Clinical and Economic Outcomes Associated with Bleeding During Coronary Artery Bypass Graft Surgery among Elderly Americans

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Clinical and Economic Outcomes Associated with Bleeding During Coronary Artery Bypass Graft Surgery among Elderly Americans

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Introduction and Objective

– Bleeding during cardiac surgery has been associated with poor clinical outcomes and high costs

– Most data on these relationships are limited:
  • Cross-sectional
  • Small sample size
  • Restricted observation period

– Using the medical claims of a random 5% sample of Medicare beneficiaries, we comprehensively examined the clinical and economic effects associated with major bleeding during CABG
Methods: Data Source

- We analyzed immediate and long-term outcomes associated with major bleeding during coronary artery bypass graft (CABG) surgery requiring cardiopulmonary bypass (CPB) using a large longitudinal data source

- Medicare’s 5% Public Use Files for the years 2002–2005
Methods: Definition of Study Population

- Inclusion criteria:
  - All patients who underwent a CABG procedure requiring CPB between January-December, 2003
  - ICD-9-CM procedure codes 36.10-36.19 and 39.61

- Exclusion criteria:
  - Patients who underwent a CABG with CPB in the previous 12 months
  - Patients who underwent concurrent cardiac procedures
Methods: Definition of Major Bleeding

- Consistent with previous research, we used the number of units of blood transfused as a proxy for bleeding

- Bleeding was dichotomized as “major” and “not major”

- Patients who received \( \geq 4 \) units of blood were considered “major” bleeders
Methods: Clinical Outcomes

- Discharge status and peri- and post-operative mortality were identified for the index hospitalization.

- Long-term complications and mortality were assessed across 2 years of post-hospitalization follow-up.

- Death was determined either from hospital discharge disposition data or imputed from the absence of medical claims for six consecutive months.
Methods: Economic Outcomes

- Analyses were performed from 2 perspectives:
  - Medicare: payments/reimbursements
  - Hospital: charges

- Economic outcomes were assessed for the index hospitalization and across two years following that hospital stay.

- Reported in 2006 US dollars.
Methods: Statistical Analyses

- Descriptive statistics/univariate analyses to compare between the major and not major groups:
  - Chi-squared test for categorical variables
  - Wilcoxon test for cost and LOS variables

- Generalized linear models (GLM) for costs adjusted for demographic and comorbidity measures
  - GLM used a log link function & gamma distribution

- The resulting coefficients from the GLM were used to compute the adjusted average reimbursements and charges for the major and not major bleeders
Results

- 4,005 Medicare beneficiaries underwent CABG surgery requiring CPB in 2003

- Of those 4,005 patients:
  - 4.7% received $\geq 4$ units of blood (major bleeders)

- Patients who underwent transfusion received about 6.0 units of blood on average (median = 3)
## Demographic Characteristics (p<0.01)

<table>
<thead>
<tr>
<th>Age &amp; Sex</th>
<th>Major Bleeding (N=190)</th>
<th>Not Major Bleeding (N=3,815)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-69</td>
<td>17%</td>
<td>30%</td>
</tr>
<tr>
<td>70-74</td>
<td>26%</td>
<td>29%</td>
</tr>
<tr>
<td>75-79</td>
<td>28%</td>
<td>25%</td>
</tr>
<tr>
<td>80-84</td>
<td>22%</td>
<td>12%</td>
</tr>
<tr>
<td>≥85</td>
<td>6%</td>
<td>3%</td>
</tr>
<tr>
<td>Male</td>
<td>59%</td>
<td>69%</td>
</tr>
</tbody>
</table>
### Demographic Characteristics (p<0.01)

<table>
<thead>
<tr>
<th>Region</th>
<th>Major Bleeding (N=190)</th>
<th>Not Major Bleeding (N=3,815)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>26%</td>
<td>17%</td>
</tr>
<tr>
<td>South</td>
<td>31%</td>
<td>43%</td>
</tr>
<tr>
<td>Midwest</td>
<td>25%</td>
<td>27%</td>
</tr>
<tr>
<td>West</td>
<td>18%</td>
<td>13%</td>
</tr>
</tbody>
</table>
Demographic/Health Characteristics (NS)

<table>
<thead>
<tr>
<th>Race/ Ethnicity</th>
<th>Major Bleeding (N=190)</th>
<th>Not Major Bleeding (N=3,815)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>94%</td>
<td>91%</td>
</tr>
<tr>
<td>Black</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>Charlson 0-1</td>
<td>98%</td>
<td>96%</td>
</tr>
<tr>
<td>Charlson ≥ 2</td>
<td>2%</td>
<td>4%</td>
</tr>
</tbody>
</table>
## Immediate Clinical Outcomes: Discharge Status

<table>
<thead>
<tr>
<th></th>
<th>Major Bleeding (N=190)</th>
<th>Not Major Bleeding (N=3,815)</th>
<th>Adj. Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inpatient Care</strong></td>
<td>25%</td>
<td>21%</td>
<td>1.13 (0.80 – 1.60)</td>
</tr>
<tr>
<td><strong>Home</strong></td>
<td>30%</td>
<td>39%</td>
<td>0.84 (0.60 – 1.18) *</td>
</tr>
<tr>
<td><strong>SNF</strong></td>
<td>14%</td>
<td>9%</td>
<td>1.27 (0.82 – 1.97) *</td>
</tr>
<tr>
<td><strong>Home Health</strong></td>
<td>20%</td>
<td>25%</td>
<td>0.71 (0.49 – 1.03)</td>
</tr>
</tbody>
</table>

*1.00 ≠ Crude OR
## Immediate Clinical Outcomes: In-Hospital Mortality and Complications

<table>
<thead>
<tr>
<th></th>
<th>Major Bleeding (N=190)</th>
<th>Not Major Bleeding (N=3,815)</th>
<th>Adj. Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality (Per 1,000)</td>
<td>78</td>
<td>38</td>
<td>1.95 (1.11 – 3.41)</td>
</tr>
<tr>
<td>Embolic Events</td>
<td>4%</td>
<td>3%</td>
<td>1.46 (0.70 – 3.07)</td>
</tr>
<tr>
<td>Acute MI</td>
<td>13%</td>
<td>12%</td>
<td>1.03 (0.66 – 1.61)</td>
</tr>
<tr>
<td>Cerebral Infarction</td>
<td>3%</td>
<td>2%</td>
<td>1.11 (0.44 – 2.79)</td>
</tr>
</tbody>
</table>
Immediate Economic Outcomes

- Patients who experienced major bleeding tended to have longer
  • LOS (11.5 days vs. 9.8 days, P<0.01)
  • ICU LOS (10.0 days vs. 7.7 days, P<0.01)

- Hospital charges were higher for patients who experienced major bleeding:
  • $108,416 vs. $89,905 (P<0.01)

- Medicare reimbursements were higher for patients who experienced major bleeding:
  • $32,565 vs. $29,922 (P<0.01)
Mean per Patient Charge and Corresponding Reimbursement During Index Hospitalization

Hospital charge

Medicare reimbursement

Major Bleeding

Not Major Bleeding
Results: Longer-Term Outcomes

- Patients who experienced major bleeding during their index hospitalizations also tended to have less favorable clinical and economic outcomes over their two-year follow-up periods
Results: Longer-Term Clinical Outcomes

- Patients who experienced major bleeding were more likely to:
  - Experience renal failure (OR=1.40, P=0.06)
  - Exhibit a higher cumulative mortality rate (P<0.01)
Cumulative Mortality

Rate per 1,000

Index

Quarter

Major Bleeding

Not Major Bleeding
Results: Longer-Term Economic Outcomes

- Patients who experienced major bleeding were more likely to incur higher health care costs across the two years post-procedure
  - Mean cumulative charges increased from $147,000 during the first quarter to $231,000 through the last quarter ($121,000 to $198,000 for not major bleeders)
  - Average reimbursements increased from $41,600 to $68,000 ($37,000 to $61,000 for not major bleeders)

- Consistent with index hospitalization costs, Medicare consistently reimbursed about half of the extra resources consumed by those patients who experienced major bleeding, compared to those who did not experience major bleeding
Average Per Patient Charges and Reimbursements over the Follow-Up Period

- Charges (Major / Not Major)
- Reimbursements (Major / Not Major)
Discussion

– Major bleeding during CABG is associated with immediate and long-term clinical and economic effects

– There were no known differences in pre-surgery health conditions between the two bleeding groups:
  • Pre-existing health conditions cannot substantially account for the observed relationships.

– This in-depth examination makes a unique contribution to the literature and provides information to physicians, health care providers, and payers on the impact of major bleeding during CABG
Reimbursement Implications

- Major bleeding was more strongly associated with higher hospital charges indicating higher complexity and more intensive resource use.

- However, major bleeding was less strongly associated with reimbursement levels, suggesting that current levels of reimbursement may not be adequately accounting for the intensive resource use associated with major bleeding.
Limitations

- Patients $\geq 65$ who are covered by Medicare
  - Medicare accounts for $\sim 50\%$ of CABG procedures

- The number of blood units may have been underestimated
  - This would suggest that the actual association may be of greater magnitude than what is reported here

- Not all medical expenditures of beneficiaries are covered by Medicare (SNF care $>100$ days, outpatient prescription drugs)
  - Direct medical costs presented here underestimate total treatment costs

- Our real-world, non-randomized study design do not prove a causal link between major bleeding and these outcomes
Conclusions

– These results provide evidence that patients who experienced major bleeding during CABG tended to have poorer immediate and longer-term outcomes

– Interventions to prevent major bleeding during cardiac surgery may diminish or prevent these negative outcomes
Thank You!
Contact Information

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