Does the Volume of Ischemic Stroke Admissions Relate to Clinical Outcomes in the Ontario Stroke System?  

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Introduction

Previous research has found decreased mortality rates among hospitals/providers that treat high volumes of patients for specific surgical and medical conditions. The degree of association between mortality and volume varies substantially by condition and procedure¹, and while this relationship has been examined for many surgical procedures and medical conditions such as congestive heart failure, myocardial infarction, pneumonia and cancer²-⁴, stroke studies are limited⁵-⁷.

Objectives

We examined the volume-outcome relationship among ischemic stroke patients to inform regional stroke care planning given the increasing concern for the growing costs of medical care.

Methodology

Data Sources and Sample
• The Canadian Institute for Health Information Discharge Abstract Database (DAD) was used to identify all adult ischemic stroke separations (> 18 years old) at 128 acute hospitals in the province of Ontario between April 1, 2005 to March 31, 2012.
• We excluded hospitals with <15 ischemic stroke discharges per year, in-hospital strokes and elective admissions.
• Ischemic stroke patients were identified if the most responsible diagnosis code was either ICD-10-CA I63 (excluding I63.6), I64 or H34.1.
• We took the first ischemic stroke event for each individual in each fiscal year.

Statistical analysis
1. Hospital Volume: annual ischemic stroke discharge volume was assigned as the mean (+/- SD) at each hospital over 7 years (April 1, 2005 to March 31, 2012).
• Small, medium and high volume-based categories used to describe the association between hospital ischemic stroke volume and 30-day all-cause mortality.

Methodology

2. Risk- adjusted Mortality
• We used a modified version of Get With The Guidelines Ischemic Stroke 30-day mortality model⁶ and included year.
• Hierarchical multivariate logistic regression accounting for within hospital patient clustering.

Results

Table 1. Ischemic Patient Characteristics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Small Volume</th>
<th>Medium Volume</th>
<th>High Volume</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (%)</td>
<td>76,385</td>
<td>23,532</td>
<td>25,373</td>
<td>25,582</td>
</tr>
<tr>
<td>Female (%)</td>
<td>56.8</td>
<td>55.6</td>
<td>59.0</td>
<td>58.6</td>
</tr>
<tr>
<td>Age (years)</td>
<td>70-74</td>
<td>36.9</td>
<td>37.0</td>
<td>37.1</td>
</tr>
<tr>
<td>80-89</td>
<td>36.4</td>
<td>35.8</td>
<td>36.5</td>
<td>0.0001</td>
</tr>
<tr>
<td>90+</td>
<td>16.7</td>
<td>15.7</td>
<td>16.8</td>
<td>16.7</td>
</tr>
<tr>
<td>Comorbid Conditions (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Failure</td>
<td>13.6</td>
<td>17.5</td>
<td>18.5</td>
<td>22.7</td>
</tr>
<tr>
<td>Past History of Stroke/TIA</td>
<td>2.5</td>
<td>4.8</td>
<td>5.3</td>
<td>5.5</td>
</tr>
<tr>
<td>Past History of CAD</td>
<td>13.9</td>
<td>14.8</td>
<td>13.8</td>
<td>14.9</td>
</tr>
<tr>
<td>Past History of Carotid Disease</td>
<td>3.3</td>
<td>2.4</td>
<td>3.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Diabetes</td>
<td>20.6</td>
<td>23.5</td>
<td>27.6</td>
<td>23.9</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>2.0</td>
<td>2.1</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Hypertension</td>
<td>49.0</td>
<td>46.2</td>
<td>43.2</td>
<td>43.5</td>
</tr>
<tr>
<td>Prior History of Stroke/TIA</td>
<td>2.0</td>
<td>1.6</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Female% Ambulance (%)</td>
<td>55.8</td>
<td>52.0</td>
<td>50.5</td>
<td>50.6</td>
</tr>
<tr>
<td>30-day Mortality</td>
<td>12.2</td>
<td>11.0</td>
<td>12.9</td>
<td>12.8</td>
</tr>
</tbody>
</table>

Table 2. Hospital Characteristics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Small Volume</th>
<th>Medium Volume</th>
<th>High Volume</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Hospitals</td>
<td>102</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>% of Hospitals</td>
<td>71.5</td>
<td>87.7</td>
<td>93.7</td>
<td>96.7</td>
</tr>
<tr>
<td>Mean-volume (SD)</td>
<td>90.3 ± 86.3</td>
<td>147.7 ± 21.7</td>
<td>83.7 ± 10.9</td>
<td>200.5 ± 77.9</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>64 (21-143)</td>
<td>50 (14-98)</td>
<td>144 (144-266)</td>
<td>226 (230-357)</td>
</tr>
<tr>
<td>Min</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Max</td>
<td>499</td>
<td>289</td>
<td>244</td>
<td>244</td>
</tr>
<tr>
<td>Regional Stroke Centre</td>
<td>19 (19%)</td>
<td>9 (0%)</td>
<td>10 (0%)</td>
<td>7 (20%)</td>
</tr>
<tr>
<td>District Stroke Centre</td>
<td>19 (10%)</td>
<td>19 (10%)</td>
<td>7 (10%)</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>Non-designated</td>
<td>93 (77%)</td>
<td>90 (70%)</td>
<td>83 (80%)</td>
<td>60 (90%)</td>
</tr>
<tr>
<td>Teaching Hospitals</td>
<td>12 (10%)</td>
<td>6 (6%)</td>
<td>9 (13%)</td>
<td>4 (0%)</td>
</tr>
</tbody>
</table>

Conclusions

• Patients seen at hospitals with annual ischemic stroke volumes < 130 are 31% more likely to die within 30-days of their stroke compared to patients seen at hospitals with annual ischemic stroke volumes > 200.
• Using the estimates from the tercile categorization, a volume-based referral strategy could potentially avoid 1,481 deaths vs. 1,077 deaths.
• These results may be useful in the planning or restructuring regional stroke services.
• A volume-based referral strategy also needs to consider the impact of increased travel time and the resource implications for higher volume hospitals.
• Future work will explore these factors in the Ontario context.

References