

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

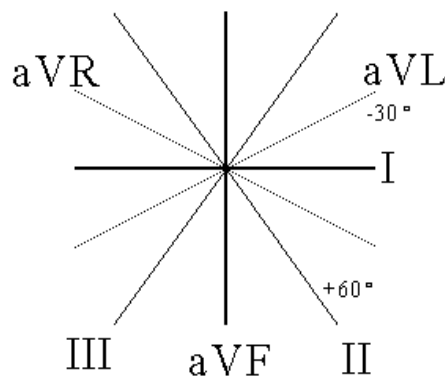
1. Check for the longest strip, usually II:
 - a. regular
 - b. regularly irregular,
 - c. irregularly irregular
2. Check for P before each QRS and QRS after P
3. Check PR interval, QRS, QT interval

AXIS (Normal -30 to 90degrees)

I	II	Cardiac Axis	
Positive	Positive	Normal	(0 to + 90 degrees)
Negative/Isoelectric	Positive	Right axis deviation	(+90 to + 180)
Positive	Negative/Isoelectric	Left axis deviation	(-30 to +180)
Negative	Negative	Indeterminate	(-90 to -180)

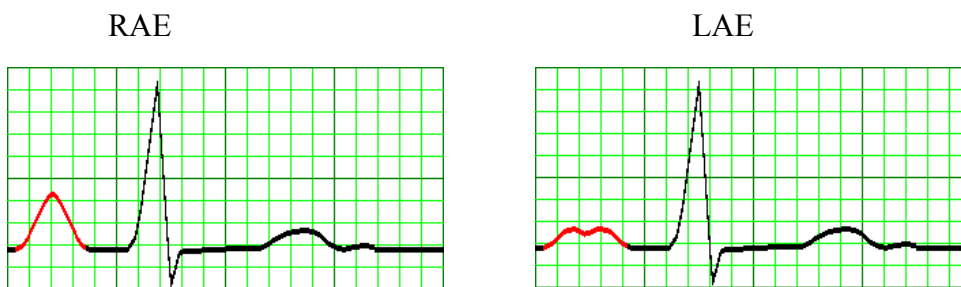
Positive means more above baseline than below baseline
 Negative means more below baseline than above baseline

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



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 > 1 mm horizontal or down sloping, 60-80 ms after QRSⁱ
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

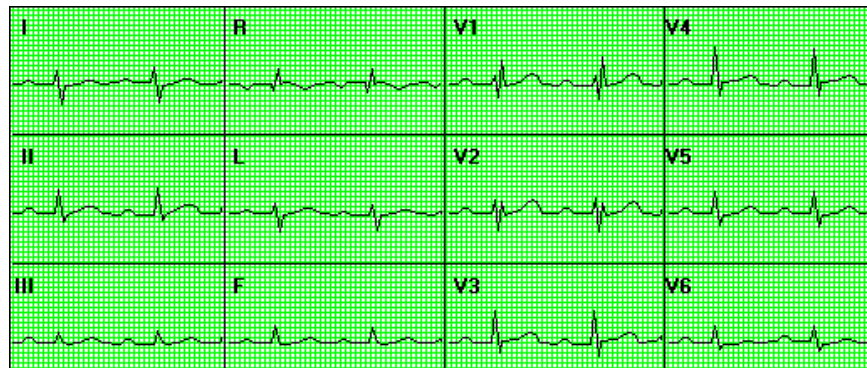
Anterior	Q in V3, V4
Anteroseptal	Q in V1, V2
Inferior	Q in II, III, aVF
Lateral	Q in I, aVL, V5, V6
Posterior	Tall R in V1, V2

HEART BLOCKS

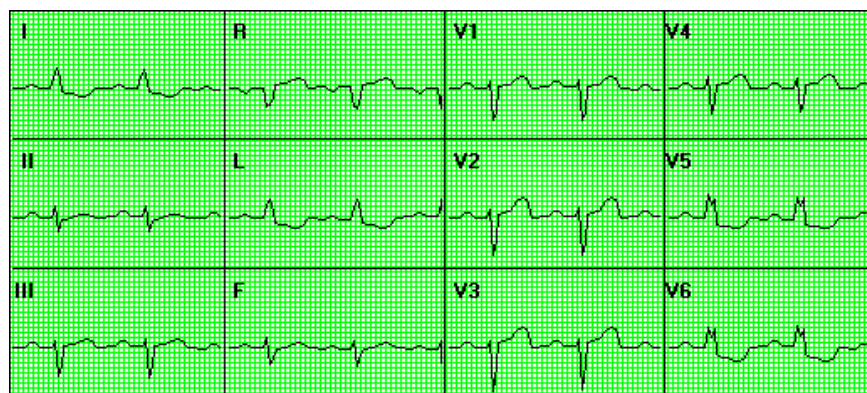
	1° AV	Mobitz I	2° AV Mobitz II	3° AV
Number P-QRS	Equal	P>QRS	P>QRS	P>QRS
P-R interval	≥ 0.20 Constant	Progressive prolongation and a QRS is dropped	Regular, sudden QRS drop	Irregular
R-R interval	Regular	Irregular with progressive shortening	Regular	Regular

BUNDLE BRANCH BLOCK

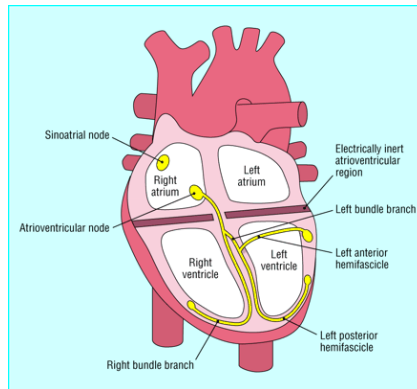
Right RR' Seen in V1; S in I (rabbit ears in V1, V2)
 Complete (QRSD > 0.12 sec.) or incomplete (QRSD < 0.12 sec)



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



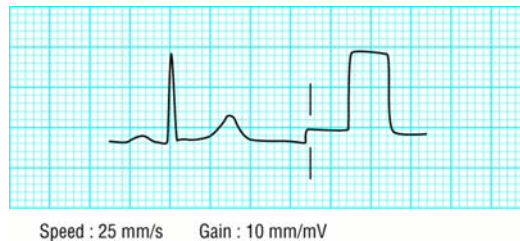
BASIC EKG



The sinoatrial (SA) node initiates depolarization. The impulse is propagated by atrioventricular (AV) node and spreads throughout ventricles via His-Purkinje system.

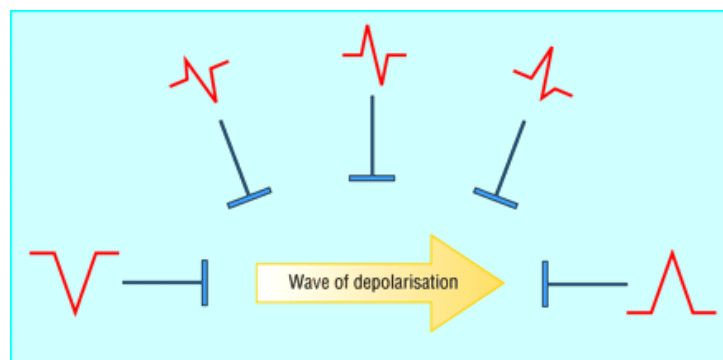
The EKG is recorded on standard paper at 25 mm/s. Paper is divided: large squares: 5 mm wide = 0.2 sec. Five small squares = large square, each small square: 1 mm wide = 0.04 sec.

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



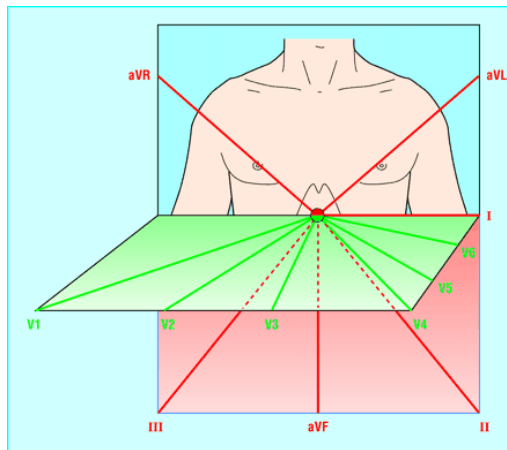
The direction of deflection depends on whether electrical impulse is traveling towards or away from a detecting electrode.

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 equiphase 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.

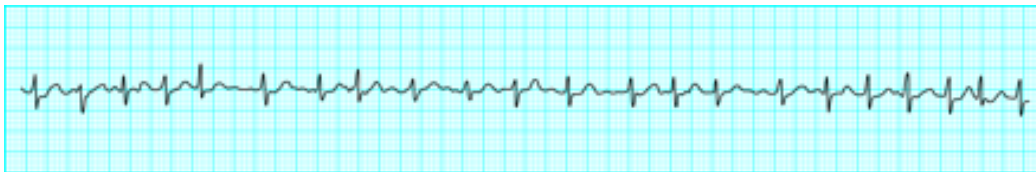


The term tachycardia is used to describe a heart rate greater than 100 beats/min. A bradycardia is defined as a rate less than 60 beats/min (or <50 beats/min during sleep).

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

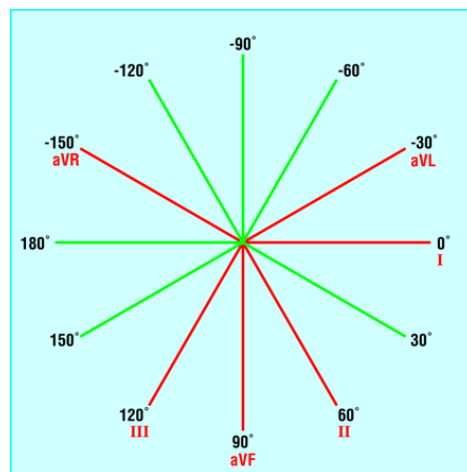
- The P wave is upright in leads I and II
- Each P wave is usually followed by a QRS complex
- The heart rate is 60-99 beats/min

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

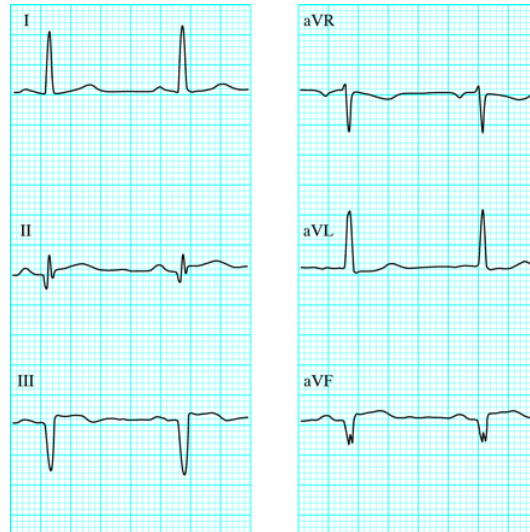
Cardiac axis refers to mean direction of the wave of ventricular depolarization in the vertical plane, measured from zero reference point. The zero reference = same viewpoint as lead I. An axis above line is negative number, and axis below line is positive number. The normal range for cardiac axis is between -30° and 90° . 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 equiphase QRS complex.

The axis is determined as follows:

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

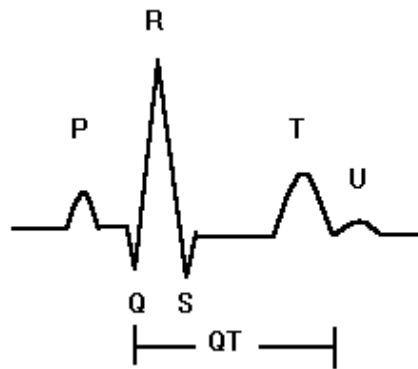
Delta wave: "shoulder" to initial QRS

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>

¹ Steve Meek, Francis Morris, ABC of Clinical Electrocardiography, Introduction 1 and 2, BMJ, 16 February 2002, Vol. 324, pp 415-418, 470-473

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¹Gibbons Et Al., 2002 Guideline Update For Exercise Testing Circulation 2002;106:1883-1892 A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines)