The Role of DHMC as an ST Elevation Myocardial Infarction Receiving Center in a Regional STEMI Care Network:

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CREST Symposium
November 7th, 2008
STEMI = Acute Coronary Thrombosis
**STEMI** (ST elevation Myocardial Infarction)

- Relatively common
- Multiple treatment strategy options
- Requires coordination
  - Multidisciplinary
    - EMS
    - Emergency Medicine
    - Cardiology
  - Interhospital
- Must be managed quickly

Time ~ Muscle
Pre-Hospital Delay
The Golden early hours:

Meta-analysis on 50,246 patients in thrombolytic trials

Thrombolytic Therapy is Inferior to PCI for Treating STEMI

23 study systematic review: short-term outcomes

Frequency (%)

<table>
<thead>
<tr>
<th>Event</th>
<th>PCI</th>
<th>Thrombolytic Therapy</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>7</td>
<td>9</td>
<td>0.0002</td>
</tr>
<tr>
<td>Non-fatal reinfarction</td>
<td>3</td>
<td>7</td>
<td>0.0003</td>
</tr>
<tr>
<td>Total stroke</td>
<td>1</td>
<td>2</td>
<td>0.0004</td>
</tr>
<tr>
<td>Recurrent ischemia</td>
<td>6</td>
<td>21</td>
<td>0.0001</td>
</tr>
<tr>
<td>Death, reinfarction, stroke</td>
<td>8</td>
<td>14</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Lancet 2003;361:13-20
Transfer for PCI vs On-site Thrombolytic

5 study systematic review:

Average Transfer Time 39 minutes

<table>
<thead>
<tr>
<th></th>
<th>1(^o) PCI (n=1466)</th>
<th>TTx (n=1443)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>7</td>
<td>9</td>
<td>0.057</td>
</tr>
<tr>
<td>Non-fatal</td>
<td>2</td>
<td>6.9</td>
<td>0.0001</td>
</tr>
<tr>
<td>reinfarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total stroke</td>
<td>1.3</td>
<td>2.5</td>
<td>0.049</td>
</tr>
<tr>
<td>ICH</td>
<td>0</td>
<td>2.45</td>
<td>0.25</td>
</tr>
<tr>
<td>Death,</td>
<td>8</td>
<td>15</td>
<td>0.0001</td>
</tr>
<tr>
<td>reinfarction,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stroke</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lancet 2003;361:13-20
PCI Benefit also time dependent
Mortality benefit with primary PCI as function of PCI-related time delay

Circle sizes = sample size of the individual study.
Solid line = weighted meta-regression.

P = 0.006

62 min

Benefit Favors PCI
Harm Favors Lysis

Nallamothu BK, Bates ER. Am J Cardiol. 2003;92:824-6
STEMI patients presenting to a hospital with PCI capability should be treated with primary PCI within 90 minutes of first medical contact as a systems goal (Level of Evidence: A).

STEMI patients presenting to a hospital without PCI capability and who cannot be transferred to a PCI center and undergo PCI within 90 minutes of first medical contact should be treated with fibrinolytic therapy within 30 minutes of hospital presentation as a systems goal unless contraindicated. (Level of Evidence: B)
Regional STEMI Care Network

**Rationale**

- PCI is > thrombolytic therapy
- Transfer for PCI > on-site fibrinolytic therapy
- Death during transfer rare
- US Guidelines: D2B ≤90 minutes
- Only ~ 25% acute care hospitals in the US are PCI capable and even fewer have 24/7 cath labs
- Hospital “specialization” on primary PCI → faster treatment and lower mortality

**So…**

What once could be treated locally (Ttx can be given at any hospital) now requires a regional network around a PCI Center to diagnose STEMI get the patient rapidly to PCI

**Moreover…**

- Trauma center systems have been successful
- Formalization of regional networks will better enable payers to track quality (treatment times) and structure incentives
DHMC Position in the System

 STEMISTEMI Patient

ED

16%

EMS

Primary PCI-Capable Hospital

DHMC

Zone 1

Local Non PCI-Capable Hospital

STEMI Referral Hospital

STEMI Patient

~4%

Zone 2

Remote Non PCI-Capable Hospital

STEMI Referral Hospital

STEMI Patient

80%
Reperfusion Strategy

DHMC ED
Primary PCI-Capable Hospital → 1º PCI

STEMI Patient

Zone 1
Non PCI-Capable Hospital (STEMI Referral Hospital)
PCI avail within 90’ → Trf → 1º PCI

Zone 2
Non PCI-Capable Hospital (STEMI Referral Hospital)
PCI not avail within 90’ → 1º Lytic Tx or 1/2 dose Lytic plus GP 2b3a Inh → Trf for immediate PCI

Pharmaco-invasive
## CARESS Trial

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pharmaco invasive strategy (½ dose Lytic + Abciximab + PCI for all) (%)</th>
<th>Thrombolysis alone (½ dose Lytic + Abciximab + rescue PCI only) (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death/re-MI/ refractory ischemia at 30 days</td>
<td>4.1</td>
<td>11.1</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*Di Mario C. European Society of Cardiology Congress 2007; September 3, 2007; Vienna, Austria.*
How has DHMC really performed as a STEMI Receiving Center?
The Region

- Upper CT Valley, ~60 m N and 45 m S on I91 and 30-40 m NW or SE on I89.
- 20 Referral Hospitals
- Zone 1 = the local area, APD and VAMC
- Zone 2 = everything else
- ~40 Ambulance services
- 2 Helicopters based at DHMC
904 total registry patients from 2001–mid 2007

891 STEMI patients
13 NSTEMI patients

742 Presented to regional referral hospitals

891 STEMI patients

149 Presented to DHMC

145 admitted with STEMI from DHMC ER

4 DHMC inpatients

9 Managed conservatively

136 to cath lab emergently
5 post lytic
131 no lytic

0 to cath lab late
post lytic

34 Zone 1 (VAMC or APD)

33 transferred emergently to DHMC with STEMI

1 Admitted to initial hospital or initially tfx’d elsewhere

1 Managed conservatively

32 to cath lab emergently
3 post lytic
29 no lytic

0 to cath lab late
post lytic

596 to cath lab emergently
470 post lytic
124 no lytic

47 to cath lab late
post lytic

53 Admitted to initial hospital or initially tfx’d elsewhere

12 Managed conservatively

708 Zone 2

655 transferred emergently to DHMC with STEMI
Median Times Over Time

**DHMC ED STEMI Patients**

- **Door-to-tabletop**
- **Tabletop-to-balloon**
- **Door-to-balloon**

**Graphs:**
- Comparison of percentage of patients ≤ 90 minutes across the years.

**Data:**
- 2001-2003:
  - Door-to-tabletop: 98 minutes
  - Tabletop-to-balloon: 35 minutes
  - Door-to-balloon: 149 minutes
- 2004-2007:
  - Door-to-tabletop: 90 minutes
  - Tabletop-to-balloon: 30 minutes
  - Door-to-balloon: 126 minutes

**Percentage of patients ≤ 90 minutes:**
- 2001-2003: 17%
- 2004-2007: 34%
MEDIAN DOOR-TO-BALLOON TIMES

Distribution among 365 hospitals studied
Median 100.4 SD 23.5 - April to September 2005

DHMC ED STEMI Patients

$n=131$

Actual 30 day mortality (%)

TIMI score predicted 30 day mortality (%)

Years

2001-2003

2004-2007

15

10

5

0

ns

10.0

3.9

7.9

8.2

ns
DHMC ED & Zone 1 STEMI Patients

$n=168$

Actual 30 day mortality (%)

TIMI score predicted 30 day mortality (%)

Years
Zone 2 Patients

(STEMI Patients Transferred from Remote Referral Hospitals)
Median Times Over Time

Zone 2 STEMI Patients

**“Ideal” (Weekdays 7 AM to 5 PM)**

- Door-to-tabletop: 203, 179
- Tabletop-to-balloon: 47, 40
- Door-to-balloon: 260, 223


**“Suboptimal” (After hours and Weekends)**

- Door-to-tabletop: 188, 176
- Tabletop-to-balloon: 47, 38
- Door-to-balloon: 230, 231

Initial Door-to-balloon times in Transfer Patients Undergoing 1° PCI in the US
n=4278

- 28% >240 minutes
- 12% 90-120 minutes
- 56% 120-240 minutes

4% < 90 minutes

50% had door-to-balloon time > 3 hours

*Circulation. 2005;111:761-767.*
Zone 2 STEMI Emergent Transfers: Median Door-to-table time Q1(01)-Q2(07)

![Graph showing median door-to-table time for various hospitals between 2001-2003 and 2004-2007.](image-url)
Zone 2 Transfers: Helicopter vs Ground Transport

Median Door-to-table time Q1(01)-Q2(07)

Mean of Median differences = 69 min
STEMI Emergent Transfer Volumes Q1(01)-Q2(07)

- **Half Dose**
- **Full Dose**
- **No Lytic Given**
- **Ukn**

Percent of STEMI Patients vs. Time (Q1(01)-Q2(07))
Zone 2 STEMI Emergent Transfer Patients: By Intended Dose

30 Day Mortality

<table>
<thead>
<tr>
<th>Lytic Dose Strategy</th>
<th>% Mortality</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>None Given</td>
<td>11.8%</td>
<td>136</td>
</tr>
<tr>
<td>Full Dose</td>
<td>7%</td>
<td>171</td>
</tr>
<tr>
<td>Half Dose</td>
<td>3.5%</td>
<td>339</td>
</tr>
</tbody>
</table>

p<0.0006
ns
p=0.08
Zone 2 STEMI Emergent Transfer Patients: By Intended Dose

Neuro Complications (ICH, Total Stroke)

Lytic Dose Strategy

None Given  | Full Dose  | Half Dose  
--- | --- | ---  
ICH: 0.74% | ICH: 0.59% | ICH: 1.5%  
Total Stroke: 1.5% | Total Stroke: 1.2% | Total Stroke: 2.4%  

ns

ns

ns
Zone 2 Transfer Patients

\( n=641 \)

Actual 30 day mortality (%)

- 2001-2003: 8.1%
- 2004-2007: 5.1%

TIMI Score predicted 30 day mortality (%)

- 2001-2003: 7.6%
- 2004-2007: 7.5%

Years
## Door-to-Balloon Times

<table>
<thead>
<tr>
<th></th>
<th>Non-transfers (PPCI) (min)</th>
<th>Transfers</th>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>No lytic (PPCI) (min)</td>
<td>No Lytic (PPCI) (min)</td>
<td>½ Dose Lytic (min)</td>
<td>Full Dose Lytic (min)</td>
<td></td>
</tr>
<tr>
<td>DHMC</td>
<td>126</td>
<td>151</td>
<td>282</td>
<td>210</td>
<td>244</td>
</tr>
<tr>
<td>ANW</td>
<td>65</td>
<td>95</td>
<td>Not reported</td>
<td>120</td>
<td>-</td>
</tr>
<tr>
<td>Mayo</td>
<td>71</td>
<td>116</td>
<td>-</td>
<td>Not reported</td>
<td></td>
</tr>
</tbody>
</table>
## 30 day Mortality

<table>
<thead>
<tr>
<th></th>
<th>Non-transfers (PPCI)</th>
<th>Transfers</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No lytic (PPCI)</td>
<td>½ Dose Lytic</td>
</tr>
<tr>
<td>DHMC n=395</td>
<td>5.6</td>
<td>9.2</td>
<td>3.7*</td>
</tr>
<tr>
<td>ANW N=1345</td>
<td>4.4</td>
<td>4.6</td>
<td>5.7*</td>
</tr>
<tr>
<td>Mayo N=597</td>
<td>7.2</td>
<td>7.1‡</td>
<td>-</td>
</tr>
</tbody>
</table>

*Facilitated PCI
† Primary Ttx with rescue PCI if necessary
‡ Late presenters only
§ Early presenters only
DHMC ED & Zone 1 - 1° PCI Patients

Early and Late Door-to-Balloon Times vs:

30 Day Mortality (%)

TIMI Risk Predicted 30 Day Mortality (%)

Pre-Cath Shock or Intubation

Door-to-Balloon Time
Zone 2 PCI Patients

Door-to-Balloon Time

30 Day Mortality (%)

TIMI Risk Predicted 30 Day Mortality (%)

Pre-Cath Shock or Intubation

Door-to-Balloon Time

0.0016

0.0001

ns

0-2 hours
2-4 hours
>4 hours

0-2 hours
2-4 hours
>4 hours

0-2 hours
2-4 hours
>4 hours
Can we be satisfied... No!

- In-house D2B times are too slow
- We can see a relationship between D2B time and 30 day outcome in our overall data
- Less than 20% of our patients are offered 1º PCI
- ICH risk of ½ dose lytic protocol (1.5%- in our hands too high?)
- A STEMI Center Certification Program is in the works (Criteria for eligibility will likely be based on treatment times and volumes as well as quality outcomes)
- Pay-for-performance reimbursement strategies are here or coming
STEP 1 - Get Organized

**ST Elevation MI Process Upgrade**

**STEP UP Project**

- Obtain commitment of DHMC Senior management
- Form a multidisciplinary group with members from Cardiology, Emergency medicine, EMS, Communications, CCU, Cardiac Cath Lab, DHMC administration and Quality management
- Identify/develop and implement strategies which improve the process of care, treatment times and outcomes of STEMI patients within our hospital and within our region
**STEP UP Project: Goals**

1. Implement proven strategies for reducing Door-to-balloon time to < 90 min in > 75% of STEMI patients
2. Design a STEMI pre-hospital triage network for the purpose of providing timely primary angioplasty to STEMI patients from an enlarged geographic area around DHMC
3. Critically assess our current inter-hospital transfer system including the current facilitated PCI program in order to identify process/protocol improvements
STEP 2 - Improve In-house D2B

D2B: An Alliance for Quality
Evidence-based Strategies for reducing Door-to-balloon time to < 90 min in > 75% of STEMI patients

1. ED physician activates the cath lab
2. One call activates the cath lab
3. Cath lab team ready in 20-30 minutes
4. Prompt data feedback
5. Team-based approach
6. Pre-hospital ECG to activate the cath lab*
STEMI Patients Presenting to DHMC ED
QC Chart D2B Individual Measurements
2001-2008(Q3)

May 1st 2008
STEMI Patients Presenting to DHMC ED

% D2B ≤ 90 min by Quarter

>75% ≤ 90 min Target!

On line with D2B Strategies May 1st 2008
STEP 3 Expanding EMS → DHMC system

Strategies

- EMS 12 lead ECG capability (Medtronic grant)
- EMS checklist to establish candidacy for 1º PCI and collect QI data
- Cath Lab activation based on ECG in the field (automated reading)
- “Destination protocols” for local ED bypass and transport directly to DHMC Cath Lab

Goal = 35 miles up and down I91 and I89
**STEP 4 Expanding Zone 1**

**Strategy**

Shorten “in-door-out-door” time at presenting hospital

- ECG within 10 minutes of arrival for all Suspected STEMI patients
- EMS transported patients remain on stretcher for ECG and transfer decision
- Doc, Nurse, Scribe Checklists to allow parallel workflow and QI data feedback system
- Zone 1 ED Physician activates cath lab if transport is immediately available.
- Response to interhospital STEMI transfer based on 9-1-1 system rather than “next available ambulance”

**Goal = 20-25 min.**
Who requires a screening ECG?

Patients > 30 years old experiencing any of the following:
- Chest pain or discomfort
- Chest pressure or tightness
- “Heartburn” or epigastric pain
- Complaints of “heart racing” (HR >150 or irregular and >120)
- Complaints of “heart too slow” (HR < 50 and symptomatic)
- A syncopal episode or severe weakness in patients > 45 years old
- New onset stroke symptoms (< 24 hours old)
- Difficulty breathing (with no obvious non-cardiac cause)

These patients require an ECG immediately in any available bed or at triage. Time to ECG < 5 minutes!

Patients (regardless of age) with any of the above symptoms and history of:
- Prior cardiac disease such as heart attack
- A family history of early heart disease
- Diabetes mellitus
- Severe obesity
- Recent cocaine use

These patients require an ECG within 10 minutes!
Show all ECG’s immediately to a physician for signature!
STEMI Detection & Management:
4 Keys to Improvement

1. Use ECGs to constantly screen patients for STEMI
2. Once a STEMI is detected, open a STEMI ALERT PACKET
3. During a STEMI ALERT, complete Data Sheets A and B
4. After the ALERT, follow instructions for Data Management

**Diagram:***

- EMS
- Triage
- ECG indicates STEMI
- Main ED
- Chest Pain Center
- Normal Triage and Treatment

**STEMI Alert Activated!**

**Steps:***

2. Once a STEMI is detected, a red STEMI ALERT PACKET is immediately opened. The check-lists and data sheets inside are distributed. These help guide treatment and collect data.
2. Once a STEMI is detected, a red STEMI ALERT PACKET is immediately opened. The checklists and data sheets inside are distributed. These help guide treatment and collect data.

Providers use checklists to decrease errors and minimize time to reperfusion

3. Initial portions of Data Sheets A and B completed in ED during STEMI ALERT

TREATMENT (Reperfusion)

Patient receives on-site PCI or thrombolytics (or is transferred)

4. Data Management:
   - Data Sheet A and checklists collected in ED and sent to ED QI person
   - Data Sheet B transferred with patient

DATA SHEET A
Remains in ED after ALERT

DATA SHEET B
Always transfers with patient to final treatment site, i.e. PCI lab or another facility

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STEP 5

Rethink the Zone 2 Strategy

- Continue the Facilitated PCI option?  √ Yes
- Selected patients only?  √ No
- Change lytic regimen?  √ Yes
The Pharmaco-invasive Option for Zone 2 Patients
Alternative Regimens

½ dose Lytic plus GP IIb/IIIa inhibitor plus low dose heparin infusion followed by PCI ASAP

Pros
Superior to “Stand-alone” lytic Tx in
CARESS Trial
Benefits early presenters
We have good mortality track record

Cons
Increased bleeding/ICH in our hands
Not guideline compliant
Complex and time consuming

Full dose lytic and clopidogrel plus low dose heparin bolus followed by PCI ASAP

Pros
Superior to “Stand-alone” lytic Tx in TRANSFER AMI and CAPITAL AMI Trials
Benefits early presenters
Simpler / Quicker

Cons
More Bleeding / ICH risk
Questions?