Benefits of Pre-hospital ECG in Recognition of STEMI

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Disclosures

None
Case

54 year-old male who awoke suddenly at 3 AM with acute, severe sub-sternal chest pain/pressure.

EMS was activated.
Abbreviations

STEMI = ST-Segment Elevation Myocardial Infarction
PCI = Percutaneous Coronary Intervention
D2B = Door-to-balloon
D2N = Door-to-needle
Outline

- STEMI Definition
- D2B Time Associated Mortality
- 12-Lead ECG Interpretation by EMS
- Door-to-Balloon Time Improvement by EMS Diagnosis
- PreACT Algorithm
STEMI Definition
STEMI Definition

New ST segment elevation at the J-point in at least 2 contiguous leads of ≥ 2mm (0.2mV) in men or ≥1.5mm (0.15mV) in women in leads V2-V3 and/or of ≥1mm (0.1mV) in other contiguous leads or the limb leads.
STEMI
STEMI

ECG Results:
- **Rate**: 78
- **PR**: 161
- **QRS**: 151
- **QT**: 338
- **QTc**: 368

**Axis**: 90

**ABNORMAL ECG**

Lead I, aVR, V1-V4, AVL, V5, aVF, V3, V6, II

Unconfirmed Study

Gotta love it!
D2B Time Associated Mortality
Microscopic morphologic changes evolve over time as follows:

**Time from Onset - Microscopic Morphologic Finding**

1 - 3 Hours - Wavy myocardial fibers
2 - 3 Hours - Staining defect with tetrazolium or basic fuchsin dye
4 - 12 Hours - Coagulation necrosis with loss of cross striations, contraction bands, edema, hemorrhage, and early neutrophilic infiltrate
18 - 24 Hours - Continuing coagulation necrosis, pyknosis of nuclei, and marginal contraction bands
24 - 72 Hours - Total loss of nuclei and striations along with heavy neutrophilic infiltrate
3 - 7 Days - Macrophage and mononuclear infiltration begin, fibrovascular response begins
10 - 21 Days - Fibrovascular response with prominent granulation tissue
7 Weeks - Fibrosis
2007-2010 Acute Myocardial Infarction (ICD10 I21 & I22)  
35+ Age-Adjusted Mortality per 100,000  
STEMI Recieving Center Drive Time

Created: 4/1/14
Ischemic Time, Myocardial Salvage and Mortality
Principals

- Quicker D2B times are associated with improved CA patency
- Quicker D2B times are associated with higher rates of TIMI III flow
- Slower D2B times are associated with increased mortality
- Slower D2B times are associated with increased rates of CHF
D2B Time and Mortality

43801 patients
D2B Time and Mortality

\[ Y = 2.86 \pm 1.46 + 0.0045X^1 + 0.000043X^2 \]

\[ p < 0.001 \]

1791 patients
Twelve-Lead ECG Interpretation by EMS
Potential Challenges

- Equipment costs/maintenance
- Training costs
- Accuracy/False-positive rates
Accuracy/False Positive Activations

• 107 paramedics; Written test with 5 chest pain scenarios
• Diagnosis – Sensitivity = 92.6%; Specificity = 85.4%
• Cath Lab activation – Sensitivity = 88%; Specificity = 88.3%; False-positive rate = 8.1%
• STEMI Cases – 94.1% correct dx; 91% appropriate activation
• Non-STEMI Cases – 14.9% called STEMI; 12.0% inappropriate activations
• “Chest pain alert” not different than activating the Cardiac Cath Lab
Real World Performance

- 2014 – 1,933 patients from Los Angeles from 2008–2009 – 7.8% false-positive activations
- 2007 – 1,335 patients from Minneapolis 2003-2006 – 9.2% false-positive activations
- 2012 – 411 patients; 411 STEMI activations by emergency physicians
Real World Performance

..... 36% false-positive activations. What?!!!

Reasons –
1. Structural heart disease
2. CHF
3. LVH
4. Hx of CAD
5. Prior illicit drug use
6. High BMI
7. Angina
Real World Performance

2012 – 2008-2009 in North Carolina
3,973 Cardiac Cath Lab activations (29% by EMS, 71% by emergency physicians)
85% were deemed appropriate with 76.9% receiving PCI
Re-interpretations – 15% (6% of EMS)
Not a CCL candidate – 28%
Delay at the Scene?

- 21,742 patients evaluated for CP in the field
- Scene times increased from 19 min 10s to 19 min 20s with a pre-hospital 12-lead ECG
- Transport time was increased by 12 s
- In STEMI patients, a pre-hospital 12-lead ECG shortened scene time from 19 min 31 s to 17 min 51 s and transport time from 13 min 31 s to 12 min 34 s
D2B Time Improvement with EMS Diagnosis
San Diego

- Consecutive patients from 1/2005 – 6/2006 with field activation were evaluated
- Control group consisted of consecutive STEMI patients who presented to the ED
- D2B times EMS Activation – 73 +/- 19 minutes
- D2B times ER Activation – 141 +/- 49 minutes
- Patients who achieved D2B < 90 minutes = 80% field STEMI, 25% ER STEMI
Before and After - Canada

• 24-month period; 95 patients pre- and 80 patients post-implementation
• E2B was <90 minutes increased from 28.4% to 91.3% post-implementation
• False-positive activation = 12.4%
ACTION Registry

- From 1/2007 – 12/2007 a total of 12,097 STEMI patients were logged
- 7,098 utilized EMS; 1,941 of these patients received a pre-hospital 12-lead ECG
- D2N times were 19 min vs 29 min
- D2B times were 61 min vs 75 min
- Mortality was trending towards significant with an OR of 0.80 (CI 0.63 to 1.01)
Direct Transfer to a PCI Center

• Between 5/2005 – 4/2006, 344 consecutive STEMI patients were enrolled
• 135 directly from the field and 209 from the ERs (transfer)
• Median D2B time for field patients = 69 minutes (43–87 min)
• Median D2B time for ER patients (transfer) = 123 minutes (101–153 min)
• D2B <90 minutes achieved in 79.7% of field patients and 11.9% of ER patients (transfer)
30-Day MACE

Multivariate Analysis (n=267)

<table>
<thead>
<tr>
<th>Predictors 30-day MACE</th>
<th>Univariate Analysis</th>
<th>Multivariate Analysis Pts 30-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age&gt;80 years</td>
<td>2.6</td>
<td>4.9</td>
</tr>
<tr>
<td>Killip Class 4</td>
<td>13.4</td>
<td>18.5</td>
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</table>

<table>
<thead>
<tr>
<th>S2DT (mins)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Quartile 1=77–133</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Quartile 2=134–171</td>
<td>4.8</td>
<td>6.8</td>
</tr>
<tr>
<td>Quartile 3=172–242</td>
<td>9.6</td>
<td>17.6</td>
</tr>
<tr>
<td>Quartile 4=243–1567</td>
<td>7.6</td>
<td>13.9</td>
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</tbody>
</table>
Mortality Improvement?

1,516 STEMI patients

922 patients excluded
- Self-presentation to local ER
- Local residents of New Westminster

167 patients

594 STEMI patients who call 911 outside of New Westminster

427 patients

Pre-hosp. ECG Triage: STEMI

• Digital transmission of ECG to the cath lab (day) or RCH ER (night)
• Diagnosis confirmed
• Cath lab activation by contacting cath lab (day) or Interventionalist (night)

Bypass local hospital and re-direct to RCH for primary PCI

Admission to a local hospital

• ECG: STEMI
• ASA 325mg, clopidogrel 600mg, UFH, GPIIb/IIIa inhibitor

Transfer to RCH for primary PCI

Admit to RCH or repatriate to local hospital
Mortality Improvement?
Mortality Improvement?
A Potential Limit...
D2B Time and Mortality

43801 patients
British Registry
Registry Specifics

- 288,990 total ACS patients from 2005-2009
- Pre-hospital ECG in 145,247
- None in 91,827
- Unknown 51,916
### Registry Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Prehospital ECG (n = 102,831)</th>
<th>No Prehospital ECG (n = 51,715)</th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All Patients</strong></td>
<td>7.4%</td>
<td>8.2%</td>
<td>0.94 (0.91-0.96)</td>
</tr>
<tr>
<td><strong>STEMI Patients</strong></td>
<td>8.6%</td>
<td>11.4%</td>
<td>0.94 (0.90-0.98)</td>
</tr>
<tr>
<td><strong>Reperfused STEMI Patients</strong></td>
<td>7.3%</td>
<td>9.4%</td>
<td>0.94 (0.89-1.00)</td>
</tr>
<tr>
<td><strong>Non-STEMI Patients</strong></td>
<td>5.9%</td>
<td>6.5%</td>
<td>0.84 (0.81-0.88)</td>
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Home Grown Evidence
Mission: Lifeline SD/ND/MN

- From 2012-2015, ACTION-GTWG STEMI patients were reviewed who received PPCI
- 1,101 Interfacility Transfer, 376 Direct Transport
- 1,078 Pre-hospital ECG, 308 w/o pre-hospital ECG
- D2B in DT vs. IT – 79 vs. 145 min.
- Transfer time in PH ECG vs. No ECG – 40 vs. 55 min.
- The DT and PH groups had a statistically significant less risk of in-hospital CGS, CHF, cardiac arrest and death.
Polish Experience
Nationwide Registry

- Direct Transfer patients demonstrated a lower 1-year mortality rate, 9.6% vs. 10.4% for IF Transfer patients.
PreACT
PreACT Algorithm
PreACT Direct Inclusion/Exclusion

• Paramedic confident in STEMI diagnosis
• ER physician and/or cardiologist is confident in the STEMI diagnosis
• Patient ability to consent
• No do not resuscitate
• ECG meets stringent STEMI criteria; QRSd <0.12 ms; No ventricular pacing; No dysrhythmias
• Patient age evaluation (very young versus very old)
• Chest pain <24 hours
• SBP >80 mmHg; HR <130; No significant hypoxia
THANK YOU
1. ACCF/AHA 2013 STEMI Guidelines