A QUICK GUIDE TO INTERPRETATIONS OF MI PATTERNS ON THE 12 LEAD ECG
Session Purpose
To introduce a method for reviewing the 12-Lead ECG for myocardial infarction.
Learning Objectives

- Describe normal cardiac anatomy and physiology
- Describe proper electrode placement
- Describe a systematic approach to 12-lead analysis
Electrical System of the Heart
Electrical System of the Heart

- Sinus node
- A-V node
- A-V bundle
- Internodal pathways
- Left bundle branch
- Right bundle branch
- Purkinje fibers
Normal Sinus Rhythm
Electrical System of the Heart
Cardiac Action Potential

**Phase 0**
Depolarization Na+ rapidly flows into cell via sodium channels

**Phase 1**
Sodium channels close blocking the inward flow of Na+ and initiating repolarization.

**Phase 2**
Plateau; Absolute refractory, influx of Ca+ ions and slow efflux of K+

**Phase 3**
Repolarization; Relative refractory. Calcium channels close, K+ continues to leave cell

**Phase 4**
Resting membrane potential

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The coronary arteries deliver oxygen-rich blood to the muscle tissues of the heart. If the arteries become blocked, heart muscle will die resulting in a heart attack.
ECG Electrode Placement

Proper 12-Lead Placement for Left Side of Chest

1. 6th intercostal space to the right of the sternum
2. 4th intercostal space to the left of the sternum
3. Directly between the leads V2 & V4
4. 5th intercostal space at midclavicular line
5. Level with V4 at left anterior axillary line
6. Level with V4 at left midaxillary line (directly under the midpoint of the arm pit)
7. 5th intercostal space, right midclavicular line

Proper 12-Lead Placement for Right Side of Chest

1. 4th intercostal space to the left of the sternum
2. 6th intercostal space to the right of the sternum
3. Directly between the leads V2 & V4
4. 5th intercostal space at right midclavicular line
5. Level with V4 at right anterior axillary line
6. Level with V4 at right midaxillary line (directly under the midpoint of the arm pit)
7. 5th intercostal space, right midclavicular line

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Frontal Plane (limb) Leads

Activity coming toward the camera = upright complexes
Activity going away from the camera = downward complexes

Mean QRS Axis in the Frontal Plane Examples 1
Horizontal Plane (chest) Leads
12-Lead ECG Walls of the Heart

I  Lateral
II Inferior
III Inferior
aVR Lateral
aVL Lateral
aVF Inferior
V1 Septal
V2 Septal
V3 Anterior
V4 Anterior
V5 Lateral
V6 Lateral
R Wave Progression

In a normal R wave progression the R wave in Lead 2 should be slightly larger. R wave progression in the V leads demonstrates that the septum is healthy, absence of an R wave in V2 should make us suspicious of a septal infarct. Poor R Wave progression can indicate LBBB, Lt Ventricular hypertrophy and emphysema.
Axis Deviation

<table>
<thead>
<tr>
<th>QRS deflection</th>
<th>Axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead 1</td>
<td>aVF</td>
</tr>
<tr>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

Fast way to calculate Electrical axis of heart
# Causes of Axis Deviation

<table>
<thead>
<tr>
<th>RT Axis Deviation</th>
<th>LT Axis Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Right Ventricular hypertrophy</td>
<td>• Normal Variations: (physiologic, often with age)</td>
</tr>
<tr>
<td>• Rt Bundle Branch Block</td>
<td>• Mechanical shifts: (pregnancies, ascites)</td>
</tr>
<tr>
<td>• Dextrocardia</td>
<td>• Left ventricular hypertrophy</td>
</tr>
<tr>
<td>• Ventricular ectopic rhythms</td>
<td>• LBBB</td>
</tr>
<tr>
<td>• Lateral Wall MI</td>
<td>• Congenital heart disease: (Atrial septal defect)</td>
</tr>
<tr>
<td>• Rt ventricular load; i.e. pulmonary embolism or COPD</td>
<td>• Emphysema</td>
</tr>
<tr>
<td></td>
<td>• Hyperkalemia</td>
</tr>
<tr>
<td></td>
<td>• Ventricular ectopic rhythms</td>
</tr>
<tr>
<td></td>
<td>• Inferior MI</td>
</tr>
</tbody>
</table>
Axis

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<table>
<thead>
<tr>
<th></th>
<th>Lead I</th>
<th>aVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>NL</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>RAD</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>LAD</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Indet.</td>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

I and aVF both positive
Axis = normal
The 12-Lead ECG

Purpose

To help identify primary conduction abnormalities, arrhythmias, cardiac hypertrophy, pericarditis, electrolyte imbalance, myocardial infarction (MI), and the site and extent of any MI.
12-Lead ECG Interpretation

Sequence for 12 Lead ECG Interpretation

1. Determine the rate
2. Determine the rhythm & axis
3. Measure intervals
4. Is there ‘R’ wave progression
5. Compare with previous 12 Lead ECG’s and any other clinical data

*** ST elevation must be present in at least 2 leads to confirm the diagnosis of a Myocardial Infarction

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NMLB 048 [A]-CD-0477

This chart is provided as a clinical reference and not as a diagnostic tool. Refer to physician to confirm diagnosis.

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1. Determine Rate

Normal Sinus Rhythm

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2. Determine Rhythm

Normal Sinus Rhythm

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR Interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-100 bpm</td>
<td>Regular</td>
<td>Before each QRS, identical</td>
<td>.12 to .20</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>
2a. Axis net QRS Deflection

<table>
<thead>
<tr>
<th></th>
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<th>aVF</th>
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</tr>
<tr>
<td>Indet.</td>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

I - positive aVF - negative
Axis = LAD
4. Assess R-wave Progression
5. Compare and Assess

Previous 12 Leads and Presenting Clinical Data

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Assess the 12 Lead ECG for MI
Principal Indicators of Acute Infarction

Compare ST Segments/T-Waves and presence of Q-Waves

**ST Segment Elevation (=injury)**
- Early ("Hyperacute") Stage
- Caved ("Frowny") ST Segment Elevation (=Acute Injury Pattern)

**Development of Q Waves**
- Early Q wave development
- Established Q Wave Stage
- QS Complex

**T Wave Inversion (=ischemia)**
- Early T wave Inversion
- Deeper, Symmetric T Wave Inversion (=ischemia)

**Reciprocal ST Segment Depression**
- Mirror Image ST Depression
- Subtle Reciprocal ST Segment Depression


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Why does the ST elevate?

![Diagram showing depolarization, repolarization, QRS, ST segment, and T-wave]

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Evolution of an Infarct

Transmural Infarction

**Before Coronary Occlusion**
- Heart muscle normal
- Normal ECG

**Onset and First Several Hours**
- Subendocardial injury and myocardial ischemia. No cell death (infarction) yet
- R wave normal or nearly normal
- T wave peaked
- ST segment elevated

**First Day**
- Ischemia and injury extend to epicardial surface. Subendocardial muscle dying in area of most severe injury
- R wave amplitude diminishing
- ST elevation more marked

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Acute Antero-septal MI

ST elevations
V1-V4
Q waves
Terminal R wave
RBBB

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Let’s interpret this EKG
Anterolateral STEMI

1. ST elevation leads V1-V4
2. Q waves in V1-V2
3. Subtle ST elevation in I, aVL, & V5 with Reciprocal Depression in lead III
4. Hyperacute (peaked T waves in V2-V4
Any Questions?
References


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