12 Lead ECG Interpretation

Significant increase in mortality for every 15 minutes of delay!

Who should get a 12-lead ECG?

- Chest pain
- Atypical chest pain
- Epigastric pain
- Back, neck, jaw, or arm pain without chest pain
- Palpitations
- Syncope or near syncope
- Pulmonary edema
- Exertional dyspnea
- Weakness
- Diaphoresis unexplained by ambient temperature
- Feeling of anxiety or impending doom
- Suspected diabetic ketoacidosis

Also include patients who are successfully resuscitated from cardiac arrest!
12 Lead ECG

- Provides spatial information or 3D look at the hearts electrical activity
- Each of the 12 leads represents a particular orientation in space in a frontal plane using limb leads and a horizontal plane using precordial leads

Views from the 12-lead ECG

- Inferior — right wall of heart closest to sternum
- Anterior — front wall of heart closest to rib cage
- Lateral — left wall of heart closest to left chest wall
- Posterior — posterior wall closest to inferior vena cava

Frontal Plane Leads
ECG Limb Leads

ECG Augmented Limb Leads

I  II  III

aVR  aVL  aVF
Views From Horizontal Plane

Frontal Plane shows Limb Leads I, II, III, AVR, AVL and AVF
Horizontal Plane shows Precordial Leads V1 – V6
Precordial Lead Placement

- **Right Ventricle**
  - V1 - 4th intercostal space R of sternum
  - V2 - 4th intercostal space L of sternum
- **Interventricular Septum**
  - V3 - ½ way btwn V2, V4
  - V4 - 5th intercostal space midclavicular line
- **Left Ventricle**
  - V5 - 5th intercostal space anterior axillary line
  - V6 - 5th intercostal space mid axillary line

Provide Proper Skin Preparation

- Clip excess hair at ECG electrode site as needed
- Wash the isolated electrode area with soap and water, perform CHG bath and allow to dry.
- Use a dry washcloth or gauze to roughen the area of the skin where the electrode will lay
  - Do not use alcohol wipes to prep skin at electrode site.

Proper ECG skin prep & placement = better conduction and fewer false alarms
Right Chest EKG

15 – Lead EKG

18 – Lead EKG

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Lead Views

- I, AVR V1 V4 • I, AVL – Lateral wall of LV
- II, AVL V2 V5 • II, III, AVF – Inferior, Posterior of LV
- III, AVF V3 V6 • V1, V2 – Septal wall of LV
- V3, V4 – Anterior wall of LV
- V5, V6 – Lateral wall, Apex of LV

12 Lead Layout

Most 12 Leads have this common layout
OK Now What?

Systematic Approach: Overall Survey

• Look for ST elevation
• Identify in which leads it is seen
• Check R-R interval, is rhythm regular?
• Is there a P wave in front of every QRS Complex and upright in Lead II?
• What is the atrial rate? Ventricular rate?
• Identify rhythm
• Examine limb leads I, II, III.
  — Each lead should have flat ST segments and upright T waves and no Q waves
• R waves should progress in V1-V5 then get smaller in V6

Gradual R Wave Progression in Precordial Leads

NORMAL R WAVE PROGRESSION

R wave height gradually increases to approximately V4 and then decreases.
12 Lead ECG Analysis

• Observe for ST elevation and T wave inversion in Lead Sets
  – Anterior Lead Set – V3, V4
  – Inferior Lead Set – II, III, AVF
  – Lateral Lead Set – I, AVL, V5, V6
  – Septal Lead Set – V1, V2
  – Posterior Lead Set – V5, V6

ST segment and the T wave

• ST segment
  – After DEpolarization, before REPolarization
  – If depressed, may signify ISCHEMIA
  – If elevated, may signify INJURY or INFARCTION

• T wave
  – REPolarization of the RV and LV
  – May become INVERTED with ischemia

- Locate the J-Point
- Compare it to the TP Segment
- Determine if the J-Point is elevated by 1 mm or more above the TP Segment
Clues to Diagnoses Obtained From 12 Lead ECG

- **Angina**
  - T wave and ST segment changes

- **Myocardial infarction**
  - Myocardium deprived of oxygen reflects ischemia, injury, infarction
  - Q wave and non-Q wave

- **Bundle-branch block**
  - RBBB occurs with anterior wall MI, CAD, and pulmonary embolism
  - LBBB usually caused by hypertension, aortic stenosis, degenerative changes of CAD
  - LBBB occurring with Ant. MI usually requires a pacemaker
Locating Myocardial Damage

- **Anterior wall** supplied by LAD
  - look for ECG changes in leads V1-V4
- **Septal wall** supplied by LAD
- **Lateral wall** supplied by left circumflex
  - look in leads V5, V6 and AVL
- **Inferior wall** supplied by RCA
  - look for ECG changes in leads II, III, and AVF
- **Posterior wall** supplied by both RCA and left circ.
  - look for mirror image changes to anterior in V1-V4 (i.e. ST depression and dominant R-wave).

Right Coronary Artery

- Supply oxygenated blood direct from root of aorta during diastole
- Supply epicardial layer and then pass deeper into endocardium
- RCA “marginals”
  - RA & RV
  - Inferior wall LV
  - Interventricular septum
  - SA node (55%)
  - AV node (90%)

Left Coronary Artery

- LMCA “widowmaker”
  - divides into LAD & Circumflex
- LAD “diagonal & septals”
  - anterior & apex of LV
  - interventricular septum
  - Bundle of His and Bundle Branches
- Circumflex
  - LA
  - Lateral & posterior wall of LV
  - SA node (45%)
  - AV node (10%)
Posterior Branches

- **Post Descending**
  - branches off RCA
  - supplies posterior portion of interventricular septum
  - R posterior wall

- **Circumflex**
  - L posterior wall

Ischemia

- Angina on 12 Lead has many presentations
  - peaked T wave
  - flattened T wave
  - T wave inversion
  - ST segment depression with wave inversion
  - ST depression with T wave without T wave inversion

3 I’s of Myocardial Infarction

- **Zone of Ischemia** outermost area
  - Lack of sufficient oxygen
  - Represented by symmetrical T wave inversion (upside down) and ST depression
  - Reversible with addition of oxygen

- **Zone of Injury** surrounds zone of infarction
  - Stage beyond injury
  - ST segment elevation
  - Reversible process

- **Zone of Infarction**
  - Cell necrosis or death of tissue
  - Look for significant “pathologic” Q waves
  - To be significant, a Q wave must be at least one small box wide or one-third the entire QRS height
  - MI’s with no Q waves are called non-Q wave
Ischemia, Injury and Infarction

- **Ischemia**: Reversible
  - Tall, peaked (a) or inverted (b) T waves
- **Injury**: Reversible
  - Elevated ST segments
- **Infarction**: Irreversible
  - Abnormal Q waves and QRS complexes
  - Tall R waves

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Evolution of Acute MI

- **Ischemia**
- **Injury**
- **Infarction**

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Is ST elevation present in 2 contiguous leads? If so, suspect STEMI
II, III & aVF share a common positive electrode located on the left leg. This view is of the inferior wall of the left ventricle.
**Inferior Myocardial Infarction**

- Look for ST elevation in II, III, AVF
  - Complications include sinus bradycardia, sinus arrest, heart block and PVCs
  - Occurs alone or with lateral wall MI or RV MI

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[ECG Image]

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[Heart Diagram]

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[ECG Image]

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[ECG Image]
Anterior MI

Anterior Myocardial Infarction

- ST elevation in V1 to V4
  - Complications include varying degrees of heart block, ventricular irritability and LV failure
  - Listen to heart sounds for Murmur due to ruptured papillary muscles which supports mitral valve
Lateral MI

Lateral Wall Myocardial Infarction

- ST elevation in I, AVL, V5, V6
  - Causes PVC's and varying degrees of heart block
Posterior MI
Posterior Myocardial Infarction

- Posterior wall changes will be mirrored in the leads opposite the lesion
- Look for tall R waves, ST segment depression and upright T waves
  - Usually accompanies inferior infarction
  - Use posterior ECG to see pathologic Q waves

Bundle Branch Blocks (BBB)

- Sometimes needs to be treated
- Sometimes indicates cardiac disease
- Sometimes little significance & no treatment
- When bundle branches function normally, ventricles contract nearly simultaneously
**Significance of RBBB**

- Occurs fairly commonly in the following:
  - Conditions that affect heart
    - Cardiomyopathy
    - Atrial and ventricular septal defects
    - Anterior MI
    - CAD
  - Conditions that affect lungs
    - Pulmonary embolus
    - Chronic lung disease
  - "Normal" healthy individuals
    - Screening exam still required
    - Deemed to be a “Normal Variant”

**Significance of LBBB**

- Can occur in the following:
  - Dilated cardiomyopathy
  - Hypertrophic cardiomyopathy
  - Hypertension
  - Aortic valve disease
  - Acute MI
  - Coronary artery disease
  - Primary disease of electrical conduction system
  - Other cardiac conditions
  - Occasionally in healthy people

- Triggers a thorough search (not just simple screening) for underlying cardiac problems

**Right bundle branch block**

[Diagram of right bundle branch block]
Left bundle branch block
Differentiating MI Treatments

- **Left Circulation**
  - Anterior Wall
  - Nitrates
  - Preload & Afterload Reduction
  - Fluid Restriction
  - Decrease myocardial oxygen consumption

- **Right Circulation**
  - Inferior/Posterior Wall
  - Decrease myocardial oxygen consumption
  - Optimize contractility while optimizing fluid volume
  - Restrict vasodilatation

Myocardial Muscle Damage

- **Transmural or full thickness injury**
  - ST elevation
  - **Will develop Q wave**

- **Subendocardial or partial thickness injury**
  - ST elevation
  - Will not develop Q wave
  - Many will go on to develop Transmural injury within 6 months
MI with Q waves

Case Study 1

- Mr P, a 44-year-old man, came to the emergency department within 40 minutes of a sudden onset of chest pain 8/10
- VS are HR 82, BP 136/79· O2 sat 92% RA
- A 12-lead ECG is below.
- What should you do next?

Case Study 2

- Mr D was a 49-year-old man came to the emergency department with chest pain accompanied by shortness of breath, nausea, and diaphoresis that had started 30 minutes before he arrived.
- A 12-lead ECG is below
- What should you do next?
Case Study 3

• Mr T was a 52-year-old man with midsternal heaviness and tightness that radiated down both arms and into his neck for last 20 minutes
• VS 159/98, HR 100, RR 24
• A 12-lead ECG is below

![ECG Image]

Case Study

• Your patient arrives via ambulance at 1300. Paramedic reports the patient has c/o chest pain 8/10, BP 80/50, 12 lead ECG done in the field shows ST elevation in leads II, III, and AVF.
• What information is important?
• What other information do you want?
• What is your next action?