The Challenge of Achieving 1% Operative Mortality for Coronary Artery Bypass Grafting: A Multi-institution Society of Thoracic Surgeons Database Analysis

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Disclosures

None
Virginia Cardiac Surgery Quality Initiative

- Voluntary consortium of 17 collaborating cardiac surgical centers with Virginia.
- Capture approximately 99% of Virginia’s cardiac operations.
- Each center contributes data to STS Adult Cardiac Surgery Database.
- Quarterly Meetings:
  - Quality initiative development and planning
  - Outcomes Analysis and Review
  - Establish cooperative guidelines for clinical and systems-based intervention
Trends and Challenges in CABG Mortality

- Performance of CABG has declined as first-line treatment for coronary artery disease with advances in PCI technology.

- Current estimates of mortality following PCI are approximately 1%, while those for isolated CABG are approximately 2%.

- Surgical community recently challenged by cardiothoracic surgical leadership to achieve a ≤1% CABG mortality rate in next 3-5 years.

- Feasibility of this goal remains unknown.
1. To determine whether the challenge to achieve a ≤1% operative mortality rate for primary, isolated CABG operations is feasible in the modern surgical era

2. To identify in which patient populations this mortality goal is achievable relative to STS Predicted Risk of Mortality (STS PROM)

3. To identify factors that contribute most to mortality among patients where goal mortality was deemed not achievable in order to determine whether certain patients should not receive surgical myocardial revascularization
VCSQI (2001-2011)

Primary, Isolated CABG (n=34,416)

Identify Threshold for STS PROM with 1% CABG mortality

STS PROM ≤ Threshold (n=19,720)

STS PROM > Threshold (n=14,687)

Survivors (n=14,138)

Decedents (n=549)
Methods

- **Primary Outcome:**
  - Risk adjusted association:
    - STS PROM score and operative mortality

- **Secondary Outcomes:**
  - Mortality risk adjusted associations:
    - 30 predictor variables used to calculate STS PROM
    - Process of Care Measures
      - IMA Use
      - Perioperative/Discharge Medication Use
        - Beta-blocker
        - Anti-platelet
        - Lipid lowering
Statistical Analyses

- **Univariate Analyses:**
  - Categorical data: Pearson’s Chi-square or Fisher’s Exact
  - Continuous data: ANOVA or Wilcoxon Rank Sum

- **Hierarchical mixed effects regression:**
  - Hospitals as random effect
  - Operative Mortality
    - Adjustment:
      - STS PROM (restricted cubic spline)
      - Surgeon Volume (restricted cubic spline)
      - Operative Year
Results
## STS PROM Highly Associated with CABG Mortality

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect Size (Likelihood Ratio)</th>
<th>Adjusted Odds Ratio [95% C.I.]</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS PROM (linear)</td>
<td>846.7</td>
<td>1.89 [1.68, 2.09]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>STS PROM (non-linear)</td>
<td>251.5</td>
<td>6.59 [5.35, 8.12]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Operative Year (ref=2005)</td>
<td>46.3</td>
<td>-</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Surgeon Operative Volume (linear)</td>
<td>16.3</td>
<td>0.31 [0.47, 0.15]</td>
<td>0.0003</td>
</tr>
<tr>
<td>Surgeon Operative volume (non-linear)</td>
<td>0.8</td>
<td>0.73 [0.62, 0.86]</td>
<td>0.36</td>
</tr>
</tbody>
</table>
Adjusted Relationship CABG Mortality ~ STS PROM
STS PROM Threshold (1.27%) = 1% CABG Mortality
Modeled Factor Effect Sizes:

STS PROM ≤ Threshold (1.27%)
Modeled Factor Effect Sizes:

STS PROM > Threshold (1.27%)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Survivors (n=14,138)</th>
<th>Decedents (n=549)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median STS PROM (%)</td>
<td>2.4 [1.7,3.9]</td>
<td>4.6 [2.7,9.2]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age (years)</td>
<td>70.4±9.5</td>
<td>72.3±9.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dialysis</td>
<td>5.3%</td>
<td>11.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>23.9%</td>
<td>32.1%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>21.0%</td>
<td>37.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NYHA Class IV</td>
<td>25.7%</td>
<td>41.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>6.9%</td>
<td>11.1%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ejection Fraction (%)</td>
<td>50 [40,60]</td>
<td>45 [30,55]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Elective Status</td>
<td>32.7%</td>
<td>22.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Emergent Status</td>
<td>7.3%</td>
<td>16.9%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Surgeon Volume</td>
<td>582 [319,930]</td>
<td>464 [266,739]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Beta Blocker (Discharge)</td>
<td>85.8%</td>
<td>19.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anti-platelet (Discharge)</td>
<td>94.5%</td>
<td>21.1%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lipid Lowering Medication (Discharge)</td>
<td>84.7%</td>
<td>19.5%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Limitations

- Retrospective design
- STS definitions
- De-identified data points
- Lack of long-term follow-up
Conclusions

1. Goal to achieve $\leq 1\%$ operative mortality for primary, isolated coronary artery bypass grafting may be feasible but only in highly selected patients in the modern surgical era.

2. STS Predicted Risk of Mortality score can be used to strongly identify patients with a threshold value of estimated mortality risk $\leq 1.27\%$ to achieve this goal.

3. Goal may only be achievable in less than 60\% of CABG patients without other improvements in processes of care.