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 procedure[1], and while this relationship has been examined for many surgical procedures and medical conditions such as congestive heart failure, myocardial infarction, pneumonia and cancer[2-4], stroke studies are limited[5,6,7,8,9].

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 model[10] and included year.

- Hierarchical multivariate logistic regression accounting for within hospital patient clustering.

Results

Table 1. Ischemic Patient Characteristics

	Overall	Small Volume	Medium Volume	High Volume	X^2 P value
Patients (N)	**70,985**	23,533	23,379	23,983	
Female (%)	**50.4**	51.6	50.9	48.6	< 0.0001
Age Group (years)					
18-49	**5.4**	4.0	5.4	6.6	
50-64	**17.2**	15.4	17.5	18.8	
65-74	**20.9**	20.7	21.1	21.0	<0.0001
75+	**56.4**	59.8	56.0	53.6	
Comorbid Conditions (%)					
Atrial Fibrillation	19.6	17.5	18.5	22.7	<0.0001
Past History of Stroke/TIA	2.5	1.4	2.8	3.3	<0.0001
Past History of CAD	13.9	13.0	13.8	14.9	<0.0001
Past History of Carotid Disease	3.3	2.4	3.3	4.2	<0.0001
Diabetes	26.4	25.5	27.6	25.9	<0.0001
Peripheral Vascular Disease	2.0	2.1	1.7	2.1	0.0048
Hypertension	49.8	46.2	48.3	54.9	<0.0001
Hyperlipidemia	9.5	6.8	8.2	13.5	<0.0001
Arrival by Ambulance (%)	65.8	62.0	65.0	70.3	<0.0001
30-day Mortality	15.2	17.0	14.9	13.8	<0.0001

Table 2. Hospital Characteristics

	Overall	Small Volume	Medium Volume	High Volume
Number of Hospitals	123	88	23	12
% of Hospitals		71.5	18.7	9.7
Mean volume ± SD	90.9 ± 89.6	44.7 ± 31.7	158.7 ± 18.9	299.5 ± 77.9
Median (IQR)	64 (21-143)	30 (19-68)	155 (144-169)	290 (236-357)
Min	15	15	133	206
Max	469	129	202	469
Designation				
Regional Stroke Centre	9 (7%)	0 (0%)	2 (9%)	7 (58%)
District Stroke Centre	19 (15%)	9 (10%)	6 (26%)	4 (33%)
Non-designated	95 (77%)	79 (90%)	15 (65%)	1 (8%)
Teaching Hospitals	12 (10%)	4 (4%)	3 (13%)	5 (42%)

Results

30-day mortality and hospital mean annual volume

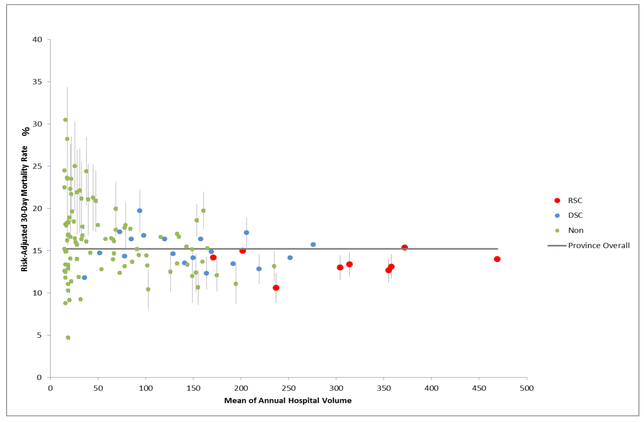

Table 4. Effects of a Volume Based Referral Strategy on 30-day Mortality

Hospital Volume	< 132	132-205	205-470	Total No. Potential Avoidable Deaths*
Number of Hospitals	88	23	12	
Total Number of Patients	23,533	23,379	23,983	
30-day Mortality (%)	17.0	14.9	13.8	
Risk- Adjusted Odds Ratio† (95% CI)	1.31 (1.15, 1.49)	1.07 (0.93, 1.23)	1.00	
No. of deaths avoided‡	**1,237**	**244**	**--**	**1,481**
No. of deaths avoided if 10% reduction in mortality	**400**	**348**	**330**	**1,077**

*This represents the total number of avoidable deaths based on volume-based referral and 10% relative reduction in mortality policies.

†Adjusted for age, sex, ambulance arrival, atrial fibrillation, past stroke/TIA, coronary artery disease or percutaneous coronary intervention or coronary artery bypass graft, carotid disease or carotid endarterectomy or carotid artery stenting, diabetes, hypertension, peripheral vascular disease, hyperlipidemia and year.

‡by referring patients to highest volume hospitals

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.

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