A SIMPLE APPROACH TO 12 LEAD ECG INTERPRETATION

Objectives

- Discuss the changes reflected on the 12 Lead ECG with ischemia, injury & infarction
- Review the anatomy of a 12 Lead ECG
- Discuss signs and symptoms associated with inferior, right ventricular & anterior/septal wall myocardial infarctions
- Differentiate left vs. right BBB
Some thoughts on the 12 Lead ECG…

- It is not the “silver bullet” diagnostic
- It gives you a “picture” at a moment in time
- For ongoing ischemia, you should perform serial 12 Lead ECGs for **comparison**
- The standard 12 Lead ECG does not examine the right ventricle or posterior walls
- Poorly examines the lateral wall

Conduction Review
**SA Node “Sinus Node”**

- Dominant pacemaker (60-100 bpm)
- Depolarization flows away from the SA node in many directions
- Intrinsic rate

**AV Node “Atrio-ventricular”**

- The only conducting pathway between the atria & ventricles
- AV valves electrically insulate the ventricles from the atria
- Impulses are sent to the AV node - slowed
- Produces the “PR” interval
- Atria contract
Ventricular conduction

- Bundle of His (40-60 bpm)
- Left & Right Bundle Branch
- Purkinje Fibers (20-40 bpm)

Bedside ECG Monitoring

- 5 Lead system
  Lead V₁ best for:
  - Bundle Branch Blocks
  - Ventricular dysrhythmias

**Limb leads below the rib cage**
ECG Lead Placement

- 4 limb leads
- 6 chest leads
- Views from 2 different planes:
  - Frontal (coronal)
  - Horizontal (transverse)
- 12 different angles

**Standard Limb Leads (Bipolar Leads) Leads I, II, III**

- **Lead I**
  - Left arm positive
  - Right arm negative
- **Lead II**
  - Left leg positive
  - Right arm negative
- **Lead III**
  - Left leg positive
  - Left arm negative
Augmented Limb Leads (Unipolar Leads)  
\( a_{\text{VR}} \), \( a_{\text{VL}} \), \( a_{\text{VF}} \)

Reference point in center of chest – “telephoto lens”

- **\( a_{\text{VR}} \)**
  - Right arm positive

- **\( a_{\text{VL}} \)**
  - Left arm positive

- **\( a_{\text{VF}} \)**
  - “Foot” (left leg) positive
Precordial Leads

Normal 12 Lead ECG
ST Segment

- **ST elevation**: Injury
- **ST elevation ≥ 1 mm (limb leads)** or
- **≥ 2 mm (precordial leads)** and/or **new Left BBB**
  - 2 or more contiguous leads
  - Contiguous: Leads that look at the same anatomical area of the heart

- **ST depression**: Ischemia
- **or T wave inversion**

Q-waves

**Considered pathologic if:**

- **Width > 30 ms (≥ 0.04)**
- **Width ≥ 25% of the height of the R wave**
- **If present in contiguous leads, indicative of myocardial necrosis**
Q waves – myocardial necrosis

- May or may not be present

12 Lead ECG Review
### 12 Lead Review

#### Location Change in lead:
- **Inferior**: II, III, aVF
- **Septal**: V₁ - V₂
- **Anterior**: V₃ - V₄
- **Lateral**: I, aVL, V₅ - V₆
- **Posterior**: Posterior leads: V₇ - V₉
- **Right ventricle**: V₁ or V₂R-V₄R

#### Reciprocal changes in lead (ST Depression):
- **Inferior**: I, aVL
- **Septal**: II, III, aVF
- **Anterior**: II, III, aVF
- **Lateral**: L circumflex
- **Posterior**: V₁₋₃
- **Right ventricle**: 

#### Artery affected:
- **Inferior**: RCA in 65%
- **Septal**: L circumflex
- **Anterior**: LAD/L main
- **Lateral**: L circumflex
- **Posterior**: L circumflex
- **Right ventricle**: Proximal RCA

#### Notes:
- **Right sided ECG assess V₂R-V₄R**
- **Tall upright R wave in V₁ – V₃**

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**Case studies in ACS & 12 Lead ECGs**

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Coronary Artery Perfusion

Posterior Wall

Inferior Wall

Lateral Wall

Septal & Anterior Wall

12 Lead ECG Practice

□ Normal 12 Lead ECG
What’s your interpretation???

- Anterolateral wall MI – Left main occlusion

What’s your interpretation???

- Inferior wall MI – Right Coronary Artery
What’s your interpretation???

- Acute Anterior/Septal Wall MI – Proximal LAD occlusion

What’s your interpretation???

- Acute Inferior Wall MI – Right Coronary occlusion
Anything else look different?

- 67 yo female, L vent systolic dysfunction, c/o CP, N/V, diaphoresis, blurred vision. On diuretics, ACE Inhibitor, Imdur. S/P 3V CABG. EF 23%

What’s your interpretation???

- Acute Anterior Wall MI – Left Anterior Descending occlusion
What’s your interpretation???

- Acute anterolateral wall MI – Left main
**STEMI**

- **ST elevation**
  - ≥1mm (inferior) or
  - ≥2 mm (anterior) and/or new Left BBB
- **Hallmark signs** Chest pain > 20min. SOB, diaphoresis
- + Cardiac biomarkers
- Complete occlusion
- **Treatment:**
  - Aspirin
  - Nitroglycerin 0.4 mg SL x 3
  - Reperfusion - PCI or fibrinolytics
Case #1

- 64 y.o. male patient is admitted to the ICU s/p resuscitation from a primary ventricular fibrillation arrest
- Mechanically vented & receiving cooling therapy post arrest
- Temperature 33.6°C
- VS: HR 80s, BP 90-100s/50s-60s, O₂ sat 95%

12 Lead ECG 3 hours post arrest
Case #1 continued…

- 64 y.o. male patient is admitted to the ICU s/p resuscitation from a primary ventricular fibrillation arrest.
- Vented & receiving cooling therapy post arrest
- VS: HR 80s, BP 90-100s/50s-60s MAP ~65, O₂ sat 95%

- Monitor starts alarming and you notice a change in rhythm and appearance of the QRS complexes

Repeat 12 Lead ECG
### Case #1 Knowledge

**Interpretation of the 12 Lead ECG:**

- A. Acute Inferior wall MI
- B. Acute Lateral wall MI
- C. Acute Posterior wall MI
- D. Acute Anterior wall MI

**The rhythm change is:**

- A. Complete Heart Block
- B. First Degree AV Block
- C. Second Degree Type 1 (Mobitz I)
- D. Second Degree Type 2 (Mobitz II)
**Inferior wall MI symptoms**

- Bradycardia
- AV heart blocks – 1st degree, 2nd degree Type I
  - May need temporary pacer
- Hypotension
- N/V
- Diaphoresis

**Occurs high in the AV node**

Lengthening PR interval

Rarely progresses to CHB

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**Inferior wall MI**

- Changes noted in Leads II, III & AV_F
- If suspected RCA occlusion- Lead III preferred
- *Reciprocal* changes in Leads I & AV_L
- Monitor for RV failure
  - Tachycardia
  - Hypotension
Case #1 Knowledge

What would be the most appropriate action at this time?

- A. Start Nitroglycerin infusion to promote coronary vessel vasodilation
- B. Start rTPA as quickly as possible
- C. Activate a Code Blue response and start chest compressions
- D. Ensure the patient has received aspirin, notify the Cardiologist & activate the cardiac cath lab

Case #1 Knowledge

- Patient was in the cardiac cath lab in < 20 minutes

The patient received a stent to the:

- A. Left anterior descending
- B. Posterior descending
- C. Marginal artery
- D. Right coronary artery
Case #1 Knowledge √

- The patient returns to the ICU & cooling is continued for a total of 24 hours. He wakes up the next evening & follows commands. VSS.

Which of the following medications should be anticipated at discharge?

- A. Aspirin, Plavix, Statin, Beta blocker, ACE Inhibitor
- B. Plavix, Angiotensin Receptor Blocker & CaCh Bl.
- C. Aspirin, diuretics & beta blockers
- D. Aspirin, Plavix & Calcium Channel Blockers

Case #2

- 46 year old female is admitted to your unit with c/o nausea, diaphoresis, back discomfort, & fatigue.
- Initial troponin is 1.3 ng/mL
- Initial 12 Lead ECG is “unremarkable”
- She receives aspirin 325 mg PO, Metoprolol 25 mg PO, Mylanta
- VS: HR 72, BP 106/52 (70), RR 18, T 37.1 C, O₂ sat 97%
- Now c/o discomfort, you get a 12 Lead ECG
12 Lead ECG

- Acute inferior wall MI – next steps? Right sided ECG!!!

Right sided ECG

Key leads are V2R – V4R
Right sided ECG V2R – V4R

- Acute Inferior wall MI – right ventricular wall MI

Credit: http://lifeinthefastlane.com/ecg-library/right-ventricular-infarction/

Case #2 Knowledge

Clinical signs of a worsening right ventricular infarction include:

- A. Bradycardia, hypotension & nausea/vomiting
- B. Bradycardia, S4 heart sound & hypotension
- C. Tachycardia, + JVD & hypotension
- D. Tachycardia, S3 heart sound & hypotension
The cardiac cath lab has been activated. Repeat VS: HR 122, BP 88/46 (60), RR 22, O₂ sat 96%

Priorities for this patient include:
- A. IV fluid bolus
- B. Dobutamine infusion
- C. Lasix 40 mg IV
- D. Nitroglycerin (Tridil) infusion

Which medication should be avoided in a patient with a right ventricular infarction?
- A. IV fluids
- B. Dobutamine
- C. Nitroglycerin
- D. Aspirin & Plavix
Right Ventricular Infarction

Associated with Proximal RCA occlusion & inferior wall MI

Symptoms:
- Tachycardia
- Hypotension
- + JVD (with clear lungs)

Treatment: **IV fluids**
- + Inotrope or IABP

Avoid medications that lower preload:
- Nitrates
- Morphine
- Beta Blockers

Signs of right sided heart failure:
- Jugular venous distention
- Tricuspid regurg
- ↑Central venous pressure
- Hepatojugular reflux
- Peripheral edema
- Hepatomegaly
- Anorexia, N/V
- Ascites
- ↑Liver enzymes
Case #3 - 76 year old male

- Admitted to your unit after c/o chest pain during a colonoscopy.
- PMH: HTN, Type 2 DM, PVD, MI with stent to RCA 3 yrs ago. Meds: BB, ACE-I, statin, ASA
- Currently c/o SOB & mid-sternal chest discomfort. He also has GI/epigastric pressure that was not relieved with an antacid.
- He now rates the pressure 6/10.
- What would you like to do next?

Results of 12 Lead ECG
Case #3 Knowledge √

This 12 Lead ECG is consistent with:

- A. Acute anterior wall MI
- B. Acute inferior wall MI
- C. ST segment depression & + enzymes = NSTEMI
- D. Normal ECG

Case #3 continued

- Troponin level is: 3.2
- NSTEMI
- He is complaining of worsening SOB

Repeat VS:
- HR 108
- BP 94/46 (58)
- RR 28
- O₂ sat 91%
- S3 heart sound, crackles bilaterally

- Should he go to the cath lab?
- TIMI Risk Score

**TIMI Risk Score Table**

<table>
<thead>
<tr>
<th>Historical</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥ 65</td>
<td>1</td>
</tr>
<tr>
<td>≥ 3 CAD risk factors (FH, HTN, ↑ chol, DM)</td>
<td>1</td>
</tr>
<tr>
<td>KnownCAD (stenosis ≥ 50%)</td>
<td>1</td>
</tr>
<tr>
<td>ASA use in past 7 days</td>
<td>1</td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
</tr>
<tr>
<td>Recent (≤24h) severe angina</td>
<td>1</td>
</tr>
<tr>
<td>↑ cardiac markers</td>
<td>1</td>
</tr>
<tr>
<td>ST deviation ≥ 0.05 mV</td>
<td>1</td>
</tr>
</tbody>
</table>

Risk Score = Total Points (0-7)
Case #3 continued

Which discharge meds do you anticipate the patient will be prescribed?

- Aspirin
- Plavix, Effient or Brilinta
- Beta blocker
- Statin
- Possibly long acting nitrate
- ACE Inhibitor

Case #4

- 46 year old female Type 1 diabetic presents with c/o shortness of breath.
- On physical exam is diaphoretic, with S3 heart sounds and poor capillary refill. Extremities appear dusky.
- Labs have been sent (chem panel, CBC, troponins, HgbA1C, coags)
- Called for portable chest x-ray
- VS: HR 122, BP 94/46 (62), RR 32, O2 sat 90%
- You hear audible crackles
Case #4 Knowledge

This patient is experiencing an acute:
- A. Inferior/Right ventricular wall MI
- B. Inferior/Lateral wall MI
- C. Inferior/Posterior wall MI
- D. Anterolateral wall MI

Anterior/Septal MI

- Changes noted in $V_1 - V_4$
- Reciprocal changes in II, III, AVF
- Loss of R wave progression
- Culprit vessel: LAD/Left main
- Symptoms:
  - Left ventricular failure, shock
- Monitor for:
  - Heart failure
  - Heart block (2nd degree Type 2, CHB)
  - Bundle branch block
  - Loud murmur → suspect ventricular septal rupture
Anterior Wall ECG changes

- Occurs below the AV node
- Can progress to CHB
- Constant PR interval
- 2:1 difficult to diagnose
- Place a transcutaneous pacer
- Prepare for transvenous pacer

Complete heart block/Third degree AV Block

- No atrial impulses pass through the AV node
- Ventricles generate their own rhythm

Case #4 next steps...

- Cardiac catheterization lab activated
- Furosemide 40 mg IV administered
- Aspirin

- VS: HR 90, BP 96/54 (68), RR 32, O2 sat 90%

- Stent placed to the:
- Left main!!!
Case #5

- Inferior/posterior MI – perform posterior ECG

Case #5 Knowledge

The results of the 12 Lead ECG reveal:

- A. Anterior wall infarction
- B. Lateral wall infarction
- C. Inferior wall infarction
- D. Posterior wall infarction
Case #5 Knowledge √

Which vessel is likely the culprit?

- A. Left anterior descending
- B. Right coronary artery
- C. Marginal artery
- D. Circumflex artery

Posterior ECG

Assess posterior leads V₇ – V₉ for ST elevation
Posterior

- Changes in $V_1$-$V_2$
- Tall, broad R wave (>0.04) & ST depression (reciprocal change)
- Posterior leads $V_7$ - $V_9$
- Associated with inferior/lateral wall MI
- Occlusion of RCA or left circumflex
OTHER INTERESTING CASES IN ACUTE CORONARY SYNDROME

Case #6

- Patient presents c/o stabbing chest pain that is worse with inspiration. The pain is better when they sit up & lean forward.
- Had a MI 2 weeks ago, this pain started 3 days ago.
- Ibuprofen is the only medication that decreased the pain level.
What’s your interpretation?

This patient is likely experiencing:

- A. Acute anterior wall MI
- B. Acute pericarditis
- C. Acute lateral wall MI
- D. Acute decompensated heart failure
Pericarditis

- Inflammation of the pericardial sac
- Acute or chronic
- Chest pain – sharp, stabbing, or dull & achy
  - Pain improved when sit-up, lean forward
  - Left sided radiation
  - Pain worse with cough, positional changes & inspiration
- Pericardial friction rub
- Treatment:
  - NSAIDS – high dose Ibuprofen
  - Antibiotic if bacterial, antifungal if fungus

Case #7

- 59 y.o. male presents to the ED with “palpitations” and severe mid-sternal chest pain
- PMH: HTN, Chronic renal insufficiency, drug abuse

- Currently rates pain 10/10
- 12 Lead ECG
Case studies in ACS & 12 Lead ECGs
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Initial 12 Lead ECG Case #7

Case #7 continued…

- What would you like to do?
- Activated the cardiac cath lab
- Aspirin 325 mg PO
- Nitroglycerin 0.4 mg SL q 5 min x3
- Beta blocker?
Case #7 continued

- Chest compressions started
- Defibrillated with 200 joules
- Continued the cath & his coronaries were “clean”
- Severe vasospasm of the RCA
- Intra-coronary NTG
- Started on Calcium channel blocker
Intra-Coronary Nitroglycerin

What looks different?
58 year old missed dialysis
K+ 8.2

On dialysis – K+ 6.1
Bundle Branch Blocks

Left or right BBB?
Left or right BBB?
Left or right BBB?
Left or right BBB?

In conclusion...

- I hope this helped!
- The 12 Lead ECG is not perfect
- Use older 12 Leads as a comparison
- Consider monitoring patients in Lead III with ACS vs. Lead II
- Use multi-leads in the setting of inferior Mls/ischemia or with V1 – V2 changes