The Development of Primary Percutaneous Coronary Intervention Services in Singapore

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No Conflicts of Interest
Reperfusion Therapy for STEMI

ST Elevation Myocardial Infarction

Thrombolysis or Primary PCI
Primary PTCA versus intravenous thrombolytic therapy for AMI: a quantitative review: Primary PCI better than thrombolysis

Weaver WD et al, JAMA 1997 Dec 17;278(23):2093

10 randomized trials comparing PTCA with iv thrombolytic therapy among 2606 patients. (4 trials comparing PTCA with SK, 3 with 3- to 4-hours of tPA, and 3 with accelerated tPA)
Primary Angioplasty vs Thrombolytic Therapy for Acute ST elevation Infarction: Quantitative Review of 23 Randomized Trials:

Primary PCI better than thrombolysis

- Primary Angioplasty vs Thrombolytic Therapy for Acute ST elevation Infarction: Quantitative Review of 23 Randomized Trials:
  - Primary PCI better than thrombolysis


23 trials, with 7739 thrombolytic-eligible patients with ST-segment elevation AMI to primary PTCA (n=3872) or thrombolytic therapy (n=3867).
Primary PCI in Singapore: The initial years

Primary PCI

• Initially offered as an alternative to thrombolytic therapy during office hours in the 1990s
• 24 hour PCI service initiated in National Heart Centre, Singapore in late 1990’s
• 24 hour PCI service started in National University Hospital in 2002
• Both hospitals have on-site cardiothoracic surgery (Only two public hospitals with CTS service in Singapore)
Public General Hospitals in Singapore:

Hospital with onsite cardiac surgery
Hospital without onsite cardiac surgery but with diagnostic cath lab
Hospital without cath lab
Primary PCI in Singapore: Thrombolysis vs PCI

**Hospitals with onsite surgery and elective PCI services**
- Primary PCI offered as 24 hour service

**Hospitals without onsite surgery / elective PCI**

**Options for STEMI presenting within 12 hours:**
- Thrombolysis or primary PCI without surgical support?
  - or
- Transfer for primary PCI to tertiary hospital?
  - or
- Re-route ambulance for STEMI patients?
- Which option and when (during or after office hours?)
Thrombolysis or Transfer for PCI?

- Hospital without onsite CTS
  - STEMI
  - Primary PCI without CTS onsite
  - Thrombolysis

- Tertiary Hospital with on-site CTS
  - Transfer
  - Primary PCI with CTS onsite
  - Primary PTCA
Re-route Ambulance to Hospital with PCI Capability?

- STEMI
- Home or workplace
- Hospital without PCI capability
- Re-route ambulance
- Ambulance with ECG capability
- Transfer
- Hospital with PCI capability, on-site CTS
National Committee for Coronary Heart Disease Strategy: Emergency Cardiac Care Subcommittee 2008

Principles

• Ensuring best possible outcomes for patients
• National perspective vs individual institution
• Based on evidence from trials & guidelines
• Review of current practice and outcomes
• Adapted to local situation
Primary PCI for patients with STEMI might be considered in hospitals without on-site surgery, provided: (Class IIb)

- experienced physician operators (> 75 total PCIs, > 11 primary PCIs per year for STEMI),
- experienced team on a 24 hours per day, 7 days/week call schedule,
- well-equipped cathlab with digital imaging equipment, a full array of interventional equipment, and IABP capability,
- plan for rapid transport to cardiac operating room in a nearby hospital
- performed in a timely fashion (goal of balloon inflation within 90 minutes of presentation) by persons skilled in the procedure (at least 75 PCIs per year) and at hospitals that perform a minimum of 36 primary PCI procedures per year. (Level of Evidence: B)

**Class IIb:** Usefulness/efficacy is less well established by evidence/opinion.
Elective PCI *without* On-site surgery
ACC/AHA Guideline Update for PCI 2005

- Class III recommendation: Not recommended
- Elective PCI for stable CAD not shown to improve survival, no time urgency
- Some studies suggesting poorer outcomes - controversial
- In addition, potential adverse impact on volumes and outcomes of existing programs
- Actual practice varies widely in different countries
- Wide range of views on appropriateness
Challenges to Providing Primary PCI

- Adequate numbers of trained interventionists
- 24 hour call roster for each hospital cath-lab
- Sharing of manpower where needed
- Cross-cover from different hospitals, private sector
- Achieving target door-to-balloon times
- Independent monitoring of outcomes
Considerations

- Some hospitals without on-site CTS had trained interventionists doing diagnostic cath during office hours.
- These interventional cardiologists were performing PCI at hospitals with onsite CTS.
- Most patients with STEMI do not come by ambulance – 70-75% self-transport.
- Transfer for PCI involves additional delay and manpower.
Clinical outcomes of patients with diabetes mellitus and acute myocardial infarction treated with primary angioplasty or fibrinolysis

L F Hsu, K H Mak, K W Lau, L L Sim, C Chan, T H Koh, S C Chuah, R Kam, Z P Ding, W S Teo, Y L Lim

Objective: To compare the early and late outcomes of primary percutaneous transluminal coronary angioplasty (PTCA) with fibrinolytic treatment among diabetic patients with acute myocardial infarction (AMI).

Design: Retrospective observational study with data obtained from prospective registries.

Setting: Tertiary cardiovascular institution with 24 hour acute interventional facilities.

Patients: 202 consecutive diabetic patients with AMI receiving reperfusion treatment within six hours of symptom onset.

Interventions: Fibrinolytic treatment was administered to 99 patients, and 103 patients underwent primary PTCA. Most patients undergoing PTCA received adjunctive stenting (94.2%) and glycoprotein Ilb/Ilia inhibition (63.1%).

Main outcome measures: Death, non-fatal reinfarction, and target vessel revascularisation at 30 days and one year were assessed.

Results: Baseline characteristics were similar in these two treatment groups except that the proportion of patients with Killip class III or IV was considerably higher in those treated with PTCA (15.5% v 6.1%, p = 0.03) and time to treatment was significantly longer (103.7 v 68.0 minutes, p < 0.001). Among those treated with PTCA, the rates for in-hospital recurrent ischaemia (5.8% v 17.2%, p = 0.011) and target vessel revascularisation at one year (19.4% v 36.4%, p = 0.007) were lower. Death or reinfarction at one year was also reduced among those treated with PTCA (17.5% v 31.3%, p = 0.02), with an adjusted relative risk of 0.29 (95% confidence interval 0.15 to 0.57) compared with fibrinolysis.

Conclusion: Among diabetic patients with AMI, primary PTCA was associated with reduced early and late adverse events compared with fibrinolytic treatment.
Acute MI in diabetes

Clinical outcomes of patients with diabetes mellitus and acute myocardial infarction treated with primary angioplasty or fibrinolysis.

**Figure 1** Kaplan-Meier curves depicting survival free of death or reinfarction for diabetic patients treated with fibrinolysis or angioplasty at 12 months of follow up.
National Committee for Coronary Heart Disease Strategy:
Emergency Cardiac Care Subcommittee 2008

Consensus:

• Primary PCI in hospitals without onsite surgery acceptable if certain criteria met:
  • Skilled and experienced operators / lab staff
  • Minimum volume of primary PCI
  • Plan for evacuation
  • Good outcomes documented
Public General Hospitals in Singapore:
**Hospital with onsite cardiac surgery**
**Hospital without onsite cardiac surgery but with diagnostic cath lab**
**Hospital without cath lab**
ACC/AHA guidelines: “Strict performance criteria must be mandated for primary PCI programs so that long door-to-balloon times and performance by low-volume or poor-outcome operators/laboratories do not occur”

“Interventional cardiologists and centers should strive for outcomes to include:
1) medical contact–to-balloon or door-to-balloon times < 90 minutes,
2) TIMI 2/3 flow rates obtained in more than 90% of patients,
3) emergency CABG rate < 2% among all patients undergoing the procedure,
4) actual performance of PCI in a high percentage of patients (85%) brought to the laboratory, and
5) risk-adjusted in-hospital mortality rate less than 7% in patients without cardiogenic shock.”
NRMI data: Effect of Door-to-balloon time on mortality

Figure 1. In-hospital mortality and door-to-balloon time; p for trend < 0.001.
Primary PCI in Singapore

Monitoring Outcomes:
The Role of National Registries
National Cardiac Registries in Singapore

Singapore Myocardial Infarct Registry (SMIR)

• Established in 1987 to study MI incidence in Singapore
• Based on cardiac enzymes, discharge codes & case-notes
• Piloted in SGH Cardiac dept. & Alexandra Hospital
• Later extended nationally
• Guidance from WHO MONICA project – Dr Hugh Tunstall-Pedoe
• Nurses trained in MONICA ECG coding
Myocardial Infarction in Singapore: A Nationwide 10-year Study of Multiethnic Differences in Incidence and Mortality

A T H Tan, *, FAMS, M Med, FRACP, S C Emmanuel, **, FAMS, MBBS, MSc, B Y Tan, ***, MSc, W S Teo, ****, FAMS, M Med, FRACP, T S J Chua, †, FAMS, M Med, MRCP, B H Tan, ‡

Fig. 1. Trends in age-standardised acute myocardial infarction incidence rates per 100,000 Singaporeans aged 20 to 64 years by gender (1988 to 1997).

Fig. 2. Trends in age-standardised acute myocardial infarction incidence rates per 100,000 Singaporeans aged 20 to 64 years by gender and ethnic group (1988 to 1997).
Conclusion: We found strong ethnic differences in MI event, case-fatality and coronary mortality rates among the three ethnic groups in Singapore. While Indians have the greatest MI event rates, Malays have the highest case fatality.
National Cardiac Registries in Singapore

**Singapore Myocardial Infarct Registry**
- Established 1987

**Singapore Cardiac Data Bank**
- Established 2000
- Registry of all major cardiac procedures in public hospitals
- Cath/PCI, CABG, EPS, pacing
- Team of nurses to track all procedures & outcomes

**National Registry of Disease Office (MOH)**
- Monitoring of all myocardial infarcts since 2007
- Team of nurses to review ECGs, notes of all possible MIs
National Data on Primary PCI (SMIR)

Percentage of STEMI patients undergoing primary PCI

<table>
<thead>
<tr>
<th>Year</th>
<th>Numerator</th>
<th>Denominator</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>43.7</td>
<td>904 / 2,068</td>
</tr>
<tr>
<td>2008</td>
<td>50.0</td>
<td>979 / 1,959</td>
</tr>
<tr>
<td>2009</td>
<td>62.8</td>
<td>1,255 / 1,997</td>
</tr>
</tbody>
</table>

Data courtesy of NRDO

*Numerator: Number of STEMI cases with primary PCI
Denominator: Number of STEMI cases

Source: Singapore Myocardial Infarction Registry
National Data on Thrombolysis (SMIR)

Percentage of STEMI patients undergoing thrombolysis

Data courtesy of NRDO

<table>
<thead>
<tr>
<th>Year</th>
<th>Numerator (n)</th>
<th>Denominator (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>249</td>
<td>2,068</td>
</tr>
<tr>
<td>2008</td>
<td>189</td>
<td>1,959</td>
</tr>
<tr>
<td>2009</td>
<td>29</td>
<td>1,997</td>
</tr>
</tbody>
</table>

**Numerator:** Number of STEMI cases with thrombolysis  
**Denominator:** Number of STEMI cases  
**Source:** Singapore Myocardial Infarction Registry
National Data: Primary PCI for STEMI

30-day mortality after ePCI
Percentage (adjusted)*

*adjusted for age, gender, ethnic group, HPT, DM, CAD risk factors, prior MI, PCI, CABG, smoking,

Data courtesy of NRDO

Numerator: Number of STEMI cases with primary PCI who died within 30-day
denominator: Number of STEMI cases with primary PCI

*Adjusted for age, gender, ethnic group, past history (HPT, DM, Dyslipidemia, AMI, PTCA, CABG), smoking, and LVSD with 2007-09 reference population.
National Data on STEMI (SMIR)

30-day mortality after STEMI
Percentage (Adjusted)*

*adjusted for age, gender, ethnic group, HPT, DM, CAD risk factors, prior MI, PCI, CABG, smoking.

Data courtesy of NRDO

Numerator: Number of STEMI cases with primary PCI presenting in shock who died within 30-day
Denominator: Number of STEMI cases with primary PCI presenting in shock
*Adjusted for age, gender, ethnic group, past history (HPT, DM, Dyslipidemia, AMI, PTCA, CABG), smoking, and LVSD with 2007-09 reference population.
National Data: Primary PCI for STEMI

30-day mortality after ePCI presenting in shock
Percentage (adjusted)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>49.6</td>
</tr>
<tr>
<td>2008</td>
<td>47.1</td>
</tr>
<tr>
<td>2009</td>
<td>40.0</td>
</tr>
</tbody>
</table>

*adjusted for age, gender, ethnic group, HPT, DM, CAD risk factors, prior MI, PCI, CABG, smoking,

Data courtesy of NRDO
Primary PCI in Singapore

Monitoring Outcomes: Door-to-Balloon Times
ePCI within 90 minutes of arrival
Percentage

- 2007: 45.3%
- 2008: 57.9%
- 2009: 74.3%

Data courtesy of NRDO
National Data Primary PCI

Median Door-to-Balloon time

<table>
<thead>
<tr>
<th>Year</th>
<th>Median (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>95</td>
</tr>
<tr>
<td>2008</td>
<td>84</td>
</tr>
<tr>
<td>2009</td>
<td>69</td>
</tr>
</tbody>
</table>

Source: Singapore Myocardial Infarction Registry

Data courtesy of NRDO
Median Door-to-Balloon Time (min)
National Heart Centre, Singapore 2005 - 2011
Percentage of Primary PCI in 90 min
National Heart Centre, Singapore 2005 - 2011

- CPIP DTB project
- CVL activation by A & E
- Night nurse to open CVL

Mean 27%
Mean 64%
Mean 89%

Feb 2011: 84.6%
Strategies for Reducing the Door-to-Balloon Time in Acute Myocardial Infarction


- Analysis of 28 strategies from 356 hospitals
- 6 strategies significantly associated with faster DTB:

  1. ER physicians activate the cathlab (8.2 minutes)
  2. Single call to a central page operator to activate cath lab (13.8 minutes)
  3. Activate the cathlab while the patient is en route to the hospital (15.4 minutes)
  4. Expecting staff to arrive in the cathlab within 20 minutes after being paged (19.3 minutes)
  5. Attending cardiologist always on site (14.6 minutes)
  6. Staff in the emergency department and the cathlab use real-time data feedback (8.6 minutes).
Development of Primary PCI Services in Singapore

Strategies to reduce DTB times

- Close cooperation between A & E and cardiology departments
- Targets set for triage, activation of staff
- Direct activation of cath lab by emergency department
- CCU staff to open cathlab
- Pre-hospital ECG transmission from ambulances
Guideline Review (ACC/AHA STEMI guidelines 2007)

“An underutilized but effective strategy for improving systems of care for STEMI patients is to expand the use of pre-hospital 12-lead electrocardiography programs by emergency medical systems (EMS) that provide advanced life support.”
Pre-hospital ECG for earlier activation of Cath Lab

Home or workplace

Transfer

Hospital activates CVL team

CVL team activated

Primary PTCA

STEMI

ECG transmission To ER

CVL team activated

Primary PTCA earlier
Utilization and Impact of Pre-Hospital Electrocardiograms for Patients With Acute ST-Segment Elevation Myocardial Infarction

Data From the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry

Deborah B. Diercks, MD, MSc,* Michael C. Kontos, MD,† Anita Y. Chen, MS,‡ Charles V. Pollack, Jr, MD, MS,§ Stephen D. Wiviott, MD,‖ John S. Rumsfeld, MD, PHD,¶ David J. Magid, MD, MPH,‖ W. Brian Gibler, MD,# Christopher P. Cannon, MD,** Eric D. Peterson, MD, MPH,‡ Matthew T. Roe, MD, MHS,‡ on behalf of the NCDR ACTION Registry Participants

Table 5  Timing of Reperfusion Therapy by Pre- Versus In-Hospital ECG Utilization

<table>
<thead>
<tr>
<th>Reperfusion Times</th>
<th>Overall   (N = 7,098)</th>
<th>Pre-Hospital ECG (n = 1,941)</th>
<th>In-Hospital ECG (n = 5,157)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 239)</td>
<td>(n = 72)</td>
<td>(n = 167)</td>
<td></td>
</tr>
<tr>
<td>Fibrinolytic agents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Door-to-needle time (min)*</td>
<td>26 (15, 41)</td>
<td>19 (10, 30)</td>
<td>29 (19, 45)</td>
<td>0.003</td>
</tr>
<tr>
<td>Door-to-needle time ≤30 min</td>
<td>56.2</td>
<td>72.4</td>
<td>49.1</td>
<td>0.05</td>
</tr>
<tr>
<td>Primary PCI</td>
<td>(n = 5,117)</td>
<td>(n = 1,501)</td>
<td>(n = 3,563)</td>
<td></td>
</tr>
<tr>
<td>Door-to-balloon time (min)*</td>
<td>71 (55, 91)</td>
<td>61 (46, 79)</td>
<td>75 (58, 95)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Door-to-balloon time ≤90 min</td>
<td>73.6</td>
<td>82.3</td>
<td>70.0</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Data are expressed as percentages except where indicated. *Expressed as medians (25th, 75th percentiles). Abbreviations as in Table 3.
Nationwide Study To Improve Door-To-Balloon Times In Patients With Acute St Elevation Myocardial Infarction Requiring Primary Percutaneous Coronary Intervention Using Prehospital ECG Transmission

**A/Prof Marcus Ong** MBBS (Singapore), FRCS Ed (A&E), MPH, FAMS
Senior Consultant, Director of Research and Clinician Scientist
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Office of Clinical Sciences, Duke-NUS GMS
Prehospital Ambulance ECG Transmission Project

• Aim: Reduce DTB for STEMI
• Methods:
  – ECG performed in ambulance prior to transport
  – ECG transmitted to central station, automatically re-routed to emergency dept that ambulance is headed towards
  – Emergency dept activates cathlab team if ECG indicates STEMI
• Results (Dec 08 to March 10):
  – 2,653 ECGs transmitted, with 325 (12%) STEMIs
  – D2B time significantly reduced by 41 min after implementation of pre-hospital ECG transmission compared to previous
  – ECG performance added 66 s to scene time
  – No adverse events or “false positive” activations
Results

Median D2B times by month

ECG transmission
Results

Comparison of Scene Time

<table>
<thead>
<tr>
<th>Phase</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD) (min)</td>
<td>10.59 (3.37)</td>
<td>11.38 (4.13)</td>
</tr>
<tr>
<td>Median (min)</td>
<td>10.18</td>
<td>11.37</td>
</tr>
</tbody>
</table>

Mean scene time increased by slightly more than half a minute, while median scene time increased by slightly more than a minute, after implementation of pre-hospital ECG transmission.
ECG Transmission Project: Acknowledgements

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Pin Pin Pek, BSc (Psychology)
Research Coordinator, Department of Emergency Medicine, Singapore General Hospital, Singapore

Huihua Li
Senior Biostatistician, Department of Clinical Research, Singapore General Hospital, Singapore
Conclusions: Pre-hospital ECG

- Pre-hospital ECG transmission significantly reduced D2B time by more than half an hour, regardless of time of presentation.

- Median scene time only increased by slightly more than a minute after implementation of pre-hospital ECG transmission.

- No increase in false activations was found in the “After” phase.

- Pre-hospital ECG transmission should be adopted as “standard of care” for all STEMI cases meeting the criteria for PCI.
Development of Primary PCI Services in Singapore

Challenges

• Ensuring adequate trained staff for PCI
• Improving door-to-balloon times in busy hospitals
• Monitoring outcomes requires manpower
• Pre-hospital ECG transmission from ambulances – logistics
• Failure to use ambulance service by public (self-transport)
Development of Primary PCI Services in Singapore

Conclusions

• 24 hour PCI feasible in public hospitals in Singapore
• Close monitoring of outcomes, DTB times
• Quality initiatives to improve outcomes
• Pre-hospital ECG transmission from ambulances reduces DTB time
• Public education needed to increase use of ambulances
AsiaPCR SingLIVE
Suntec City
Jan 12-15, 2011

SAVE THE DATE!
Thank You!

National Heart Centre Singapore’s new building in 2013
National Trends in Primary PCI for STEMI
Singapore Myocardial Infarct Registry

Percentage of STEMI undergoing primary PCI

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of STEMI</th>
<th>Total PCI Attempts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>904/2,068</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>979/1,959</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>1,255/1,997</td>
<td></td>
</tr>
</tbody>
</table>

2007: 43.7%
2008: 50%
2009: 62.8%
5.2. Prehospital Chest Pain Evaluation and Treatment

Class I
Prehospital EMS providers should administer 162 to 325 mg of aspirin (chewed) to chest pain patients suspected of having STEMI unless contraindicated or already taken by the patient. Although some trials have used enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated formulations. (*Level of Evidence: C*)

Class IIa
1. It is reasonable for all 9-1-1 dispatchers to advise patients without a history of aspirin allergy who have symptoms of STEMI to chew aspirin (162 to 325 mg) while awaiting arrival of prehospital EMS providers. Although some trials have used enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated formulations. (*Level of Evidence: C*)
2. It is reasonable that all ACLS providers perform and evaluate 12-lead ECGs routinely on chest pain patients suspected of STEMI. (*Level of Evidence: B*)
3. If the ECG shows evidence of STEMI, it is reasonable that prehospital ACLS providers review a reperfusion “checklist” and relay the ECG and checklist findings to a predetermined medical control facility and/or receiving hospital. (*Level of Evidence: C*)

1. Aspirin
2. Pre-hospital ECG
3. Transmission

Requirements:
- Amb ECG & transmission
- Training
- Reception