PCI with On-Site Surgical Services is most Cost-Effective Strategy (Primary or Elective PCI)

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Medical Director, The Christ Hospital Heart and Vascular Center and the Lindner Research Center, Cincinnati, Ohio
Professor of Clinical Medicine, Ohio State University
Consulting fees:

- **Modest**: Medpace, HCRI, Ablative Solutions, Inc.
- **Significant**: Boston Scientific, Abbott Vascular, REVA Medical Inc.
## Primary PCI vs. Fibrinolytic Therapy: Bayesian Hierarchical Meta-analysis of All Trials

<table>
<thead>
<tr>
<th>Condition</th>
<th>RCCT (n)</th>
<th>Observational (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term Death</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td><strong>Long-term Death</strong></td>
<td>11</td>
<td></td>
</tr>
<tr>
<td><strong>Short-term MI</strong></td>
<td>22</td>
<td></td>
</tr>
<tr>
<td><strong>Long-term MI</strong></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td><strong>Major Bleed</strong></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

### Short-term Death
- Favors Primary PCI \( * \)
  - OR: 0.66 (0.51 - 0.82)

### Long-term Death
- Favors Primary PCI \( * \)
  - OR: 0.76 (0.58 - 0.95)

### Short-term MI
- Favors Primary PCI \( * \)
  - OR: 0.35 (0.24 - 0.51)

### Long-term MI
- Favors Primary PCI \( * \)
  - OR: 0.49 (0.32 – 0.66)

### Stroke
- Favors Primary PCI \( * \)
  - OR: 0.37 (0.21 – 0.60)

### Major Bleed
- Favors Primary PCI \( * \)
  - OR: 1.40 (0.88 – 2.00)

### Observational
- OR: 1.30 (0.37 - 4.42)

* >frequent, complete, durable reperfusion

Huynh, Theroux et al. Circ 2009;119:3101
Options for Catheter-Based Therapy of STEMI*

• Take the patient to PCI at a regional facility ("heart-attack center")

• Take PCI to the patient at a smaller community hospital

*PPCI preferred Rx ACC/AHA/SCAI Guidelines; Ohio 67/157(43%) acute care/critical access hospitals with ER’s report D2B to CMS (~39% nationally)
“Truths” in Medicine Which Apply to PPCI for STEMI and Elective PCI

- Volume drives proficiency and efficiency: “practice makes perfect”
- Resources in medicine are limited (specialized nurses, doctors, equipment, etc.)
- Regionalization facilitates guideline adherence, QI monitoring and access to advanced technologies / expertise (M.D. and staff)
- C-PORT PPCI was not definitive (prematurely terminated, underpowered pilot trial with outcomes and statistical methods); C-PORT E and MASS COMM have not fulfilled the promise of increased access to cost-efficient, quality PCI
Hospital Mortality Stratified by Hospital Primary Angioplasty Volumes\(^1\): NRMI Database

Death During Hospitalization %

- **Low**
  - Thrombolytic Therapy: 5.9%
  - Primary Angioplasty: 6.2%
  - N: 10144

- **Intermediate**
  - Thrombolytic Therapy: 5.9%
  - Primary Angioplasty: 4.5%
  - N: 21577

- **High\(^*\)**
  - Thrombolytic Therapy: 5.4%
  - Primary Angioplasty: 3.4%
  - N: 8805

\(^*\)Low \(\leq 16\), Intermediate 17-48, High \(\geq 49/\text{PCI/yr}\)

\(^1\)Magid, Barron et al. JAMA 2000;284:3131
Relationship of Hospital Primary PCI Volume and Hospital Mortality: New York State Database*

* 7,321 patients 2000-2002

Srinivas et al. JACC 2009;53:574

% Risk Adjusted Mortality vs. Annual Hospital Volume (per year)

State-wide mortality
Relationship of Operator Primary PCI Volume and Hospital Mortality: New York State Database*

* 7,321 patients 2000-2002

Srinivas et al. JACC 2009;53:574
PCI Outcomes by Institutional Volume* of PCI

In Hospital Death:

Doucet (2002)
Jollis (1997)
Ho (2004)
Ritchie (1999)
Kimmel (1995)
Epstein (2004)

Total (n=1,377,059)

*High ≥ 200; Low < 200 PCI

Keeley, Grines  Circ 2005;112:3520
Cardiovascular Manpower

The Looming Crisis

Robert O. Bonow, MD; Sidney C. Smith, Jr, MD
CRISIS in WHITE

A nursing shortage is quickly transforming round-the-clock hospital care into a fantasy of the past. Here's what you need to know to protect your loved ones.
Nurses wanted
The supply and demand for full-time registered nurses (in thousands):

<table>
<thead>
<tr>
<th>Year</th>
<th>Supply 2000</th>
<th>Demand 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>'00</td>
<td>1,890</td>
<td></td>
</tr>
<tr>
<td>'05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 2010, 2015, 2020 numbers projected
Source: American Hospital Association
Nursing shortage: Local hospitals recruit overseas

“Monthly pay here can top a year’s in Philippines”
99,479 Patients were screened for eligibility

- 23,805 Did not provide consent
  - 19,375 Were not approached
  - 4,430 Declined to participate

75,674 Provided consent

- 56,807 Did not undergo randomization
  - 2,298 Were considered high risk for PCI
  - 6,978 Underwent CABG
  - 29,762 Underwent other medical therapy
  - 17,769 Had other reasons

18,867 Underwent randomization

- 4718 Were assigned to undergo PCI at site with on-site cardiac surgery
  - 180 Did not undergo PCI
  - 42 (0.9%) Withdrew
  - 87 (1.8%) Were lost to follow-up

14,149 Were assigned to undergo PCI at site without on-site cardiac surgery

- 14,010 Underwent PCI
  - 13,967 (99.7%) Underwent PCI at site without on-site cardiac surgery
  - 43 (0.3%) Crossed over and underwent PCI at site with on-site cardiac surgery
  - 139 Did not undergo PCI
  - 52 (0.4%) Withdrew
  - 271 (1.9%) Were lost to follow-up

13,967 (99.7%) Underwent PCI at site without on-site cardiac surgery

4538 Underwent PCI

- 4508 (99.3%) Underwent PCI at site with on-site cardiac surgery
  - 42 (0.9%) Withdrew
  - 87 (1.8%) Were lost to follow-up

30 (0.7%) Crossed over and underwent PCI at site without on-site cardiac surgery
C-PORT E: Procedural Success

PCI-Success

- Per-Patient: 90.7, 91.4
- Per-Lesion: 93.4, 94.1

PCI-Failure

- Per-Patient: 3.4, 2.5
- Per-Lesion: 6.6, 5.9

P = 0.007
P = 0.04

C-PORT E: Clinical Outcomes

- **No SOS**
- **SOS**

**6 weeks**

- **Death**
  - 0.9% (No SOS)
  - 1.0% (SOS)

- **TVR**
  - 6.5% (No SOS)
  - 5.4% (SOS)

- **MACE**
  - 12.1% (No SOS)
  - 11.2% (SOS)

**9 mos ITT**

- **Death**
  - p=0.0098

- **TVR**
  - p=0.0977

- **MACE**
  - P<0.001*

**Per protocol**

- **Death**
  - p=0.0030

- **TVR**
  - 6.2% (No SOS)
  - 4.5% (SOS)

- **MACE**
  - 12.0% (No SOS)
  - 10.4% (SOS)

*Chi-squared analysis

C-PORT E: Cost-Effectiveness

Adapted from Eisenstein et al. AHA 2012
C-PORT E: Cost-Effectiveness

Adapted from Eisenstein et al. AHA 2012

**Low volume <200 PCI**

- **Index Procedure**: No SOS 19,807, SOS 19,365
- **Follow-up**: No SOS 4,857, SOS 5,836
- **Total 9 Months**: No SOS 25,643, SOS 24,222

**High volume ≥200 PCI**

- **Index Procedure**: No SOS 19,912, SOS 18,666
- **Follow-up**: No SOS 5,172, SOS 5,453
- **Total 9 Months**: No SOS 25,365, SOS 23,838

**P-values**:
- Low volume: P=0.41, P=0.000, P=0.02
- High volume: P=0.18, P=0.23, P=0.15

Adapted from Eisenstein et al. AHA 2012
6,694 pts PCI at or originating from non-SOS center

5,392 pts meet trial inclusion criteria

3,691 pts randomized

2,774 PCI No-SOS
- 2,706 (97.5%) included
  - 2,439 (87.9%) included
    - 12 months analysis
- 68 excluded

917 PCI SOS
- 886 (96.6%) included
  - 787 (85.8%) included
    - 12 months analysis
- 31 excluded

Exclusions:
- 109 PCI ≤ 30 days
- 151 emergent/salvage procedure
- 361 SVG target
- 22 LVEF <20%
- 219 creat >2.5/dialysis
- 18 STEMI ≤ 48 hours
- 30 pre-op eval
- 157 atherectomy / thrombectomy
- 4 shock
- 131 left main >50%

Primary Endpoint Events: MASS COMM

- MACE 30 days: No-SOS (9.5%), SOS (17.3%)
- MACE 12 months: No-SOS (17.4%), SOS (17.8%)
- Repeat revasc: No-SOS (8.5%), SOS (9.9%)

Non-Emergency PCI At Hospitals With And Without On-Site Cardiac Surgery: MASS COMM

12-month MACE by Site

*S Absolute between site variance of 17%

Jacobs et al. NEJM 2013 (pre-pub)
### Average Annual Operator Total PCI Procedural Volume 2006-2011: MASS-COMM Operators

<table>
<thead>
<tr>
<th>Operator category</th>
<th>2006 Mean (min,max)</th>
<th>2007 Mean (min,max)</th>
<th>2008 Mean (min,max)</th>
<th>2009 Mean (min,max)</th>
<th>2010 Mean (min,max)</th>
<th>2011* Mean (min,max)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOS Only</strong></td>
<td>143.5 (51, 269)</td>
<td>122.6 (11, 274)</td>
<td>118.0 (5, 212)</td>
<td>105.4 (28, 185)</td>
<td>102.3 (18, 181)</td>
<td>103.9 (11, 176)</td>
</tr>
<tr>
<td>(n=34 all yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong># by yr</strong></td>
<td>29</td>
<td>32</td>
<td>33</td>
<td>33</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td><strong>SOS plus Non-SOS</strong></td>
<td>130.2 (11, 256)</td>
<td>116.0 (10, 235)</td>
<td>105.0 (6, 217)</td>
<td>109.4 (1, 257)</td>
<td>105.1 (5, 305)</td>
<td>118.8 (48, 359)</td>
</tr>
<tr>
<td>(n=34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong># by yr</strong></td>
<td>24</td>
<td>27</td>
<td>30</td>
<td>30</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td><strong>Average annual volume</strong></td>
<td>116.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112.9</td>
</tr>
</tbody>
</table>

*~40% reduction in SOS annual operator volumes during course of study (vs. 9% no-SOS plus SOS)*

Jacobs et al. NEJM 2013 (pre-pub; Supplemental Appendix Table S2)
**Adjudicated Procedural Characteristics In The Angiographic Review Cohort: MASS COMM**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PCI at no-SOS hospitals without on-site cardiac surgery (n=289 pts and 392 lesions)</th>
<th>PCI at SOS hospitals with on-site cardiac surgery (n=87 pts and 106 lesions)</th>
<th>Relative Risk (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful treatment of lesion – # of lesions (%) (per lesion)</td>
<td>366 / 383 (95.6)</td>
<td>102 / 105 (97.1)</td>
<td>0.98 (0.95-1.02)</td>
<td>0.59</td>
</tr>
<tr>
<td>Procedural success – # of pts (%) (per pt)</td>
<td>235 / 289 (81.3)</td>
<td>65 / 87 (74.7)</td>
<td>1.09 (0.95-1.24)</td>
<td>0.22</td>
</tr>
<tr>
<td>Complete revascularization – no. of pts (%)</td>
<td>174 / 289 (60.2)</td>
<td>52 / 87 (59.8)</td>
<td>1.01 (0.83-1.23)</td>
<td>1.00</td>
</tr>
<tr>
<td>Met indication criteria for PCI – no. of lesions (%)</td>
<td>369 / 392 (94.1)</td>
<td>97 / 106 (91.5)</td>
<td>1.03 (0.97-1.10)</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Procedural Success Percentages

MASS-COMM SOS hospitals

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Per patient</th>
<th>Per lesion success</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>97</td>
<td>98.3 10th</td>
</tr>
<tr>
<td>97</td>
<td>100</td>
<td>98.9 25th</td>
</tr>
<tr>
<td>97</td>
<td>100</td>
<td>99.4 50th</td>
</tr>
<tr>
<td>97</td>
<td>100</td>
<td>99.7 75th</td>
</tr>
<tr>
<td>97</td>
<td>100</td>
<td>100 90th</td>
</tr>
</tbody>
</table>

ACC-NCDR®
CathPCI Registry™
Percentile Rankings
PCI Volume at Facilities With and Without On-Site Cardiac Surgery

**ACC / NCDR**

Dehmer et al. JACC 2012 (epub)

*89% of no SOS centers ≤ 400 cases/year*

**83% of centers < 200 cases/year are no SOS**
“Assume the average state PCI mortality is 1%, but in a given year, an individual hospital has a mortality of 2%. At a facility volume of 400 cases annually and using a 95% confidence interval, it would take just about 2 years of data at 2% mortality to be certain the increase was significant rather than variation; at a facility volume of 200 PCIs annually, it would take almost 4 years to be certain. Therefore, as PCI volumes decrease, using a hospital’s risk-adjusted mortality as the sole measure of quality is problematic.”

Dehmer GJ. JACC Card Int 2013;6:631-633
Another Volume Outcome Relationship

Statewide Mortality = 1%
Site Mortality = 2%

Aversano, T.  ODH meeting, 12/12/12
# Total PCI Volumes by Year: Ohio Waiver Hospitals

<table>
<thead>
<tr>
<th>Hospital</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knox CH</td>
<td>338</td>
<td>361</td>
</tr>
<tr>
<td>CH Williams County</td>
<td>137</td>
<td>136</td>
</tr>
<tr>
<td>Fort Hamilton Hughes</td>
<td>117</td>
<td>130</td>
</tr>
<tr>
<td>Marietta Memorial</td>
<td>214</td>
<td>235</td>
</tr>
<tr>
<td>Licking Memorial</td>
<td>181</td>
<td>240</td>
</tr>
<tr>
<td>OSU East</td>
<td>14</td>
<td>67</td>
</tr>
<tr>
<td>West Chester</td>
<td>120</td>
<td>115</td>
</tr>
<tr>
<td>UH Geauga</td>
<td>53</td>
<td>135</td>
</tr>
<tr>
<td>Southview M.C.</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>Mt. Carmel St. Ann’s</td>
<td>279</td>
<td>254</td>
</tr>
</tbody>
</table>

*Data provided by Ohio Department of Health 2/7/13*
“It is important to note that a signal exists suggesting that an institutional volume threshold <200 PCI/year appears to be consistently associated with worse outcomes across various studies.”

“Accordingly, the writing committee recommends that an institution without on-site surgery with a volume fewer than 200 PCI annually, unless in a region underserved because of geography, should strongly consider whether or not it should continue to offer this service.”
• “It is important to note that a signal exists suggesting that an institutional volume threshold <200 PCI/year appears to be consistently associated with worse outcomes across various studies.”

• “Accordingly, the writing committee recommends that an institution without on-site surgery with a volume fewer than 200 PCI annually, unless in a region underserved because of geography, should strongly consider whether or not it should continue to offer this service.”
Access to PPCI in Cincinnati

Legend
- H: C-Port Participating Hospital
- H: NonPCI Capable Hospital
- H: PCI Capable Hospital (SOS)
Systematic Duplication of PCI Services by new PCI Programs: 2004-2008

Concannon et al. Circ Card Qual Outcomes 2013;6: E-pub

Census tracts with timely access to PPCI:
251 New PCI programs/estimated cost $2-4 billion

New Access          Duplicated Access
Ohio CPORT Hospitals
Drive Time Analysis for PPCI/SOS Hospitals

Drive Time to PPCI/SOS
- Yellow: 15 minutes
- Green: 30 minutes
- Blue: 45 minutes

[Map showing drive times across Ohio with areas shaded in yellow, green, and blue to indicate time ranges.]
“Nearly 80% of the adult population in the United States lived within 60 minutes of a PCI hospital in 2000”

*44% increase PCI capacity (521 new programs) with 1% increase in access (79 vs 80% ≤ 60min ground transport)

Nallamothu et al. Circ 2006;113:1189
Conconnan et al. Circ Cardiovasc Qual Outcomes 2012;5:14-20
89% of Ohio population lives within 30 minutes of hospital that does primary PCI
Transportation and Reperfusion Options for STEMI

Goal:
- Call 911, call fast

- Patient symptom onset of STEMI
- 911 EMS dispatch
- EMS on-scene
  - Encourage 12-lead ECGs at FMC
  - Consider pre-hospital fibrinolytic if capable and EMS-needle ≤ 30 min
- EMS transport
  - EMS-balloon ≤ 90 min
- Interhospital transfer
- Not PCI capable
- PCI capable

- Patient self-transport: hospital door-balloon ≤ 90 min

*pre-hospital ECG transmit / NHLBI Consensus document

Antman E, in Braunwald, Heart Disease 2005
Comparative Effectiveness of STEMI Regionalization Strategies *

**Cost in 2008 Dollars (Millions)**

- **Hospital-based strategies**
- **EMS-based strategy**

**QALYs Saved**

*“build more” vs “use more effectively”*

EMS-based = less costly and more effective

AMI Hospitalization Rate (per 100,000 Beneficiary-Years*)
For Men and Women 2002-2007

* Medicare Fee-For-Service

Chen et al.  Circ 2010;121:1322
U.S. Coronary Revascularization Trends 2001-2009:

Year / Year % Change

CABG

2002 2003 2004 2005 2006 2007 2008 2009

-10 -8 -6 -4 -2 0 2 4

2002 2003 2004 2005 2006 2007 2008 2009

PCI

2002 2003 2004 2005 2006 2007 2008 2009

-15 -10 -5 0 5 10

*2004-2009 2.5%/yr decline

Unintended (?) Consequences of no-SOS center proliferation:

- Promote the performance of unnecessary PCI procedures to justify their existence (Chan et al. JACC 2013)
- Less likely to document objective measures of ischemia and/or lesion severity (FFR, IVUS)
- Geographic disparity in location exaggerates decline in annual per center procedural volumes (MASS-COMM) with consequent adverse clinical outcomes and confounds quality analyses.
- PCI results are no better (CPORT-E and MASS-COMM “not inferior” hypothesis: PCI success less / repeat revascularization more) and cost appears to be greater!

Who benefits from this?
Conclusions

• Volume drives proficiency and efficiency/resources in medicine are limited. Regionalized STEMI care with EMS integration is the most cost-effective approach to STEMI.

• Fragmentation and reduplication of CV services is costly in both dollars and outcomes. CPORT PPCI/E and MASS COMM have increased PCI capacity with no change in access and the “covert” objective has been market share.

• Focus should now be placed on developing regional centers of excellence in care for STEMI with global EMS integration to facilitate pre-hospital identification and triage of STEMI patients.

• Elective PCI is most cost-effectively provided by higher volume centers with on-site CV surgery (SOS) facilities.
### Predictors of Inappropriate PCI

#### OR (95% CI) | P value
--- | ---
Men | 1.08 (1.05-1.11) | <0.001
White | 1.09 (1.05-1.14) | <0.001
Medicare | 0.85 (0.83-0.88) | <0.001
No Insurance | 0.56 (0.50-0.61) | <0.001
Rural hosp | 0.92 (0.88-0.96) | <0.001
Suburban hosp | 1.10 (1.07-1.13) | <0.001
Annual # elective PCI (per 100 cases) | 0.99 (0.99-0.99) | <0.001

Adapted from Chan et al. JACC 2013 (prepub-Sept)
Physician Annual PCI Volume And In-Hospital Mortality ACC/NCDR*
July 2008-July 2009

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All PCI</td>
<td>1.14 (1.05, 1.24)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>(n=345,526)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEMI/Shock</td>
<td>1.10 (1.00, 1.21)</td>
<td>0.06</td>
</tr>
<tr>
<td>No STEMI/Shock</td>
<td>1.27 (1.11, 1.45)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*3649 physicians; 345,526 PCI; 543 Cath PCI hospitals

PCI Center Volume* And In-Hospital Mortality: Meta-Analysis Of 10 Studies Involving 1,322,342 Patients

<table>
<thead>
<tr>
<th>Model</th>
<th>Study name</th>
<th>Mean study year</th>
<th>Odds ratio</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>Odds ratio and 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho⁴</td>
<td></td>
<td>1986</td>
<td>0.840</td>
<td>0.787</td>
<td>0.897</td>
<td></td>
</tr>
<tr>
<td>Ho⁴</td>
<td></td>
<td>1990</td>
<td>0.850</td>
<td>0.797</td>
<td>0.907</td>
<td></td>
</tr>
<tr>
<td>Hannan et al.²³</td>
<td></td>
<td>1993</td>
<td>0.860</td>
<td>0.775</td>
<td>0.954</td>
<td></td>
</tr>
<tr>
<td>Vakili et al.¹⁵</td>
<td></td>
<td>1995</td>
<td>0.670</td>
<td>0.414</td>
<td>1.084</td>
<td></td>
</tr>
<tr>
<td>Ho⁴</td>
<td></td>
<td>1995</td>
<td>0.910</td>
<td>0.852</td>
<td>0.972</td>
<td></td>
</tr>
<tr>
<td>Kimmel et al.¹³</td>
<td></td>
<td>1995</td>
<td>1.230</td>
<td>0.910</td>
<td>1.662</td>
<td></td>
</tr>
<tr>
<td>Canto et al.¹²ᵃ</td>
<td></td>
<td>1996</td>
<td>0.870</td>
<td>0.767</td>
<td>0.986</td>
<td></td>
</tr>
<tr>
<td>Tsuchihashi et al.¹⁰</td>
<td></td>
<td>1997</td>
<td>0.840</td>
<td>0.456</td>
<td>1.547</td>
<td></td>
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<tr>
<td>Hannan et al.²⁴</td>
<td></td>
<td>1999</td>
<td>0.660</td>
<td>0.505</td>
<td>0.862</td>
<td></td>
</tr>
<tr>
<td>Carey et al.¹⁴ᵃ</td>
<td></td>
<td>2000</td>
<td>0.950</td>
<td>0.849</td>
<td>1.063</td>
<td></td>
</tr>
<tr>
<td>Allareddy et al.²²</td>
<td></td>
<td>2002</td>
<td>0.813</td>
<td>0.731</td>
<td>0.904</td>
<td></td>
</tr>
<tr>
<td>Shirashi et al.¹¹</td>
<td></td>
<td>2003</td>
<td>0.807</td>
<td>0.557</td>
<td>1.169</td>
<td></td>
</tr>
<tr>
<td>Random</td>
<td></td>
<td></td>
<td>0.865</td>
<td>0.827</td>
<td>0.905</td>
<td></td>
</tr>
</tbody>
</table>

*High volume ≥600/yr; lower volume 400-600/yr

ACCF/AHA/SCAI 2013 Update Clinical Competence Statement
Meta-Regression of % Stent PCI on PCI Volume In Hospital Mortality Effect Size*

* >negative log odds ratio = stronger effect size (greater volume-outcome relationship)

Deaths in the United States by Cause

- Heart: 725,192
- Cancer: 607,265
- Stroke: 549,838
- COPD: 390,122
- Trauma: 167,366
- All: 124,184
- Age ≥ 65: 97,860

*CHD=7x all-cause trauma; 3x stroke

CONCLUSIONS

Our findings show that the risk of death is significantly lower when care is provided in a trauma center than in a non-trauma center and argue for continued efforts at regionalization.
AHA/ASA Scientific Statement

Metrics for Measuring Quality of Care in Comprehensive Stroke Centers: Detailed Follow-Up to Brain Attack Coalition Comprehensive Stroke Center Recommendations

A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association

Endorsed by the Society of Vascular and Interventional Neurology

Dana Leifer, MD, FAHA, Chair; Dawn M. Bravata, MD; J.J. (Buddy) Connors III, MD; Judith A. Hinchey, MD, MS, FAHA; Edward C. Jauch, MD, MS, FAHA; S. Claiborne Johnston, MD, PhD; Richard Latchaw, MD; William Likosky, MD, FAHA; Christopher Ogilvy, MD; Adnan I. Qureshi, MD, FAHA; Debbie Summers, RN, MSN, FAHA; Gene Y. Sung, MD, MPH, FAHA; Linda S. Williams, MD; Richard Zorowitz, MD, FAHA; on behalf of the American Heart Association Special Writing Group of the Stroke Council, Atherosclerotic Peripheral Vascular Disease Working Group, Council on Cardiovascular Surgery and Anesthesia, and Council on Cardiovascular Nursing

*certification process JCAHO
EMS Transport and Prehospital ECG to Expedite Hospital Thrombolysis (Door to Needle Time)

Kereiakes et al. Am Heart J 1992;123:835

Minutes from admission to treatment

- Walk-ins: N=57
- Private Ambulance: N=55
- EMS - No ECG Randomized: N=11
- EMS ECG Randomized: N=11
Prehospital ECG Facilitates In-hospital Primary Angioplasty

Door to balloon time (minutes)

- Walk-ins
- EMS-no cath alert
- EMS - cath alert
- Prehospital ECG

Bush et al. JACC 2005;45:222A

Min-Max
25%-75%
Median value
Pre-Hospital ECG and Door-To-Balloon Time: NRMI 4

Without pre-hosp ECG

- >120: 36.6%
- 90 to 120: 30.3%
- <90: 33.1%

With pre-hosp ECG

- >120: 20.2%
- 90 to 120: 24.6%
- <90: 55.2%
Pre-Hospital ECG and Reperfusion: ACTION NCDR

Pre-hospital ECG (n=1941)
In-hospital ECG (n=5157)

Min / %

Door-to-Needle

19.0
72.4
61.0
82.3
29.0
49.1
75.0
70.0

Door-to-Balloon

P<0.0001

P=0.003

P=0.05

P<0.0001

Adapted from Diercks et al. JACC 2009;53:161-6
SPECIAL ARTICLE

Pre-Hospital 12-Lead Electrocardiography Programs

A Call for Implementation by Emergency Medical Services Systems Providing Advanced Life Support—National Heart Attack Alert Program (NHAAP) Coordinating Committee; National Heart, Lung, and Blood Institute (NHLBI); National Institutes of Health

J. Lee Garvey, MD,* Bruce A. MacLeod, MD, FACEP,† George Sopko, MD,‡ Mary M. Hand, MSPH, RN,‡ on behalf of the National Heart Attack Alert Program (NHAAP) Coordinating Committee

Charlotte, North Carolina; Pittsburgh, Pennsylvania; and Bethesda, Maryland
PCI Facility Density Map: # PCI Centers / 1 MM Capita

Legend (# of PCI hospitals per 1 million capita)

- Top tertile (highest PCI density per capita) ; 8.1-12.1
- 2nd tertile (near the median density per capita) ; 5.9 – 8.0
- 1st tertile (fewest PCI density per capita) ; 3.2-5.8

2003-2011 PCI Center growth 21%
Population growth 8.3%
Disease (CAD, AMI) prevalence ↓

Langabeer, Henry, Kereiakes et al. JAHA (in press)
Non-Emergency PCI At Hospitals With And Without On-Site Cardiac Surgery: MASS COMM

30-day MACE by Site*

*S Absolute between site variance of 14%

Jacobs et al. NEJM 2013 (pre-pub)
Adverse Events In-Hospital Stratified By Hospital Volume Status: German CYPHER Registry

Khattab et al. Circulation 2009;120:600
Primary PCI Hospitals With And Without SOS in Grand Rapids*

Buckley et al. Am Heart J 2008;155:668-672

*"access" within 20 miles: 12 no-SOS PPCI hospitals
Improved access 4.8% in Michigan (3 centers ~ 4.3% and 9 centers ~ 0.5%)

*increased capacity without increased access