12 Lead ECG Interpretation

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Nursing Institute
12 Lead ECG (or EKG)

- Heart is an electrical field; arms and legs are a linear extension of this field
- ECG is a recording of the electrical activity of the heart over a period of time
- Detected by electrodes attached to the surface of the skin and recorded and displayed by a device external to the body
- Changes in electrical activity may indicate arrhythmias, cardiac ischemia, or electrolyte imbalances
**Aorta**

**Left coronary artery** - divides into two branches: the circumflex artery and the left anterior descending artery.

**Vena cava**

**Pulmonary artery**

**Right coronary artery (RCA)** supplies blood to the right atrium, right ventricle, bottom portion of the left ventricle and back of the septum.

**Circumflex artery** supplies blood to the left atrium and the side and back of the left ventricle.

**Left anterior descending artery (LAD)** supplies blood to the front and bottom of the left ventricle and the front of the septum.

**Coronary veins** (in blue) take oxygen-poor ("deoxygenated") blood that has already been "used" by muscles of the heart and return it to the right atrium.

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**Cleveland Clinic**
Blood Supply

- LAD: anterior wall of LV, anterior septum, bundle branches
- Left circumflex: left atrium, lateral wall LV, posterior wall LV
- RCA: right atrium, right ventricle, bottom of LV, posterior septum
12 Lead ECG System

- 3 limb leads (bipolar)
- 3 augmented limb leads (unipolar)
- 6 precordial leads
Limb Leads: Bipolar

• Leads I, II, and III
• Two electrodes (+ and -) equidistant from heart
• Records electricity flow from negative to positive electrode
• A wave of depolarization moving toward a positive electrode produces a positive deflection on the ECG
• Depolarization moving away from a positive electrode records a negative deflection
• **Lead axis** is the direction of electrical depolarization
Limb Leads: Unipolar

- Leads aVR, aVL, aVF
- Letter a refers to augmented
- Letter V refers to voltage
- Letters R, L, and F refer to where positive electrode is placed (right arm, left arm and left leg)
- Records electricity flow from center of heart toward positive electrodes
Limb Lead Placement

RA = Right Arm
LA = Left Arm
RL = Right Leg
LL = Left Leg

RA - White
LA - Black
RL - Green
LL - Red
Limb Lead Electrode Placement

• Preferred site of limb lead electrodes is slightly proximal to wrist and ankles over flat fleshy area
• Upper arms and legs may be used but must be consistent
• Avoid muscle and boney areas
Precordial Leads

- 6 precordial leads (V1 – V6)
- Letter V refers to unipolar
- Numbers 1-6 are codes for locations on precordium
Precordial Leads

• V1 and V2 are on either side of sternum at 4th ICS
• V4 is midclavicular line, 5th ICS
• V3 is halfway between V2 and V4
• V6 is at midaxillary line, 5th ICS
• V5 is halfway between V4 and V6, 5th ICS
Precordial Lead Electrode Placement

- Correct anatomical placement imperative!
- Sternal angle (angle of Louis) used as reference point
- Run finger down the sternum, from the sternal notch at the top until a boney horizontal ridge, the sternal angle is met
- With your finger on this ridge, slide down and to the right side to locate the second intercostal space
- Count down to the third and fourth space
- Locate the edge of the sternum and place V1
- In women, V4, V5, and V6 are place under the left breast
View from Precordial Leads

- V1: Right ventricle
- V2/V3: Septum
- V4: Apex
- V5/V6: LV; left lateral wall
Skin Preparation

• Assess the skin
  – If visibly oily or sweaty prepare the skin before electrode placement

• Cleanse the sites for electrode placement using the following options:
  – Soap and water and dry thoroughly
  – Alcohol and gauze pads
  – Abrading the skin to remove dead skin with a washcloth
  – Clip hair for a 2x2 area for each electrode if necessary
12 Lead ECG Lead Wires

- Lead wires fasten to the electrodes
12 Lead ECG Quality

• All tracings must have a “clean” stable baseline free of artifact and interference

• Artifact can be caused by:
  – Muscle tremors
  – Patient movement
  – Loose electrodes
  – 60 cycle interference
Poor Quality

Wandering Baseline
Good Quality
Poor Quality

VENT: 79 BPM
PR INTERVAL: 144 ms
QRS COMPLEX: 92 ms
QT/QTc: 403/400 ms
P-R: 27-29-28 ms

NORMAL SINUS RHYTHM
HIGH QRS VOLTAGE
ANTERIOR MYOCARDIAL INFARCTION, AGE UNDETERMINED
ABNORMAL ECG

Referred by "Ding"
Goal is Quality Tracings!

- Proper placement = accurate tracings = accurate treatment = quality patient outcomes
<table>
<thead>
<tr>
<th>Type of infarction</th>
<th>Coronary arteries involved</th>
<th>Indicative Leads</th>
<th>ECG Changes</th>
<th>Clinical Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior wall</td>
<td>RCA</td>
<td>II, III, aVF</td>
<td>ST Elevation T wave inversion Q waves</td>
<td>Some muscle damage; SA node dysfunction</td>
</tr>
<tr>
<td>Left lateral wall</td>
<td>Circumflex</td>
<td>I, aVL, V5, V6</td>
<td>ST elevation T wave inversion Q waves</td>
<td>Some muscle damage; SA node dysfunction</td>
</tr>
<tr>
<td>Posterior wall</td>
<td>RCA or Cx.</td>
<td>V1, V2</td>
<td>ST depression Large R waves</td>
<td>May occur with inferior wall MI; SA and AV node dysfunction</td>
</tr>
<tr>
<td>Anterior wall</td>
<td>LAD</td>
<td>V1-V6</td>
<td>ST elevation, T wave inversion, Q waves</td>
<td>Significant muscle damage; IVCD</td>
</tr>
</tbody>
</table>
Basic 12 Lead ECG Interpretation

• Determine rate
  – Bradycardia, less than 60 beats per minute
  – Tachycardia, greater than 100 beats per minute

• Determine rhythm
  – Regular or irregular

• Ischemia, injury or infarction?
Definitions

• Ischemia
  – 70% of vessel occluded
  – $O_2$ demand exceeds supply

• Injury
  – Ischemic state continues with injury to myocardium

• Infarction
  – Cell death

• Ischemia and injury are reversible

• Infarction is not reversible
Ischemia

• T wave inversion; symmetric, narrow

• ST depression of 1-2 mm or more for a duration of 0.08 seconds in the leads facing the ischemic area

• Reversible
Injury

• ST elevation over damaged myocardium

• Downward concave or coned shape

• Merge with T wave

• Reversible
Infarction

- Irreversible

- Seen on ECG in stages

- Hyperacute
  - Tall, narrow, peaked T waves
  - Invert within a few hours
Infarction

• ST segment elevation
  – Seen in early hours of infarction
  – Last from several hours to several days
  – Reciprocal changes: leads facing away from infarction may show
    ST depression

• Q waves
  – 0.04 seconds or more wide
  – 1/4 to 1/3 height of R wave
  – Develop within several hours to 48 hours after infarction
Inferior Wall MI

- Supplied by RCA
- Leads II, III, and aVF
- Damage may extend into RV
- Biventricular dysfunction
- SA node dysfunction
  - Bradyarrhythmias
  - Heart blocks
05-MAY-1949 (50 yr)
Female  Caucasian

Loc:20

Vent. rate  47 BPM
PR interval  380 ms
QRS duration  88 ms
QT/QTc  496/438 ms
P-R-T axes  56 55 112

02-JAN-2000  20:27:00  *
ROUTINE RETRIEVAL *

SINUS BRADYCARDIA WITH 1ST DEGREE AV BLOCK

Referred by: Gillinov
Confirmed by: CURTIS RIMMERMAN  M.D.
Anterior Wall MI

• Supplied by LAD

• Changes in precordial leads V1-V6
  – ST elevation
  – Q waves

• Arrhythmias
  – Ventricular (PVCs)
  – Bundle branch blocks
06-JAN-1939 (61 yr)
Female Caucasian
Room: G2001
Loc: 14

Vent. rate 64 BPM
PR interval 170 ms
QRS duration 118 ms
QT/QTc 468/482 ms
P-R-T axes 56 -50 108

Technician: 927

Referred by: SORIN BRENER
Confirmed by: PAUL MILLER M.D.

25mm/s 10mm/mV 100Hz 005A 12SL 252 CID: 99
SID: K0408461 EID: 18 EDT: 10:37 03-FEB-2000 ORDER: 26365438
Page 1 of 1
Lateral Wall MI

• Supplied by left circumflex artery
• Leads I, aVL, V5 and V6
• Potential for reduction in LV function, but not as great as with anteroseptal wall MI
• Arrhythmias from SA node dysfunction
  – Sinus arrest
  – Bradyarrhythmias
Posterior Wall MI

• Reciprocal changes
  – Tall R waves
  – ST segment depression
  – Look in leads opposite posterior wall (V1, V2)

• Frequently seen with inferior wall MI
  – Leads II, III, and aVF

• Junctional rhythm, heart blocks
25-DEC-1925 (74 yr)  Vent. rate 78 BPM  NORMAL SINUS RHYTHM
Female    Caucasian PR interval 152 ms
Room: 8    QRS duration 88 ms
Loc: 93     QT/QTc 384/437 ms

Technician ID: 914

Med: None

Referred by: GRUNDFEST
Confirmed by: SASAN GHAFFARI MD

Page 1 of 1
Pericarditis

- Signs and symptoms mimic an MI

- Diagnosis based on clinical presentation, 12 lead ECG, and echocardiogram

- Clinical Presentation
  - Sharp, pleuritic chest pain
  - Worse on inspiration
  - Pain relieved by sitting up or leaning forward
  - No response to NTG
  - Pericardial rub
12 Lead ECG Findings

- Diffuse changes that may not localize to right or left coronary artery distribution
- Diffuse ST elevation in multiple leads
- PR segment depression
- Sinus tachycardia or atrial arrhythmias
Vent. rate: 70 BPM
PR interval: 138 ms
QRS duration: 79 ms
QT/QTc: 375/405 ms
P–R–T axes: 19 87 62
Mrs. T

- 62 year old woman with a history of rheumatic fever, panic attacks, tobacco use (1/2 pack/day for 8 years)
- Last evening while walking up the stairs she had right sided chest pain radiating to the neck and over her sternum. Pain was a pressure sensation at 10/10 at its worst
- Diaphoresis and chills with the chest pain
- Last week she noticed worsening chest pain with exertion when walking to the bus or going up the stairs
- Pain subsided with rest
- On arrival to ED: HR 74 bpm, BP 196/61 mmHg
- After one SL nitroglycerine, BP 160/79 mmHg
06-APR-1954 (62 yr) Female Black

- Vent. rate: 68 BPM
- PR interval: 164 ms
- QRS duration: 100 ms
- QT/QTc: 418/444 ms
- P-R-T axes: 79 67 60

Technician: NKL
Test ind:

Referred by:

Unconfirmed

NORMAL SINUS RHYTHM
POSSIBLE LEFT ATRIAL ENLARGEMENT
LEFT VENTRICULAR HYPERTROPHY
ANTEROLATERAL T WAVE ABNORMALITY, MYOCARDIAL CHANGES
ABNORMAL ECG

[ECG Graph]

25mm/s 10mm/mV 150Hz 8.0 SP2 12SL 241 HD CID: 268
Mrs. M.

• 72 year old woman complaining of sudden onset of midepigastric pain and diaphoresis

• Past medical history
  – Atrial fibrillation
  – Known CAD with stent placement to the RCA in 2009
  – Former smoker (quit 1/1/2003)

• Medications
  – Dofetilide (tikosyn), metoprolol
  – ASA, ticagrelor (brilinta), atorvastatin (lipitor)
ID:23574128
16-JAN-2017 03:02:10
CCF-J031RN ROUTINE RECORD

19-FEB-1944 (72 yr) Female Caucasian 62 in Room:J031- Loc:300

Vent. rate 54 BPM
PR interval 184 ms
QRS duration 74 ms
QT/QTc 498/472 ms
P-R-T axes 31 65 83

SINUS BRADYCARDIA
ST ELEVATION CONSIDER INFERIOR INJURY OR ACUTE INFARCT
******* ACUTE MI *******
Consider right ventricular involvement in acute inferior infarct
ABNORMAL ECG

Technician: 887728
Test ind:

Referred by: Unconfirmed

25mm/s 10mm/mV 100Hz 8.0 SP2 12SL 239 C1D: 140
Mr. G.

- 29 year old male with a history of substance abuse
- At 4 pm on 1/05 he injected a combination of heroin and cocaine
- He was found unresponsive by his father who called EMS
- EMS gave him received 3 doses intranasal naloxone (Narcan) with no response; he was transported to the ED
- In the ED he received 2 mg naloxone (Narcan) through an intraosseous (IO) device and became responsive
- He complained of 10/10 chest pain
<table>
<thead>
<tr>
<th>24-OCT-1987 (29 yr)</th>
<th>Vent. rate</th>
<th>86 BPM</th>
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<tbody>
<tr>
<td>Male</td>
<td>PR interval</td>
<td>150 ms</td>
</tr>
<tr>
<td>Caucasian</td>
<td>QRS duration</td>
<td>88 ms</td>
</tr>
<tr>
<td>Room:</td>
<td>QT/QTc</td>
<td>354/423 ms</td>
</tr>
<tr>
<td>Loc:300</td>
<td>P-R-T axes</td>
<td>58 79 21</td>
</tr>
</tbody>
</table>

Technician: 877379
Test ind:  

<table>
<thead>
<tr>
<th>I</th>
<th>aVR</th>
<th>V1</th>
<th>V4</th>
<th>Referred by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>aVL</td>
<td>V2</td>
<td>V5</td>
<td>Unconfirmed</td>
</tr>
<tr>
<td>III</td>
<td>aVF</td>
<td>V3</td>
<td>V6</td>
<td></td>
</tr>
<tr>
<td>V1</td>
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<tr>
<td>II</td>
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<tr>
<td>V5</td>
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25mm/s 10mm/mV 100Hz 8.0 SP2 12SL 239 CID: 14
NORMAL SINUS RHYTHM
ST ELEVATION CONSIDER ANTERIOR INJURY OR ACUTE INFARCT
* * * * * * * * * ACUTE MI * * * * * * *
ABNORMAL ECG

25mm/s 10mm/mV 100Hz 8.0 SP2 12SL 239  CID: 14
Cleveland Clinic

Every life deserves world class care.