS complexes in leads adjacent to equiphasic lead. If lead to the left is positive, then axis is 90° to the equiphasic lead towards the left. If the lead to the right side is positive, then the axis is 90° to the equiphasic lead towards the right.

**SUMMARY**

**P wave:** atrium depolarization/activation
- 0.06-0.10 sec.
- amplitude: 2.5 mm

**PR interval:** from onset of P wave to onset of QRS complex
- 0.12-0.20 sec.
- atrial depolarization is spreading to AV node

**QRS:** ventricular depolarization/activation
- 0.06-0.12 sec.
- Q wave: first negative deflection not preceded by a positive deflection
- R wave: first positive deflection of the complex
- S wave: first negative deflection after first positive deflection
- R’ wave: positive deflection after S wave
- S’ wave: negative deflection after R’s wave
- QS wave: monophasic negative deflection

**ST segment:** between end of QRS complex and onset of T wave
- usually isoelectric (at the same level as preceding PR interval)
T wave: ventricular repolarization

QT interval: from onset of QRS to end of T wave
total duration of ventricular electric systole (depolarization and repolarization)
normal: < 0.40 sec. Borderline: 0.40-0.44 Prolong: > 0.45
corrected QT = measured QT divided by the square root of the R-R interval

U wave: low voltage deflection, usually positive, after T wave and before P wave

Delta wave: “shoulder” to initial QRS

Each little box represents 0.04 sec.
Each big box represents 0.20 sec.
Five big boxes represent: 1 sec.
Standard 12 Lead ECG 10 sec

Websites:

www.ecglibrary.com
http://outside.fammed.wisc.edu/medstudent/pcc/ecg/guidelines.html
