ECG & STEMI Education made easy
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Travis Spier
* No financial disclosures
What are we looking for?
How can we find it?

Diagnostic Interpretation

* EMS Clinician Interpretation
* Device Interpretation
* Transmission by EMS to a hospital
* Device analysis with EMS feedback

References and Resources
Coronary Arteries

- Aorta
- Right coronary artery
- Right marginal branch
- Left main coronary artery
- Left circumflex branch
- Left anterior descending branch
Right Coronary Artery:
- 55% SA Node, Internodal Pathways, Right Atrium, 90% AV Node, Inferior Wall, Posterior Wall, 1/3 Posterior Septum, ½ Posterior Fasicle LBB

Left Anterior Descending Coronary Artery:
- Left Anterior Wall, Bundle of His, Bundle Branch, Ant. Fasicle LBB, 2/3 Septum

Left Circumflex Coronary Artery:
- Left Atrium, Lateral Wall, Posterior Wall, 45% SA Node, 1/2 Posterior Fasicle LBB
Conductive System of the Heart

- Sinoatrial (SA) Node
- Internodal Pathways
- Atrioventricular (AV) Node
- Bundle of His
- Right Bundle Branch
- Left Bundle Branches
  - L Anterior BB
  - L Posterior BB
- Purkinje Fibers
Ideal STEMI System of Care
Onset of CP
Call 911
EMS Response
ECG by EMS
EMS Transport
ED arrival
Hosp ECG
Dx ECG
Consult
Lytic
Tx out

Approximate Total Time: 610 minutes
Onset of CP
Call 911
EMS response
ECG by EMS
Dx of ECG
Consult
EMS transport
ED Arrival
Hosp ECG Dx
Lytic
Tx Out

Timeline w/o
2 hr+  5m  15m  10m  25m  15m  5m  30m  30m  15m  180m

Approximate Total Time: 380 minutes
What does EMS look like in the ideal STEMI system of care?

* Before answering that question, it’s important to remember that there is no "one-size-fits-all" answer.
* A city swelling with residents presents different issues than a region where there is more wildlife or livestock than people.
* Providing emergency medical services to someone at the crest of a Colorado mountain poses another set of problems than transporting a STEMI patient from one Hawaiian isle to another for percutaneous coronary intervention (PCI).
  * Through Mission: Lifeline, the American Heart Association provides a set of guidelines that equip STEMI systems of care across the nation to improve timely access to appropriate medical treatment, ultimately saving lives.
  * In the ideal system for EMS and EDs, standardized point of entry protocols (created by state-based coalitions of EMS personnel, emergency physicians and cardiologists, and supported by payers and administrators) would establish which patients are transported to the nearest hospital and which patients are transported to the nearest STEMI-Receiving hospital. This will be based in part on the acquisition, interpretation and transmission of a pre-hospital 12-lead electrocardiogram (ECG).
  * The catheterization laboratory team would be activated by EMS personnel in the field or by emergency physicians after receiving the transmitted ECG. Patients transported to a STEMI Referring hospital by EMS would remain on the stretcher with EMS personnel in attendance until the decision about whether to transport to a STEMI-Receiving hospital is rendered.
  * For patients who transport themselves to a STEMI Referring hospital and require primary PCI, activation of EMS via a 9-1-1 system would occur. An ideal system would also foster a coordinated curriculum to teach EMS providers and ED staff to care for STEMI patients and provide feedback on performance and compliance with guidelines.
The ideal STEMI system of care, standardized point of entry protocols dictate the STEMI patients to be transported directly to a STEMI-receiving (PCI-capable) hospital based on:

- Specific criteria for risk
- Contraindications to fibrinolysis
- The proximity of the nearest PCI service
- Those patients transported by EMS or who arrive via self-transport (or via family or friends) at a STEMI Referring hospital would be treated according to standardized triage and (potential) transfer protocols.

Incentives are provided to rapidly:

- Treat STEMI patients in accordance with American Heart Association and American College of Cardiology guidelines
- Transfer to the STEMI-Receiving hospital for primary PCI using reperfusion checklists, standard pharmacological regimens and order sets, clinical pathways with attention to details such as eliminating continuous intravenous infusions and tubing
- Promote efficient data transfer (using Mission: Lifeline Bridging Form) to the STEMI-Receiving hospital as well as integrate data collection and feedback into the system of care
- Integrate plans for return of the patient to the local community for follow-up care following discharge from the STEMI-Receiving hospital on a routine basis
Role of Receiving Center

* STEMI Receiving hospitals have the expertise, equipment, facilities and other resources to administer percutaneous coronary intervention (PCI), within the STEMI system of care.

* Nonetheless, they still face challenges, and improvements can be made for more seamless interaction with other healthcare providers within the STEMI system.

* Mission: Lifeline helps STEMI-receiving centers leverage the capabilities of emergency medical services (EMS) and non-PCI hospitals for optimum treatment of STEMI patients.

* By working together under a shared set of guidelines and closing communication gaps about patient outcomes, the professionals within a STEMI system of care can save lives and improve the health of the communities they serve.
Hospital Benchmarks

- Door to ECG transmission: 10 minutes – EMS
- Door to diagnosis: ASAP – tele-health
- Door to transfer arrangements diagnosis: ASAP – within minutes of diagnosis
- Door to lytic: 30 minutes
- Door to transfer: 30 minutes
- Hospital data reporting Center partnership: Referral and Receiving
- Receiving center feedback and loop closure Feedback: Hospital and EMS
Intervention plan for EMS

- Out of hospital 12 lead ECG
- EMS ECG Transmission
- Early activation of ALS
- Early notification of hospital
- Rapid diagnosis/decision
- Early transport consideration

Our goal is to decrease the door-to-drug/balloon time.

STEMI care  Door – Data – Decision - Reperfusion
Acute Coronary Syndromes

1. Symptoms suggestive of ischemia or infarction

2. EMS assessment and care and hospital preparation:
   - Monitor, support ABCs. Be prepared to provide CPR and defibrillation
   - Administer aspirin and consider oxygen, nitroglycerin, and morphine if needed
   - Obtain 12-lead ECG; if ST elevation:
     - Notify receiving hospital with transmission or interpretation; note time of onset and first medical contact
   - Notified hospital should mobilize hospital resources to respond to STEMI
   - If considering prehospital fibrinolysis, use fibrinolytic checklist

3. Concurrent ED assessment (<10 minutes)
   - Check vital signs; evaluate oxygen saturation
   - Establish IV access
   - Perform brief, targeted history, physical exam
   - Review/completer fibrinolytic checklist (Figure 2; check contraindications (Table 5)
   - Obtain initial cardiac marker levels, initial electrolyte and coagulation studies
   - Obtain portable chest x-ray (<30 minutes)

4. Immediate ED general treatment
   - If O₂ sat <94%, start oxygen at 4 L/min, titrate
   - Aspirin 160 to 325 mg (if not given by EMS)
   - Nitroglycerin sublingual or spray
   - Morphine IV if discomfort not relieved by nitroglycerin

ECG interpretation
Criteria: ST Elevation Myocardial Infarction with onset of symptoms less than 12 hours

EMS ECG and Transmission: conduct and transmit ECG
Activate Transport: ground or air transport
Notify Receiving Center: activate STEMI Alert
Reperfusion Consideration: Primary PCI or Lytics
Monitor, (Oxygen), IV: (NS) – in left hand/arm if possible
Aspirin: 81mg (give 4 chewable) PO
Nitroglycerine: SL tablets or spray
Decrease all Delays

Initial ECG within 10 minutes of EMS/ED presentation

The current benchmarks for reperfusion therapy

- Door to ECG = 10 minutes or less
- ECG to Decision = 10 minutes or less
- ECG Decision to Transport Arrangements = ASAP
- Door to Drug = 30 minutes
- Door In /Door Out = 30 minutes
- Door to Balloon = 90/120 minutes

The majority of myocardial infarction occurs by 4 hours after onset of symptoms.

After 6 hours the infarct is nearly complete (90%).
Why does it matter???
STEMI Protocol – Time is muscle

* Promotes early activation of STEMI protocol
* Activation of STEMI Protocol before patient arrival
* Provides a guideline to immediately address patients with chest pain
* Guide to clinical management to those patients with STEMI
* Emphasis on reperfusion of the heart
  * PCI or Lytic
    * Where do you go?
Coronary Artery Disease

*Stent* placement - before and after placement, in the first picture you can see the spasm, and restricted blood flow.
Three Percutaneous Coronary Interventions (PCIs)

1. PTCA: Percutaneous Transluminal Coronary Angioplasty
2. PTCA + stent placement
3. Atherectomy: “grinds away” the plaque
Criteria review for administration
Relative contraindications
Absolute contraindications
Simplicity of dosing
  Weight based and reference chart
Mixing and administration technique
TNK Administration

- Remove shield assembly (use red cannula)
- Withdraw 10 mL Sterile water
- Inject sterile water into TNKase vial
- SWIRL GENTLY
- Draw out appropriate dose and recap the red cannula
CHEST PAIN CHECKLIST FOR STEMI FIBRINOLYTIC THERAPY

**Step One:**
Has patient experienced chest discomfort for greater than 15 minutes and less than 12 hours?

- **YES**
- **NO**

**Does ECG show STEMI or new or presumably new LBBB?**

- **YES**
- **NO**

Signs of STEMI or new or presumably new LBBB in the ECG are considered.

**Step Two:**
Are there contraindications to fibrinolysis?

If **ANY** of the following is CHECKED YES, fibrinolysis MAY be contraindicated.

- Systolic BP greater than 180 mm Hg
- Diastolic BP greater than 110 mm Hg
- Right vs. left arm systolic BP difference greater than 15 mm Hg
- History of structural central nervous system disease
- Significant closed head/facial trauma within the previous 3 months
- Recent (within 6 wks) major trauma, surgery (including laser eye surgery), GI/GU bleed
- Bleeding or clotting problem or on blood thinners
- CPR greater than 10 minutes
- Pregnant female
- Serious systemic disease (eg, advanced/terminal cancer, severe liver or kidney disease)

**Step Three:**
Is patient at high risk?

If **ANY** of the following is CHECKED YES, CONSIDER Transport/Transfer to PCI Facility

- Heart rate greater than or equal to 100 bpm AND systolic BP less than 100 mm Hg
- Pulmonary edema (rales)
- Signs of shock (cool, clammy)
- Contraindications to fibrinolytic therapy
Arrhythmias

- Anticipate and be prepared for cardiac arrhythmias
  - On their own – underlying condition
  - Following treatment – lytic administration
- May be managed with standard antiarrhythmic measures.
- Have Hands-Free defibrillation pads in place.
The entire story starts with a piece of paper

Quality Tracing Needed

For Diagnostic Decision
3-Lead ECG vs. 12 lead ECG

Monitor Quality

Cardiac wall monitor

Diagnostic Quality

12 lead ECG Device
Diagnostic Quality

- Produces more accurate ST segments and T waves
- More sensitive to artifact
- **YOU must take steps to improve ECG quality**
  - Hair removal
  - Skin preparation
Skin Prep
Patient Position is Key
Patient Movement

* Make patient as comfortable as possible
  * Supine preferred
  * Check for subtle movement
    * Toe tapping
    * Shivering
* Look for muscle tension
  * Hand grasping rail
  * Head raised to “watch”
Electrical Interference

* Strategies
  * Make sure patient cables do not touch power cords
  * Move away from AC equipment
  * Turn off or remove devices
  * Move away from areas with electrical “noise”
Clear ECG

Things to look for...

- Little or no artifact
- Steady baseline
Precordial Leads (V leads or MCL leads)

- V1 4th intercostal space, right of the sternum
- V2 4th intercostal space, left of the sternum
- V3 between V4 and V2
- V4 5th intercostal space, left, mid-clavicular line
- V5 5th intercostal space, left, anterior axillary line
- V6 5th intercostal space, left, mid-axillary line
- V4R 4\textsuperscript{th} intercostal space, right mid-clavicular line
Normal 12 Lead ECG
Electrical Tracing Views
Unipolar/Bipolar Lead View
Precordial Lead View

Chest Leads
12-Lead ECG

NORMAL SINUS RHYTHM
NORMAL ECG
12-lead ECG
12-Lead ECG

80 milliseconds = 0.08 seconds

Normal Duration Times in the ECG

- Each tiny box = 0.04 seconds
- PR Interval = 0.12 – 0.20
- QRS = 0.06 – 0.11
  QRS 0.12 and greater is extended
ECG Tracing Method
Q wave is the first negative deflection AFTER the P wave and BEFORE the R wave.

A completely negative ‘QRS’ complex is known as a ‘QS’ wave.
Q Wave

Q waves

Physiologic Q waves
- “Normal”
- < .04 sec (40ms)

Pathologic Q waves
- “Abnormal”
- ≥ .04 sec (40 ms)
- 1/3 the size of the R wave
R Waves are any positive deflection from the baseline within the ‘QRS’ complex
S waves are any negative deflection AFTER the R wave within the ‘QRS’ complex
Myocardial Infarction Labels

Non- ST- Elevation MI (NSTEMI) = Non-Q-Wave MI (NQMI)

ST Elevation MI (STEMI) = Q-Wave MI (QMI)

UA = unstable angina
Cardiac Events

Three I’s of an **AMI**

- **Injury** –
  - pathologic Q wave

- **Ischemia** –
  - inverted T wave

- **Infarct** –
  - ST elevation
J-Point
ST Segment
Compare ST segment to the TP segment
Practice

Find Baseline, J-points and ST segments

Is there ST Segment elevation?

NO  YES  YES  NO  YES
Goals

* Recognize and localize AMI on the ECG
* Feel comfortable with 12-lead interpretation
* Be able to intervene with timely decisions
* Reduce delays
AMI recognition

Two things to know:

• What to look for
• Where you are looking

Accurate ECG

Look for:

☐ Negative aVR
☐ One complete cardiac cycle in each lead
☐ Appropriate speed

AMI Recognition

What to look for:

- ST segment elevation
  One millimeter or more (one small box)
  Present in two anatomically similar viewing leads
ECG is Just a Map of a City

Looking at the different neighborhoods
<table>
<thead>
<tr>
<th>Lead Groups</th>
<th>I</th>
<th>aVR</th>
<th>V1</th>
<th>V4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>II</td>
<td>aVL</td>
<td>V2</td>
<td>V5</td>
</tr>
<tr>
<td>Inferior</td>
<td></td>
<td>Lateral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>III</td>
<td>aVF</td>
<td>V3</td>
<td>V6</td>
</tr>
<tr>
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<td></td>
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<td></td>
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</tbody>
</table>

**Limb Leads**

**Chest Leads**
A System for Assessing a 12 Lead

<table>
<thead>
<tr>
<th>I</th>
<th>Inferior Leads II, III, AVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Septal Leads V1, V2</td>
</tr>
<tr>
<td>A</td>
<td>Anterior Leads V3, V4</td>
</tr>
<tr>
<td>L</td>
<td>Lateral Leads V5, V6, I, AVL</td>
</tr>
</tbody>
</table>

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<td>Inferior</td>
<td>aVF</td>
<td>Inferior</td>
<td>Anterior</td>
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The table shows the different leads in a 12-lead ECG system, categorized by their location (inferior, septal, anterior, lateral) and labeled with their respective abbreviations (I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6).
You are the Chief Patrolling the city looking for trouble (ST elevation) in the different neighborhoods.
Inferior Wall

* II, III, aVF
* Left Leg

<table>
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</table>
Lateral Wall

Lateral Wall

I, aVL, V5, V6

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</table>
Lateral Wall MI
Anterior Wall

* V3, V4
* Left anterior chest

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Anterior Wall MI
Septal Wall

- V1, V2
- Along sternal borders

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<th></th>
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Septal Wall MI
AMI Localization

- **Anterior:** V3, V4
- **Septal:** V1, V2
- **Inferior:** II, III, AVF
- **Lateral:** I, AVL, V5, V6
Reciprocal Changes
Reciprocal Changes

II, III, aVF

I, aVL, V leads

Reciprocal changes

- Not necessary to presume infarction
- Strong confirming evidence when present
AMI Recognition

Know what to look for
- ST elevation
- > 1mm
- Two contiguous leads

Know where you are looking
- Use pocket card as a reference
- You will soon have this memorized

A normal 12-lead ECG **DOES NOT** rule out an AMI
Imitators of an infarct
- LVH  - Ventricular beats  - BBB  - Others
SINUS TACHYCARDIA WITH SINUS ARRHYTHMIA
NONSPECIFIC INTRAVENTRICULAR BLOCK
LATERAL INFARCT, AGE UNDETERMINED
INFERIOR INFARCT, AGE UNDETERMINED
ABNORMAL ECG

QT/QTc - 384/620 ms
P-R-T axes -13 248 84

Referred by: Unconfirmed
ATRIAL FIBRILLATION WITH RAPID VENTRICULAR RESPONSE WITH
5 ABERRANT CONDUCTION OR VENTRICULAR PREMATURE COMPLEXES
ABNORMAL LEFT AXIS DEVIATION
LEFT BUNDLE BRANCH BLOCK
1 ABNORMAL ECG
** UNCONFIRMED **
ATRIAL TACHYCARDIA WITH SHORT PR INTERVAL
CANNOT RULE OUT ATRIAL FLUTTER
NONSPECIFIC INTRAVENTRICULAR CONDUCTION BLOCK (130+ MS QRS DURATION)
ANTERIOR INFARCT (40+ MS Q WAVE AND/OR ST/T ABNORMALITY IN V3/V4), AGE UNDETERMINED
INFERIOR INFARCT (40+ MS Q WAVE AND/OR ST/T ABNORMALITY IN II/AVF), AGE UNDETERMINED
ABNORMAL ECG

** UNCONFIRMED **
**AMI Recognition**

*NEVER* make the mistake of presuming that a single 12-lead rules out an MI.

If time allows, repeat the 12-lead in ANY symptomatic patient.
Case Scenario # 1

You receive a phone call from the local EMS provider advising they have just transmitted an ECG to the ED. They have a 15 minute ETA to the ED. Patient is complaining of back and jaw pain for 1 hour. BP 142/92  HR 80  RR 16  SpO2 96%.
You hear a cry for help coming from the front door. You and another staff member quickly run to the front door where you find a female attempting to assist her husband into the hospital. He is diaphoretic and ashen in color. He is weak and having difficulty walking without assistance. He has been having epigastric discomfort for 3 hours unrelieved with antacids. He has had two episodes of vomiting in the past hour.
The ambulance has just arrived with an elderly patient from a local nursing home. The patient was referred to the ED for mild shortness of breath with minimal exertion. She has a history of diabetes and high blood pressure. She has had intermittent complaints of a tooth ache for the past three days.
Practice
Practice
Practice
Practice
Chest Pain Box of Supplies

Contents List for Chest Pain Box

- medications
- order set
- needles
- syringes
- emergency meds
- medication drips
- reference cards
Ongoing Education

- Proposed monthly online education
- PCI supported education
- Cardiac outreach
- Online web based opportunities
- Conferences
- Guest speakers
- Internal on-site education and meetings
- Vendor supported
Receiving Software
Summary

* AMI recognition
  * Know *what* you are looking for
    * 1mm of ST elevation
    * Two contiguous leads
  * Know *where* you are looking
    * Positive electrode as an “eye”
    * Pocket card
Reciprocal changes
  * Not necessary to presume infarction
  * Strong confirming evidence when present
* ST segment elevation is presumptive evidence for AMI

* Other conditions may also cause ST elevation

A normal 12-Lead ECG **DOES NOT** rule out AMI
Questions
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