#4: 81 yo woman with SOB, orthopnea, and edema
#4: LBBB with AMI
Acute Myocardial Infarction

- Who gets acute reperfusion therapy for presumed STEMI?
Acute Myocardial Infarction

• Who gets acute reperfusion therapy for presumed STEMI?
  – Concerning symptoms AND
  – ECG:
    • 1 mm STE in contiguous leads OR
    • Posterior STEMI OR
    • Presumed new LBBB OR
    • LBBB with Sgarbossa criteria OR
    • [Pacemaker with Sgarbossa criteria]
Who gets acute reperfusion therapy for presumed STEMI?

Concerning symptoms AND

ECG:

- 1 mm STE in contiguous leads OR
- Posterior STEMI OR
- Presumed new LBBB OR [ACC/AHA 2013]
- LBBB with Sgarbossa criteria OR
- [Pacemaker with Sgarbossa criteria]
Normal LBBB

Rule of appropriate discordance
(true for pacemakers also)
AMI in LBBB
Sgarbossa, et al. NEJM 1996

A -- Concordant ST elevation $\geq$ 1 mm in any lead (very specific)
B -- Concordant ST depression $\geq$ 1 mm in $V_1$, $V_2$, or $V_3$ (very specific)
C -- Discordant ST elevation $\geq$ 5 mm (less specific)
AMI in LBBB
Sgarbossa, et al. NEJM 1996

A  --  Concordant ST elevation $\geq 1$ mm in any lead (very specific)
B  --  Concordant ST depression $\geq 1$ mm in $V_1$, $V_2$, or $V_3$ (very specific)
C  --  Discordant ST elevation $\geq 5$ mm (less specific)
#4: LBBB with AMI
#4: LBBB with AMI
LBBB with AMI
LBBB with AMI

Courtesy Bill Brady, MD
LBBB with AMI
LBBB with AMI
LBBB with AMI
LBBB with AMI
LBBB with AMI
LBBB with AMI
LBBB with AMI

Courtesy Dr. Nicolas Pineda
LBBB with AMI

Courtesy Dr. Nicolas Pineda
85 yo woman with CP

Courtesy Dr. Eric Klotz
85 yo woman with CP

Courtesy Dr. Eric Klotz
Revised Sgarbossa “C”

- Sgarbossa criteria “C” is not specific enough
Revised Sgarbossa “C”

- Maybe the ratio of the ST deviation : size of the QRS is more important
Revised Sgarbossa “C”

Ratio = $\frac{3.2}{-10} = -0.32$

Cai, et al. Amer Heart J 2013
Revised Sgarbossa “C”
(Validation: Am Heart J 2015)

Cai, et al. Amer Heart J 2013

Ratio = 3.2/−10 = −0.32

3.2 mm
−10.0 mm
LBBB, no old ECGs

Courtesy Dr. Paul Jhun
Repeat ECG 20 m later

Sinus bradycardia
Left bundle branch block
Abnormal ECG
No previous ECGs available

BPM 58
Vent. rate 178 ms
PR interval 148 ms
QRS duration

P-R-T axes

12-NOV-1937 (76 yr)
Female
Caucasian
Room: RESUS
Loc: 29
Option: 1
Technician: BOYCE
Test ind:

SID: 82489 EID:       EDT:  ORDER:
Repeat ECG 20 m later

Sinus bradycardia
Left bundle branch block
Abnormal ECG
No previous ECGs available

Referred by: Unconfirmed

BPM: 58
Vent. rate: 178
PR interval: 148
QRS duration: 82
P-R-T axes

12-NOV-1937 (76 yr)
Female
Caucasian
Room: RESUS
Loc: 29
Option: 1

Technician: BOYCE
Test ind:
Repeat ECG 20 m later

S wave = 16 mm
Repeat ECG 20 m later

ST deviation = 5 mm
S wave = 16 mm

Sinus bradycardia
Left bundle branch block
Abnormal ECG
No previous ECGs available

BPM
58

Vent. rate
178 ms

PR interval
148 ms

QRS duration
480/471 ms
142
8
82

P-R-T axes
Repeat ECG 20 m later

ST deviation > 25% of the size of the S wave (5/16 > 25%)

ST deviation = 5 mm

S wave = 16 mm
Case

- Cath lab activated
Case

- Cath lab activated
  - Mid LAD 100% occluded, 1\textsuperscript{st} diagonal 40% blocked
  - Aspiration thrombectomy performed + stent placed
  - Initial TN was mildly positive already
  - Outcome: low EF (33%) but otherwise did well
LBBB...anything more?

 Courtesy Dr. Kristin McKee
LBBB...anything more?

Courtesy Dr. Kristin McKee
LBBB...anything more?

Is the ST:S > 25%?
LBBB...anything more?

S wave = 20 mm
LBBB...anything more?

ST deviation = 9 mm

S wave = 20 mm
LBBB...anything more?

ST deviation > 25% of the size of the S wave (9/20 > 25%)

ST deviation = 9 mm

S wave = 20 mm
Suspected AMI with LBBB

- Hemodynamic instability or acute heart failure
  - Yes
  - No

- Sgarbossa concordance
  - Yes
  - No

  ST/S ratio ≥ 25%
  - Yes
  - No

  Serial ECGs
  Serial troponin
  Bedside echocardiogram
  Normal
  Abnormal

Primary PCI or fibrinolytics
Coronary angiography
Non-invasive evaluation

(Sgarbossa “A” or “B” criteria)
(Revised Sgarbossa “C” criteria)
Normal (AV Sequential) Pacemaker
Pacemaker with AMI
38 yo woman with chest pain, Sgarbossa A

Courtesy Dr. Jim Campagna (New York)
90 yo man with chest pain, Sgarbossa B

Courtesy Dr. Nicolina Andersson (Sweden)
Sgarbossa C

Courtesy Dr. Patrick Bruss (Ohio)
76 yo man with decre. LOC + hypotension

Courtesy Dr. Santiago Harris
76 yo man with decre. LOC + hypotension

Courtesy Dr. Santiago Harris
Uncomplicated RBBB
RBBB with acute antero-lat MI (old inferior MI)
RBBB with acute antero-lateral MI
ILLITERATE?
WRITE FOR FREE HELP.

ILLITERACY FOUNDATION
806 MAIN STREET

www.StrangeCosmos.com
BRANXTON LIONS CLUB

DRIVE CAREFULLY
60

We have

TWO CEMETERIES

NO HOSPITAL
Please... NEUTER YOUR PETS AND WEIRD FRIENDS & RELATIVES
#5: 43 yo woman with chest pain and diaphoresis
#5: Isolated PMI
Anteroseptal ischemia?

- ST depression in anteroseptal leads
  - Anteroseptal ischemia
  - Posterior STEMI
  - Miscellaneous
    - RBBB
    - Hypokalemia
    - Etc.
Anteroseptal ischemia?

- ST depression in anteroseptal leads
  - Anteroseptal ischemia
  - Posterior STEMI
  - Miscellaneous
    - RBBB
    - Hypokalemia
    - Etc.
Posterior Myocardial Infarction

- ECG changes
  - Usually associated with inferior MI due to RCA or circumflex occlusion
  - 4% of STEMI are isolated PMIs
  - Increased M&M compared to isolated IMI
  - Mirror image of septal MI in leads V1-V3
    - large R-waves (instead of Qs)
    - STD (instead of STE)
    - upright T-waves (instead of inversions)
Posterior Myocardial Infarction

**ECG Changes in Leads V1-V3**

<table>
<thead>
<tr>
<th>Septal MI</th>
<th>STE</th>
<th>Inverted Ts</th>
<th>Qs develop over hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior MI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Posterior Myocardial Infarction

**ECG Changes in Leads V1-V3**

<table>
<thead>
<tr>
<th>MI Type</th>
<th>STE/STD</th>
<th>Ts/As</th>
<th>Rs/Overshoots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal MI</td>
<td>STE</td>
<td>Inverted Ts</td>
<td>Qs develop over hours</td>
</tr>
<tr>
<td>Posterior MI</td>
<td>STD</td>
<td>Upright Ts</td>
<td>Tall Rs develop over hours</td>
</tr>
</tbody>
</table>
Inferior-posterior MI
Inferior-posterior MI (after 2 hours)
43 yo woman with chest pain and diaphoresis
Isolated PMI
Isolated PMI

 Courtesy Bill Brady, MD
Isolated PMI — Posterior Leads
Isolated PMI — Posterior Leads
Isolated PMI — Posterior Leads

Courtesy Bill Brady, MD
Anteroseptal ischemia...??
Isolated PMI — Posterior Leads
Anteroseptal ischemia?
Early PLMI — Posterior Leads (V3-V6)
Anteroseptal ischemia?
Early PMI
Computer: “Possible anterior subendocardial injury”
PMI: V1-5 wrapped around left mid-back
78 yo man with syncope

Courtesy Dr. Amitava Mukhopadhyay
Case

• 15 minutes after arrival → VTach

Courtesy Dr. Amitava Mukhopadhyay
Case

- 15 minutes after arrival → VTach
- Then cardiac arrest

Courtesy Dr. Amitava Mukhopadhyay
Case

- Resuscitation attempts successful
- Went to cath lab

Courtesy Dr. Amitava Mukhopadhyay
Case

- Resuscitation attempts successful
- Went to cath lab → successful PCI
  - 100% RCA, 50% left Cx lesions

Courtesy Dr. Amitava Mukhopadhyay
85 yo with anterior ischemia vs. posterior STEMI?

Name: 12-Lead 1
ID: 091215045828
Date: 9/12/2015
Time: 05:04:00
HR: 94bpm

- Abnormal ECG **Unconfirmed**
- Sinus rhythm with PACs
- Widespread ST-T abnormality may be due to myocardial ischemia

Age: 85
Sex: M
P-QRS-T Axes: -14° 71° -90°

V1 | V4
---|---
| |

V2 | V5
---|---
| |

V3 | V6
---|---
| |
Posterior leads → no STE therefore “anterior ischemia”
What about the “flip test?”
What about the "flip test?"

- Abnormal ECG **Unconfirmed**
- Sinus rhythm with PACs
- Widespread ST-T abnormality may be due to myocardial ischemia

| Name: 12-Lead 1 | HR 94bpm          |  | Abnormal ECG **Unconfirmed** |
| Patient ID: 091215045828 | 9/12/2015 | 05:04:00 | Sinus rhythm with PACs |
| Incident ID: | PR 0.170s | QRS 0.104s | Widespread ST-T abnormality may be due to myocardial ischemia |
| Age: 85 | P-QRS-T Axes: | | |
| Sex: M | V1 | V4 |
| | V2 | V5 |
| | V3 | V6 |

x1.0 0.05-150Hz 25mm/sec

MEDIC 15 BCFD 3306808-006 LP1541443397
What about the "flip test?"
WHOEVER IS PRAYING
FOR SNOW
PLEASE STOP
#6: 84 yo man with chest pain and syncope
#6: Would you activate the cath lab for this ECG?
#6: 84 yo man with chest pain and syncope
#6: ACS with LMCA Stenosis
Normal ECG
aVR — The Forgotten 12th Lead

- STE in lead aVR in the patient with other ischemic findings on ECG is bad!
aVR — The Forgotten 12th Lead

- Important points about STE in aVR
  - Worry about major coronary occlusion if...
  - Patients are actively having symptoms and typically look sick
  - STE > 1-1.5 mm
  - ST depressions are noted in other multiple other leads as well
aVR — The Forgotten 12th Lead

- DDx for STE in aVR (with other STDs)
  - ACS: LMCO, triple vessel disease, prox LAD
DDx for STE in aVR (with other STDs)
- ACS: LMCO, triple vessel disease, prox LAD
- Any other causes of global cardiac ischemia
- TAD, severe anemia, early post-arrest (w/i 15 min of EPI or shocks)
aVR — The Forgotten 12th Lead

- DDx for STE in aVR (with other STDs)
  - ACS: LMCO, triple vessel disease, prox LAD
  - Any other causes of global cardiac ischemia
- TAD, severe anemia, early post-arrest (w/i 15 min of EPI or shocks)
  - Massive PE
  - LVH with strain, esp. with severe htn
  - LBBB, pacers
  - SVTs (esp. AVRT)
  - Severe hypoK+
  - Sodium channel pathology (incl. TCAs, hyperK+, Brugada, etc.)
aVR — The Forgotten 12th Lead

- What literature?
aVR — The Forgotten 12th Lead

• What literature?
  – Google “aVR-the forgotten 12th lead”
  – Rokos, Am Heart J, Dec 2010
  • Indications for appropriate cath lab activation
aVR — The Forgotten 12th Lead

• What literature?
  – Nikus, J Electrocardiology, 2008
  – Kosuge, Am J Cardiol, 2011 (clopidogrel)
  – Taglieri, Am J Cardiol, 2011 (clopidogrel)
aVR — The Forgotten 12th Lead

• What literature?
    • Electrocardiographic classification of acute coronary syndromes: a review by a committee of the International Society for Holter and Non-Invasive Electrocardiology
    • (pages 93, 97-98)
aVR — The Forgotten 12th Lead

• What literature?
    • Report of the third International Society for Holter and Non-invasive Electrocardiology working group on improved electrocardiographic criteria for acute and chronic ischemic heart disease
    • (page 85)
aVR — The Forgotten 12th Lead

- What literature?
  - Wagner, Macfarlane, Wellens, etc., Circulation and JACC, 2009
    - AHA/ACCF/HRS Recommendations for the Standardization and Interpretation of the ECG: Part VI: Acute Ischemia/Infarction: A Scientific Statement From...
    - (Circ → page e266; JACC → p1007)
aVR — The Forgotten 12\textsuperscript{th} Lead

- What literature?
  - Kosuge, et al., JACC, 2015
    - Discussed STE in aVR in TAD
    - aVR reflects "global subendocardial ischemia of the LV, often associated with left main or 3-vessel disease."
aVR — The Forgotten 12th Lead

- Must be used in the correct patient!
Some literature...

- 70% mortality without immediate PCI
- Medical therapy (including lytics) does not improve mortality
- Emergent PCI may decrease mortality to 40%
  - Time delay to PCI is the only predictor of survival
- Immediate transfer for PCI if necessary!
45 yo man with chest pain, dyspnea, and diaphoresis
AMI with Proximal LAD/LMCA Stenosis
AMI with LMCA Stenosis
AMI with LMCA Stenosis
ACS with LMCA Stenosis
ACS with LMCA Stenosis
ACS with LMCA Stenosis

[Graph showing an electrocardiogram (ECG) with annotations for I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6.]
ACS with LMCA Stenosis
ACS with LMCA Stenosis

Courtesy Chris Touzeau
76 yo man with chest pain... died within 30 min

Courtesy Chuck Worrilow, MD
58 yo woman with chest pain...died in cath lab

Courtesy Devang Patel, MD
58 yo man with chest pain...CL activation

Courtesy Dr. Joe Young
95% LM, 90% prox LAD, 80% left circ →

Courtesy Dr. Joe Young
80 yo man with CP

Courtesy Dr. Yen Chow
LMCA and multivessel disease → CABG

Courtesy Dr. Yen Chow
Case

• Courtesy Adam St. Pierre
  – Paramedic, firefighter
  – Westbrook, Maine

• 75 yo W with CP, weakness at PMD’s office → 911 called
  – ECG...
Case

- Patient received ASA, NTG
- EMS convinced patient they need to go to hospital with cath facility
- Contacted ED, cath lab activation based on STE in aVR + diffuse ST depressions
- Cardiology agreed with activation
Case

- Cath $\rightarrow$ near-total LMCA occlusion
- Patient needed CABG
70 yo man with palpitations...?
SVT, VR 200
Patient with atyp CP, 240/140
190/100
LVH with strain vs. LMCA stenosis; severe htn
29 yo W with anorexia, severely dehydrated, K⁺ 1.7 mEq/L

Courtesy Steve Hammond
aVR — The Forgotten 12th Lead

- Important points about STE in aVR
  - Patients are actively having ACS symptoms and typically look sick
  - STE > 1-1.5 mm
  - Consider other causes in the DDx
  - Indicative of severe generalized ischemia
    - In ACS: LMCA, triple vessel disease, prox. LAD
    - Increasing support to incorporate this into CLA criteria
Important points about STE in aVR

Baseline ECG abnormalities other than LBBB (eg, paced rhythm, LV hypertrophy, Brugada syndrome) may obscure interpretation. In addition, ST depression in ≥2 precordial leads (V1–V4) may indicate transmural posterior injury; multilead ST depression with coexistent ST elevation in lead aVR has been described in patients with left main or proximal left anterior descending artery occlusion.

2013 ACC/AHA STEMI Guidelines, p. e367
Table 4. Indications for Fibrinolytic Therapy When There Is a >120-Minute Delay From FMC to Primary PCI (Figure 2)

<table>
<thead>
<tr>
<th>Indication</th>
<th>COR</th>
<th>LOE</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic symptoms &lt;12 h</td>
<td>I</td>
<td>A</td>
<td>81, 306–311</td>
</tr>
<tr>
<td>Evidence of ongoing ischemia 12 to 24 h after symptom onset, and a large area of myocardium at risk or hemodynamic instability</td>
<td>IIa</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td>ST depression except if true posterior (inferobasal) MI suspected or when associated with ST-elevation in lead aVR</td>
<td>III: Harm</td>
<td>B</td>
<td>10, 11, 81, 312, 313</td>
</tr>
</tbody>
</table>

COR indicates Class of Recommendation; FMC, first medical contact; LOE, Level of Evidence; MI, myocardial infarction; N/A, not available; and PCI, percutaneous coronary intervention.

PCI cannot be performed within 120 minutes of FMC. (Level of Evidence: A)

Class IIa

1. In the absence of contraindications and when PCI is not available, fibrinolysis therapy is reasonable for patients with STEMI if there is clinical and/or ECG evidence of ongoing ischemia within 12 to 24 hours of symptom onset and a large area of myocardium at risk or hemodynamic instability. (Level of Evidence: C)

Class III: Harm

1. Fibrinolytic therapy should not be administered to patients with ST depression except when a true posterior (inferobasal) MI is suspected or when associated with ST elevation in lead aVR. (Level of Evidence: B)

AMI (Harmonizing Outcomes with Revascularization and Stents in Acute Myocardial Infarction) trial, the writing committee considered heparin to be in combination with oral
FOR HELP
1. Push RED BUTTON
2. Or YELL
EXECUTION CHAMBER CLOSED FOR SAFETY REASONS