Regional Variation in Postoperative Myocardial Infarction After Major Vascular Surgery Operations in the Vascular Quality Initiative

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Disclosures

None
Introduction

- ~230 x10^6 non-cardiac operations/year

- >1.5 x10^6 vascular operations/year in the U.S.

- MI incidence 8% among inpatients > 45 years
  - ~10 million postoperative MIs (POMI)/year

- Nearly all non-ST segment elevation MI
  - 50-90% associated with plaque rupture
  - Remaining causes associated with DO_2/VO_2

Poldermans et. al. NEJM 353(4):412-414
Auerbach. AHRQ. http://www.ahrq.gov/clinic/ptsafety/chap25.htm
POMI Presentation and Mortality Impact

- Most MIs only detected by troponin
  - Only 15% report chest pain
  - 65% are asymptomatic
- Mortality is identical after apparent and silent MIs
  - It’s not just “troponinitis”
- Mortality is 10% at 30-days
  - 2-fold greater than non-operative MIs

VISION: Devereaux JAMA 2012
Botto, Anesthesiology 2014
Impact of Postoperative MI

Table 4. Association of Postoperative Troponin and 30-Day Mortality After Multiple Imputation of Missing Troponin Values and Adjusted for Age, Sex, Emergency Surgery, and Preoperative Renal Failure

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted Analysis</th>
<th>Adjusted Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR</td>
<td>(95% CI)</td>
</tr>
<tr>
<td>Age (per year increase)</td>
<td>1.05 (1.02–1.07)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Female sex</td>
<td>1.02 (0.65–1.58)</td>
<td>0.94</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>6.87 (4.34–10.9)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Renal failure (preoperative)</td>
<td>2.63 (1.58–4.38)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Troponin elevation, categorical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Troponin ≤0.06 µg/L</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Troponin 0.07–0.59 µg/L</td>
<td>2.98 (1.66–5.34)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Troponin ≥0.60 µg/L</td>
<td>7.94 (4.07–15.5)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; and RR, relative risk.
Troponin Predicts Mortality

“Prognosis define diagnosis”

Even slight troponin elevations predict death
• Population attributable risk = 34%

<table>
<thead>
<tr>
<th>Peak Troponin (ng/mL)</th>
<th>30-day Mortality</th>
<th>Time to Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;.01</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>0.02</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>0.03-0.29</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>≥0.3</td>
<td>17</td>
<td>6</td>
</tr>
</tbody>
</table>
Can we prevent POMI?

- MAP < 55 mmHg: 1.5-fold increased risk of AKI, 1.8 for POMI\(^1\)
- POISE-2 Trial: Aspirin + Clonidine\(^2\)
  - no reduced risk for postoperative MI\(^*\)
  - increased risk of major bleeding
  - increased risk of clinically important hypotension
    *Vascular operations \(~\)6% of patients
- ENIGMA-2 Trial: N\(_2\)O removal didn’t result in reduced risk of POMI\(^3\)
- Methylprednisolone in high cardiac risk surgery to reduce SIRS response→ increased risk 20%!\(^4\)

\(^1\)Walsh, Anesthesiology 2013; \(^2\)Myles, Lancet, 2014
\(^3\)Devereaux, NEJM (2 papers) 2013, 2014; \(^4\)Whitlock, Lancet, 2015
“Most patients who have a perioperative MI will not experience ischemic symptoms. Nevertheless, asymptomatic perioperative MI is as strongly associated with 30-day mortality as symptomatic MI. **Routine monitoring of cardiac biomarkers in high-risk patients...after major surgery is therefore recommended.**”
• **ACC 2007 Consensus Criteria Definition for AMI**
  any of the following → Troponin I or T > 99th centile of upper reference limit + evidence of ischemia including: symptoms, ECG changes (new ST-T changes or new LBBB), new Q waves, and/or imaging demonstrating new WMA or loss of viable myocardium
VQI Definition of Postoperative MI

- Troponin only
- EKG or clinical - ECG changes or clinical evidence of MI in conjunction with any abnormality of cardiac biomarker consistent with infarction (CKMB or Troponin)
Variation in POMI

• Most reports focus on risk assessment, medical optimization, & role of preoperative coronary revascularization

• Regional variability exists in management and outcome of AMI
  - differences in medical management
  - differences in rate and type of coronary revascularization

• Little known about regional variation in POMI

McFarley et al. NEJM. 351(4):312-317
Auerbach. AHRQ. http://www.ahrq.gov/clinic/ptsafety/chap25.htm
POMI Regional Variation in VQI Patients

• Methods
  → Examine POMI, 18 regional VQI groups, 223 centers, 1297 surgeons, 73,608 non-emergent vascular operations: 2010-2014

  - CEA, n = 38,504
  - Infrainguinal bypass, n = 16,867
  - Endovascular AAA repair, n = 14,738
  - Open AAA repair, n = 3,499

• Logistic regression performed for risk adjustment
Regional Variation in POMI by Procedure

All displayed data is risk adjusted

Regional variability in POMI rates; 3 regions excluded due to < 100 cases
Red indicates troponin only POMI; blue indicates clinical POMI
Regional Variation in POMI after OAAA

OAAA POMI Rate by Region

[Bar chart showing regional variation in POMI rate after OAAA]
What can we do about POMI Regional Variation?

- Better risk stratification?
- Educate VQI centers [e.g. COPI reports]?
- Pharmacologic intervention? [e.g. preoperative high intensity statins]
- Screening?
- Follow-up and long-term management of patients w/ POMI?
## Prediction of POMI

<table>
<thead>
<tr>
<th>Variable</th>
<th># times selected</th>
<th>Cumulative AUC</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age $\geq 60$</td>
<td>100</td>
<td>.57</td>
<td>2.1 (1.5-2.9)</td>
</tr>
<tr>
<td>Any prior vascular surgery</td>
<td>100</td>
<td>.62</td>
<td>1.8 (1.5-2.2)</td>
</tr>
<tr>
<td>CAD, unstable angina or MI prior 6 months</td>
<td>100</td>
<td>.65</td>
<td>2.1 (1.4-3.2)</td>
</tr>
<tr>
<td>IDDM</td>
<td>100</td>
<td>.67</td>
<td>1.6 (1.3-1.9)</td>
</tr>
<tr>
<td>Procedure type</td>
<td>100</td>
<td>.73</td>
<td>2.2 (1.8-2.7)</td>
</tr>
<tr>
<td>Preop Cr $&gt; 1.78$ mg/dL</td>
<td>99</td>
<td>.74</td>
<td>2.0 (1.6-2.7)</td>
</tr>
<tr>
<td>Abnormal stress test</td>
<td>99</td>
<td>.74</td>
<td>1.8 (1.4-2.2)</td>
</tr>
<tr>
<td>BMI $&lt; 24$</td>
<td>99</td>
<td>.75</td>
<td>1.4 (1.2-1.7)</td>
</tr>
<tr>
<td>CHF</td>
<td>94</td>
<td>.75</td>
<td>1.8 (1.4-2.3)</td>
</tr>
</tbody>
</table>
Estimated Risk of POMI by Risk Score

Risk of POMI

Integer Risk Score

Graph showing the estimated risk of POMI by risk score for different procedures:
- OAAA
- INFRA
- EVAR
- CEA
VQI Preoperative Cardiac Risk Index

Conclusions

- **MI after Vascular Surgery**
  - Common, most are ‘silent’ but all are potentially deadly

- **No safe ‘prophylaxis’ known**
  - Beta blockers work, but can cause strokes
  - Nitrous oxide has no effect
  - Aspirin: no clear benefit if not medium-high risk patients
  - Clonidine: no benefit and hypotension
  - Steroids: increase MI rate by 20%

- **Consider MAP > 55 mmHg**
Conclusions

- Significant regional variation exists in POMI rates following major vascular surgery

- Specific preoperative and postoperative characteristics, including region, are associated with troponin only POMI

- These findings may represent an opportunity for focused quality improvement efforts to study troponin screening after major vascular surgery
Variation in AMI