Escalating Levels of Access to In-Hospital Care and Stroke Mortality

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***Background and Purpose*—**Organized stroke care is an integrated approach to managing stroke to improve stroke outcomes by ensuring that optimal treatment is offered. However, limited information is available comparing different levels of organized care. Our aim was to determine whether escalating levels of organized care can improve stroke outcomes.

***Methods*—**Cohort study including patients with acute ischemic stroke between July 2003 and March 2005 in the Registry of the Canadian Stroke Network (RCSN). The RCSN is the largest clinical database of patients with acute stroke patients seen at selected acute care hospitals in Canada. As stroke unit admission does not automatically imply receipt of comprehensive care, we created the organized care index to represent different levels of access to organized care ranging from 0 to 3 as determined by the presence of occupational therapy/physiotherapy, stroke team assessment, and admission to a stroke unit. The primary end point was early stroke mortality. Secondary end points include 30-day and 1-year mortality.

***Results*—**Overall, 3631 ischemic stroke patients were admitted to 11 hospitals. Seven day stroke mortality was 6.9% (249/3631), 30-day stroke mortality was 12.6% (457/3631), and 1-year stroke mortality was 23.6% (856/3631). Risk-adjusted 7-day mortality was 2.0%, 3.2%, 7.8%, and 22.5% for organized care index of 3, 2, 1, and 0. Higher level of care was associated with lower adjusted mortality (for organized care index 3, OR 0.03, 95% CI 0.02 to 0.07 for 7-day mortality; OR 0.09, 95% CI 0.05 to 0.17 for 30-day mortality; and OR 0.40, 95% CI 0.25 to 0.64 for 1-year mortality).

***Conclusions*—**Higher level of access to care was associated with lower stroke mortality rates. Establishing a well-organized and multidisciplinary system of stroke care will help improve the quality of service delivered and reduce the burden of stroke. **(*Stroke*. 2008;39:000-000.)**

Key Words: outcome research ■ access to care ■ organized care ■ health policy ■ stroke team

Optimal care has been defined as collaborative, high-quality, standardized, effective, and cost-effective care, carried out by an interdisciplinary team using protocols based on best practices.[1] Recent studies have supported the effectiveness of stroke unit care and rehabilitation in reducing stroke morbidity and mortality.[2–4] As a consequence, the provision of stroke services has evolved considerably in many regions.[5–8] However, it remains unclear which component (physiotherapy, occupational therapy, assessment by stroke neurologist, or simply the physical admission to the stroke unit) confers better stroke outcomes. Considering the variability in the definitions of "stroke unit" and care provided, admission does not automatically imply the receipt of comprehensive care. Some data suggest that geographic units dedicated to stroke care are better than roving stroke teams.[9] However, limited information is available to discern whether acute stroke teams, stroke units, occupational or physical therapy, or an integrated response improve patient's outcomes. Although different guidelines and the Brain Attack Coalition reports detailed key elements of a stroke center,[10] there are no studies comparing escalating levels of organized care and their impact on stroke outcomes.

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Our aim was to determine whether escalating levels of organized inpatient care can improve stroke mortality. If confirmed, the identification of levels of organized care may constitute a proxy measure of quality of stroke care and help develop quality improvement strategies.

Methods

Study Design and Data Source: Registry of the Canadian Stroke Network

We conducted a cohort study by identifying all stroke patients admitted to acute care hospitals between July 1, 2003 and March 31, 2005 through the Registry of the Canadian Stroke Network (RCSN), phase 3. Patients with incomplete or missing clinical data, nonstroke diagnoses, hemorrhagic strokes, and transient ischemic attacks were excluded. The RCSN phase 3 is the largest clinical database of patients with acute stroke seen at selected acute care hospitals in Ontario with a current accrual rate of more than 25 000 patients. The RCSN was established in 2001, and has been through 3 iterations. Its phase 3 included all consecutive stroke patients from the participating hospitals by eliminated informed consent that in Phase 1 and 2 was shown to induce a significant selection bias.[11] Phase 3 focuses on the measurement and monitoring of the quality of stroke care delivery in Ontario. All patients in this registry were identified prospectively and data were collected systematically during hospital stay and at the time of discharge, with standard case report forms. Further details regarding the RCSN are published elsewhere.[6,12]

A stroke neurologist served as a project leader at each site and trained neurology research nurses performed patient recruitment and data entry based on chart review and patient and family interviews. Every 2 years the RCSN has performed a province-wide audit of stroke care in Ontario since fiscal year 2002/03. Chart validation studies have shown excellent agreement with the RCSN database, with kappa scores of >0.8 for key variables (age, sex, stroke type, thrombolysis use, comorbid conditions). Unpublished data revealed a high accuracy rate between the Discharge Abstract database (DAD), which contains data on all hospitalizations across Canada and RCSN for stroke admissions.

We used the Charlson-Deyo index to quantify patients' comorbidities.[13] This index is a summary score based on the presence or absence of 17 medical conditions. A score of zero indicates that no comorbidities are present, and higher scores indicate a greater burden of comorbidity. Based on their Charlson-Deyo index score, patients were categorized as having 0, 1, 2, or more than 3 comorbidities.[14,15] Stroke severity was assessed by using the Canadian Neurological Scale (CNS).[16,17] The CNS is a simple, reliable, and validated scale that gives a score (the lower the score the higher the severity) for estimating the acute neurological status. Neurological deterioration was determined by the local attending physician based on deterioration of the neurological deficit from admission or deterioration in the level of consciousness during hospitalization. Stroke unit was defined as a geographically located hospital unit with a dedicated stroke team and stroke resources (eg, care pathway, educational materials, and monitored beds). This unit does not need to have all these resources nor does it have to be exclusively for stroke patients, but it must be in one location in the hospital. Stroke team was defined as a multidisciplinary group of stroke specialists including physicians, nurses, occupational therapists, physiotherapists, and speech language pathologists. Assessment by any of these allied health professionals was recorded in the RCSN as a visit at any point during the hospitalization. Use of antithrombotic drugs was defined as the exposure to any antiplatelet or anticoagulant agents during the hospitalization. Pneumonia was included as a medical complication if it occurred within the first 30 days of the hospital stay and was confirmed radiologically. Length of stay was defined as the number of days in the acute care facility from admission to discharge to the previous place of residence, rehabilitation institution, or death.

Each hospital in the RCSN is assigned a unique, encrypted identifier. This identifier was used to determine the annual acute ischemic stroke volume for each hospital that contributed to the database. Data were entered electronically, and the aggregate anonymous database was managed at the Institute for Clinical Evaluative Sciences in Toronto, Ontario. Approval for the RCSN was obtained from the Research Ethics Board at each participating institution. The design of the study was also approved by the Ethics Review Boards at St Michael's Hospital, by the RCSN publications committee, and the Sunnybrook Hospital Research Ethics Board.

Assessment of Exposure: The Organized Care Index

As stroke unit admission does not automatically imply receiving comprehensive care and individual interventions (stroke team alone, stroke unit alone or occupational therapy [OT] and physiotherapy [PT] consultation and treatment alone) had a limited impact on stroke mortality, we created an index to represent different levels of access to organized care. This index was created based on the correlation among these variables and the individual impact on stroke mortality in the study cohort (n=3631). PT and OT were highly correlated (spearman correlation coefficient [95% CI]=0.72 [0.69 to 0.75]), but low correlations existed among OT/PT, stroke team assessment, or admission to the stroke unit (spearman correlation coefficients <0.31; see supplemental Table I, available online at http://stroke.ahajournals.org). Speech language pathology was not included in the score. Therefore, the organized care index (OCI) is a summary score based on the presence of occupational therapy or physiotherapy, stroke team assessment, and admission to a stroke unit. A score of zero indicates that stroke patients received none of these services, and higher scores indicate access to more services. The "organized care" index was classified as having received 0, 1, 2, or 3 services.

Outcome Measures

Stroke mortality was analyzed by using the 7-day, 30-day, and 1-year mortality health indicators. Stroke fatality was chosen as the main outcome because it is clinically relevant, objectively measured, and reliably coded. The primary outcome was early-stroke mortality measured by the 7-day mortality indicator. The use of 7-day mortality indicator has several advantages, including high case ascertainment and the limited impact of length of stay. The adjustment for stroke severity and other crucial factors that directly affect mortality constitute an advantage using this indicator when comparing stroke mortality between different regions, provinces, or countries, particularly when limited follow-up is available after discharge. Secondary outcomes include 30-day and 1-year mortality. Previous population-based studies and randomized clinical trials have used these indicators.[18–25] Seven-day stroke mortality was defined as the proportion of ischemic stroke events that are fatal within 7 days from the onset. Thirty-day and 1-year stroke mortality were defined accordingly.

Statistical Analysis

Chi-square tests were used to compare categorical variables; ANOVA or Kruskal-Wallis tests were used to compare mean and median differences for continuous variables. Age was categorized as <60, 60 to 79, and >80 years old, and stroke severity was categorized a priori as mild (CNS >8) and moderate (CNS 5 to 7)/severe stroke (CNS ≤4) on the basis of previous studies.[26,27] Logistic regression models were developed to determine the association of age, gender, stroke severity, clinical presentation, comorbid conditions, major medical complications (pneumonia, deep venous thrombosis, pulmonary embolism, Intracerebral hemorrhage), and the organized care index with mortality after stroke. Continuous variables were entered in the multivariable analysis as continuous. Age, stroke severity, level of consciousness were included a priori in the model as previously identified as independent predictor of stroke mortality.[28,29] Other variables were considered for inclusion in the multivariable models if they were significant at the $P<0.20$ level in the univariate analysis. Statistical analysis was performed using a commercially available software package (SAS statistical software

Table 1. Population Characteristics by Organized Care Index

		Organized Care Index				
	All	0	1	2	3	*P* Value
Demographic						
n	3631	275	849	1430	1077	
Age						
Mean±SE	72.0±0.2	71.5±0.9	71.9±0.5	71.3±0.4	73.3±0.4	0.0024
Age group						
<60	18	18.5	18.7	19.0	16.2	0.15
60–79	48.4	46.4	48.8	49.5	47.1	
>80	33.6	34.9	32.5	31.5	36.8	
Gender						
Women	47.8	43.3	47.6	47.6	49.2	0.37
Charlson group						
0–1	65.8	61.1	63.1	67.3	66.9	0.17
2	16.4	18.9	16.4	16.2	16.2	
≥3	17.8	20.0	20.5	16.5	16.8	
Presenting Symptoms						
Level of consciousness						
Alert	86.7	70.9	84.5	89.8	88.5	0.0001
Drowsy/Unconscious	13.3	29.1	15.5	10.2	11.5	.
Visual field defect	18.4	14.7	17.7	17.4	20.9	0.0001
Neglect	19.8	15.1	18.4	19.7	21.8	0.0001
Weakness	82.5	69.1	80.0	82.2	88.1	0.0001
Aphasia	32.9	27.6	33.6	32.8	33.9	0.0001
Neurological deterioration	16.1	25.3	17.1	12.8	17.6	0.0001
Stroke Severity						
CNS score						
Mean±SE	8±0.05	8.5±0.21	8.3±0.1	8.1±0.07	7.6±0.08	0.0001
CNS group						
1.5–4	12.6	14.3	10.4	11.5	15.4	0.0001
5–7	31.7	23.2	28.7	31.3	36.3	
≥8	55.7	62.5	60.9	57.2	48.4	
Stroke type						
Lacunar	19	12.1	16.5	19.3	22.1	0.0001
Nonlacunar	81	87.9	83.5	80.7	79.9	
Vascular risk factors						
Hypertension	66.6	63.6	65.4	65.9	69.2	0.16
Diabetes	25.0	23.3	25.0	24.0	24.2	0.67
CHF/Pulmonary edema	9.3	10.2	10.5	8.0	9.7	0.20
Dyslipidemia	33.1	30.2	32.5	33.3	34.2	0.62
Atrial fibillation	17.0	19.3	18.0	15.5	17.5	0.23
Previous TIA/Stroke	34.3	36.0	36.0	32.7	34.5	0.37
Hospital type						
Nonacademic	33.8	48.0	56.2	34.1	12.2	0.0001
Academic	66.2	52.0	43.8	65.9	87.8	
Assessment						
Occupational therapy	77.8	0	59.1	90.2	95.7	<0.001
Physiotherapy	82.5	0	73.3	92.1	97.8	<0.001
Speech language pathology	57.9	11.1	40.3	63.4	76.4	<0.001

(*Continued*)

Table 1. Continued

		Organized Care Index				
	All	0	1	2	3	*P* Value
Stroke team	58.7	0	9.0	68.2	100	<0.001
Admission to stroke unit	47.9	0	15.7	37.0	100	<0.001
Medical complications						
Pneumonia	6.6	5.5	6.4	6.1	7.6	0.33
Pulmonary Embolism	0.8	1.1	0.5	1.1	0.6	0.25
Deep Venous Thrombosis	1.0	0.7	0.7	1.4	0.8	0.33
Antithrombotic therapy in hospital	93.0	72.0	88.8	96.1	97.7	0.0001

References: Numbers in columns represent percentages unless otherwise specified. IQR represents interquartile range; CNS, Canadian Neurological Scale score.

Charlson index is a summary score based on the presence or absence of 17 medical conditions. A score of zero indicates that no comorbidities are present, and higher scores indicate a greater burden of comorbidity. Patients were categorized as having 0–1, 2, or 3 or more comorbidity. Neurological deterioration was determined by the local attending physician based on deterioration of the neurological deficit from admission or deterioration in the level of consciousness during hospitalization.

The Canadian Neurological Scale (CNS) is a validated score to assess stroke severity that range from 1.5 (severe) to 11.5 (mild). Use of antithrombotic therapy includes antiplatelet or anticoagulant agents.

(1999), Version 9.1.3; SAS Institute Inc). All tests were 2-tailed, and probability values <0.05 were considered significant.

Role of the Funding Source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The investigators had access to the data in the study and had final decision to submit for publication.

Results

During the study period (July 2003 and March 2005), 3756 patients were admitted with an acute ischemic stroke. One hundred twenty-five patients (3%) were excluded from the analysis for not having valid unique identifier, leaving 3631 patients who met the inclusion criteria for this study. Mean age was 72.0 years; 655 (18%) were younger than 60 years, and 1219 (33.6%) were older than 80 years. There was a slightly higher proportion of men (52.2%). The median (interquartile range [IQR]) of CNS score was 8.5 (6.0 to 10.5). Overall, 1227 (34%) patients were admitted to nonacademic institutions, whereas the remaining 2404 (66%) patients were admitted to academic stroke centers. The most responsible physician was a general practitioner (12.1%), an internist (38.4%), a neurologist (46.6%), and other specialists in the remaining 2.8% of the hospitalizations. 1518 (41.8%) patients were admitted to a stroke unit, whereas 234 (6.4%) were admitted to an intensive care unit (ICU). At facilities participating in the RCSN, 510 (14%) patients received intravenous alteplase. The median (IQR) of hospital stay was 9[5–19] days (Table 1).

Patients with lower level of care (organized care index=0) were younger, had lesser severe strokes (mean CNS score 8.5 versus 7.6), and higher proportion of decreased level of consciousness on admission (29% versus 11.5%) than patients who received greater levels of care (organized care index=3). No significant differences were observed in the prevalence of vascular risk factors, comorbidities, or prior history of TIA or stroke among 4 groups by organized stroke care index over 4 groups.

Access to Care and Stroke Mortality

Overall, stroke case-fatality was 6.9% (249/3631), 12.6% (457/3631), and 23.6% (856/3631) at 7 days, 30 days, and 1 year, respectively. Access to higher levels of organized care was associated with lower mortality (Table 2). Table 3 summarizes the unadjusted odds ratios for all mortality indicators. OT/PT assessment, evaluation by the stroke team, admission to the stroke unit, and all the categories of organized care index were associated with 7-day, 30-day, and 1-year stroke mortality. Risk-adjusted 7-day mortality rates were 2.0%, 3.2%, 7.8%, and 22.5% for organized care index

Table 2. Organized Care Index and Outcome Measures

		7-Day Mortality (%)			30-Day Mortality (%)			1-Year Mortality (%)		
Organize Care Index	Overall (%)	No	Yes	*P*	No	Yes	*P*	No	Yes	*P*
0	275/3631 (7.5)	184 (66.9)	91 (33.1)	0.0001	162 (58.9)	113 (41.1)	0.0001	149 (54.2)	126 (45.8)	0.0001
1	849/3631 (23.4)	768 (90.5)	81 (9.5)		711 (83.7)	138 (16.3)		605 (71.3)	244 (28.7)	
2	1430/3631 (39.4)	1376 (96.2)	54 (3.8)		1302 (91.0)	128 (9.0)		1164 (81.4)	266 (18.6)	
3	1077/3631 (29.7)	1054 (97.9)	23 (2.1)		999 (92.8)	78 (7.2)		857 (79.6)	220 (20.4)	

Reference: The "organized care" index was classified as having received 0, 1, 2, or 3 of the following services: occupational therapy or physiotherapy, stroke team assessment, or admission to a stroke unit. Organized care index of zero indicates that stroke patients received none of the services, whereas higher scores indicate access to highly more services. Further explanation is provided in the text.

Table 3. Unadjusted OR for 7-Day, 30-Day, and 1-Year Stroke Mortality Indicators

	7-Day Mortality		30-Day Mortality		1-Year Mortality	
Variables	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Demographic						
Age, y	1.02 (1.01–1.03)	0.0003	1.04 (1.03–1.05)	<.0001	1.05 (1.05–1.06)	<.0001
Gender, women	1.02 (0.79–1.32)	0.89	1.11 (0.91–1.34)	0.28	1.33 (1.14–1.55)	0.0002
Charlson comorbidity index	1.05 (0.99–1.12)	0.10	1.15 (1.10–1.20)	<.0001	1.25 (1.20–1.30)	<.0001
0–1	1.0	Ref	1.0	Ref	1.0	Ref
2	1.36 (0.97–1.89)	0.07	1.78 (1.38–2.30)	0.0001	1.89 (1.53–2.32)	<.0001
≥3	1.32 (0.92–1.87)	0.06	2.20 (1.73–2.79)	<.0001	3.18 (2.63–3.84)	<.0001
Clinical Presentation						
Level of conciousness						
Alert	1.0	Ref	1.0	Ref	1.0	Ref
Non-alert	9.90 (7.50–13.0)	<.0001	8.26 (6.62–10.3)	<.0001	6.04 (4.93–7.39)	<.0001
Dysphagia	1.85 (1.12–2.76)	0.002	2.06 (1.55–2.74)	<.0001	2.25 (1.80–2.81)	<.0001
Weakness	2.47 (1.49–4.08)	<0.0001	3.40 (2.25–5.15)	<.0001	2.39 (1.83–3.11)	<.0001
Neglect	4.61 (3.35–6.34)	<0.0001	4.30 (3.93–5.46)	<.0001	3.21 (2.65–3.88)	<.0001
Stroke severity (Mild)	0.69 (0.65–0.73)	<0.0001	0.69 (0.67–0.72)	<.0001	0.75 (0.72–0.77)	<.0001
Hospital type						
Non-Academic vs Academic	1.23 (0.94–1.60)	0.13	1.11 (0.91–1.36)	0.31	1.14 (0.93–1.34)	0.11
Assessment						
Stroke team	0.38 (0.29–0.50)	<.0001	0.53 (0.43–0.64)	<.0001	0.70 (0.60–0.81)	<.0001
Occupational therapy	0.07 (0.05–0.09)	<.0001	0.15 (0.12–0.19)	<.0001	0.38 (0.32–0.45)	<.0001
Physiotherapy	0.08 (0.06–0.10)	<.0001	0.17 (0.14–0.21)	<.0001	0.39 (0.32–0.46)	<.0001
Speech therapy	0.18 (0.13–0.25)	<.0001	0.47 (0.39–0.57)	<.0001	0.87 (0.75–1.02)	0.08
Place of admission						
Stroke Unit vs other	0.31 (0.18–0.84)	<.0001	0.47 (0.30–0.75)	0.001	0.60 (0.41–0.87)	0.008
Organized care index						
Organized care score 1 vs 0	0.21 (0.15–0.29)	<.0001	0.28 (0.20–0.37)	<.0001	0.48 (0.36–0.63)	<.0001
Organized care score 2 vs 0	0.08 (0.05–0.11)	<.0001	0.14 (0.10–0.19)	<.0001	0.27 (0.21–0.35)	<.0001
Organized care score 3 vs 0	0.04 (0.03–0.07)	<.0001	0.11 (0.08–0.16)	<.0001	0.30 (0.23–0.40)	<.0001
Medical complications						
Pneumonia	3.28 (2.83–4.71)	<.0001	5.19 (3.91–6.88)	<.0001	5.70 (4.34–7.48)	<.0001
Pulmonary embolism	1.57 (0.46–5.09)	0.47	1.82 (0.74–4.50)	0.19	2.31 (1.10–4.86)	0.03
Glucose on admission	1.06 (1.03–1.09)	<0.0001	1.04 (1.02–1.07)	<0.0001	1.04 (1.02–1.07)	<0.0001
Use of antithrombotic therapy	0.07 (0.05–0.09)	<0.0001	0.10 (0.08–0.13)	<0.0001	0.17 (0.13–0.22)	<0.0001

References: CI indicates confidence interval; Stroke severity as determined by the Canadian Neurological Scale. Charlson index is a summary score based on the presence of 17 comorbid conditions. Patients were categorized as having 0 to 1, 2, or 3 or more comorbidities. Use of antithrombotic therapy includes antiplatelet or anticoagulant agents.

3, 2, 1, and 0 (Figure 1). In a stratified analysis by level of consciousness and stroke severity (CNS ≤4, 5 to 7 and ≥8), escalating levels of access to care improved stroke survival at 7 days, 30 days, and 1 year (Table 4).

In the multivariable analyses, organized care remained as an independent predictor of 7-day mortality after adjusting for age, gender, stroke severity, neurological worsening, comorbid conditions, antiplatelet use, and other covariates. For the secondary end points, higher level of care was also associated with lower stroke mortality (Table 5). The results also remained robust after excluding postadmission events such as neurological deterioration or patients treated palliatively (DNR order) or patients who were unconscious at admission in the multivariable analysis. Figure 2 shows a stroke mortality by organized care index in patients with moderate/severe stroke (CNS score lower than 7).

Discussion

Our study shows that escalating levels of access to "organized care" was associated with improved stroke survival. This is reflected by the graded relationship between the organized care index and the primary and secondary end points. Even when patients receiving higher levels of care had more severe strokes (CNS score <7), there was an escalating improvement in survival for all outcome measures in the stratified analysis by level of consciousness and stroke severity. In the multivariable analysis, levels of care were determinants of stroke mortality after adjusting for age, gender, comorbid

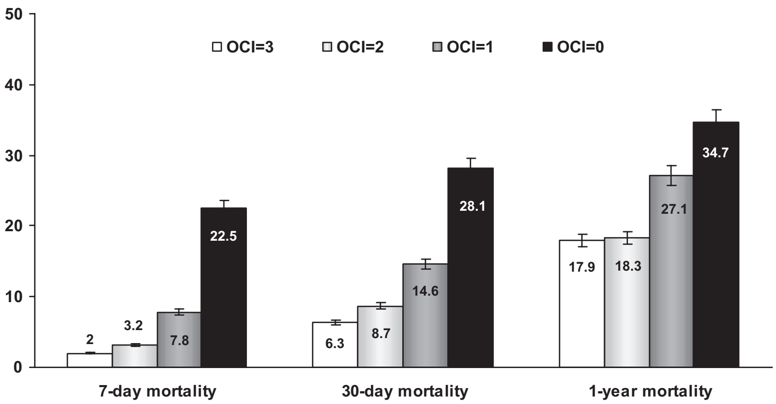

Figure 1. Risk-adjusted mortality by organized care index. Stroke mortality rates adjusted for age, gender, and stroke severity. Bars represent the 95% CI. The "organized care" index (OCI) was classified as having received 0, 1, 2, or 3 of the following services: occupational therapy or physiotherapy, stroke team assessment, or admission to a stroke unit. Organized care index of zero indicates that stroke patients received none of the services, whereas higher scores indicate access to highly more services. Further explanation is provided in the text.

conditions, level of consciousness on admission, and stroke severity among other factors.

Delivery of stroke care has been the subject of debate. Although stroke units have been associated with higher survival and reduce disability after stroke, it is unclear what components of care are associated with better outcomes.[2,30] Interestingly, the broad variability of care provided and terms used to defined "stroke unit care" does not automatically warrant that an admission to the stroke unit will be synonymous with comprehensive care (assessment by stroke neurologist, occupational therapy or physiotherapy).[31–33] In addition, the impact of any of these individual interventions has a limited effect on stroke outcome.[2,34,35] For example, in a recent systematic review care provided by a mobile stroke team had no major impact on death, dependency, or need for institutional care.[3] A meta-analysis assessed the impact of OT, the pooled high-quality studies show small but significant effect on activities of daily living and social participation.[34] Although these studies may endorse the importance of OT, PT, and stroke team, our study is unique in providing evidence that organized and multidisciplinary care decreases stroke mortality.

Table 4. Stratified Analysis of Organized Care Index by Level of Consciousness and Stroke Severity

		Organized Care Index (OCI)				
Variables	All, n=3631 (%)	0, n=275	1, n=849	2, n=1430	3, n=1077	*P* Value
Stroke Severity						
CNS ≤4 (severe) (n=430)						
7-day mortality (%)	74 (17.2)	22/32 (68.8)	25/79 (31.6)	18/159 (11.3)	9/160 (5.6)	<0.0001
30-day mortality (%)	142 (33)	26/32 (81.3)	41/79 (51.9)	45/159 (28.3)	30/160 (18.8)	<0.0001
1-year mortality (%)	209 (48.6)	27/32 (84.4)	52/79 (65.8)	66/159 (41.5)	64/160 (40.0)	<0.0001
CNS 5–7 (moderate) (n=1081)						
7-day mortality (%)	73 (6.7)	20/52 (38.5)	20/219 (9.1)	20/443 (4.6)	13/377 (3.4)	<0.0001
30-day mortality (%)	152 (14.1)	28/52 (53.8)	43/219 (19.6)	50/443 (11.5)	31/377 (8.2)	<0.0001
1-year mortality (%)	309 (28.6)	33/52 (63.5)	81/219 (37.0)	101/443 (23.3)	94/377 (24.9)	<0.0001
CNS ≥8 (mild) (n=1900)						
7-day mortality (%)	25 (1.3)	10/140 (7.1)	10/465 (2.1)	≤5	≤5	<0.0001
30-day mortality (%)	62 (3.3)	12/140 (8.6)	19/465 (4.1)	18/792 (2.3)	13/503 (2.6)	0.0010
1-year mortality (%)	203 (10.7)	17/140 (12.1)	64/465 (13.8)	74/792 (9.3)	48/503 (9.5)	0.06
Level of Consciousness						
Alert (n=3142)						
7-day mortality (%)	116 (3.7)	33/195 (16.9)	41/714 (5.7)	28/1282 (2.2)	14/951 (1.5)	<0.0001
30-day mortality (%)	245 (8.1)	46/195 (23.6)	78/714 (10.9)	80/1282 (6.2)	50/951 (5.3)	<0.0001
1-year mortality (%)	575 (18.3)	54/195 (27.7)	169/714 (23.7)	193/1282 (15.1)	159/951 (16.7)	<0.0001
Drowsy or unconscious (n=480)						
7-day mortality (%)	132 (27.5)	58/80 (72.5)	40/131 (30.5)	25/146 (17.81	9/123 (7.3)	<0.0001
30-day mortality (%)	202 (41.1)	67/80 (83.8)	60/131 (45.8)	47/146 (32.2)	28/123 (22.8)	<0.0001
1-year mortality (%)	276 (56.5)	72/80 (90.0)	73/131 (55.7)	72/146 (49.3)	59/123 (48.0)	<0.0001

Stroke severity was assessed by the Canadian Neurological Scale (CNS) categorized in mild (≤4), moderate (5–7), and severe (≥8). Note a graded survival improvement with higher levels of access to care (OCI=0 to OCI=3) for all mortality indicators.
Note: categories with less than 5 patients are not reported to protect their identities.

Table 5. Multivariable Analysis for the Primary and Secondary Outcomes

	7-Day Mortality		30-Day Mortality		1-Year Mortality	
Variables	OR	95%CI	OR	95%CI	OR	95%CI
Stroke severity (mild)	0.75	0.68–0.82	0.75	0.70–0.80	0.80	0.76–0.83
Neurological deterioration	15.3	9.82–23.8	15.2	11.0–21.0	5.40	4.18–6.99
Organized care index 1 vs 0	0.16	0.08–0.32	0.33	0.18–0.58	0.69	0.44–1.09
Organized care index 2 vs 0	0.06	0.03–0.12	0.16	0.09–0.28	0.39	0.25–0.62
Organized care index 3 vs 0	0.03	0.02−0.07	0.09	0.05–0.17	0.40	0.25–0.64
Use of antithrombotic therapy	0.17	0.10–0.29	0.17	0.10–0.26	0.33	0.22–0.50
Age, by years	1.01	0.99–1.02	1.04	1.03–1.06	1.05	1.04–1.06
Charlson index=0–1	1	...	1	...	1	...
Charlson index=2	0.89	0.50–1.56	1.45	0.96–2.19	1.71	1.29–2.27
Charlson index≥3	0.99	0.51–1.71	1.77	1.21−2.58	2.94	2.27–3.81
Pneumonia	1.69	0.96–3.00	1.95	1.25–3.04	2.20	1.52–3.18

References: CI indicates confidence interval; Stroke severity as determined by the Canadian Neurological Scale. Charlson index is a summary score based on the presence or absence of 17 medical conditions. A score of zero indicates that no comorbidities are present, and higher scores indicate a greater burden of comorbidity. Patients were categorized as having 0 to 1, 2, or 3 or more comorbidity. Neurological deterioration was determined by the local attending physician based on deterioration of the neurological deficit from admission or deterioration in the level of consciousness during hospitalization. Use of antithrombotic therapy includes antiplatelet or anticoagulant agents.

Multivariable analyses for 7-day, 30-day, and 1-year stroke mortality were adjusted for age, gender, level of consciousness, stroke severity, glucose level on admission, most responsible provider, facility type, Charlson index, pneumonia, pulmonary embolism, and antithrombotic use.

In the real world, different interventions are available for the treatment of acute stroke (intravenous, intraarterial thrombolysis) but only a few patients are eligible.[36] The vast majority of patients (thus far) will require highly specialized care to facilitate early rehabilitation, preventing complications for reducing disability after stroke.

There are some strengths as well as limitations that deserve comment. First, our study includes only patients admitted to stroke centers, which may not reflect care received and mortality rates in other facilities. However, the RCSN attempts to include all consecutive patients with acute stroke at all of the participating hospitals to reduce any selection bias. It contains detailed patient-level information that allows us comparing mortality indicators including demographic, clinical, and interventional data, not otherwise available in larger administrative databases. Second, as dependency was not studied, we cannot rule out that decreased fatality rates would be followed by increased dependency rates. Third, it is possible that fewer patients who die early receive some interventions (occupational therapy, physiotherapy, antithrombotic therapy, etc) because of administrative or practical reasons resulting in an overestimation of the magnitude of the effect. Fourth, unmeasured variables not included in the analysis (for example, time of PT/OT assessment, number of OT/PT consults) may have influenced the results.

Despite these limitations, by introducing the organized care index, our study provides strong evidence that higher access to different levels of care is associated with better stroke outcomes independently of the level of consciousness and stroke severity. These results were consistent through all mortality indicators. This study is unique in providing evidence in favor of the argument that stroke patients are best served by a comprehensive and specialized inpatient care and not by individual interventions. This very issue is under intense debate in the stroke world as hospitals organize services to meet the needs of stroke victims. It is sometimes difficult to understand that a "stroke unit" or "physiotherapy" is a treatment, in much the same way as a pharmacological

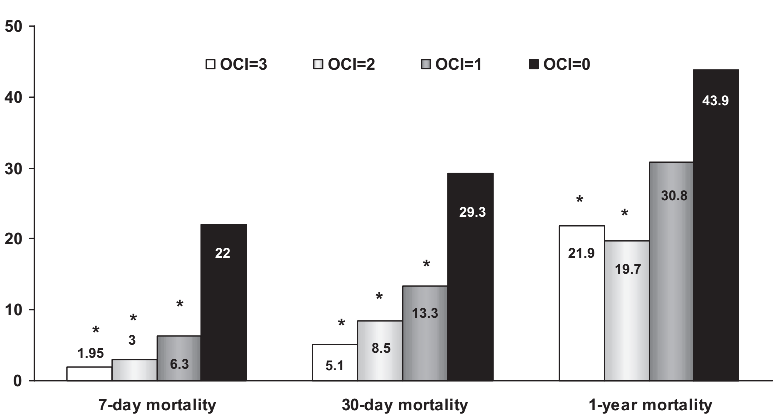

Figure 2. Stroke mortality by organized care index in patients with moderate/severe stroke (CNS score lower than 7). Patients on palliative care or unconscious are not represented in this figure (n=406). *$P<0.001$ when compared with organized care index=0. The "organized care" index (OCI) was classified as having received 0, 1, 2, or 3 of the following services: occupational therapy or physiotherapy, stroke team assessment, or admission to a stroke unit. Organized care index of zero indicates that stroke patients received none of the services, while higher scores indicate access to highly more services. Further explanation is provided in the text.

intervention or a medical procedure (e.g.: coronary artery by pass graft, thrombolytic therapy or appendectomy).

In terms of the impact of optimal care on stroke outcome, we found that stroke mortality was reduced approximately 10 times when comparing adjusted mortality rate for organized care index 2 or 3 (highest levels of care) versus organized care index 0 (lowest level of care; Figure 1). The number needed to treat (NNT) to prevent 1 death if all patients would received optimal care (organized care index=3 versus organized care index 0) is low (NNT=5 for 7 and 30-day mortality and NNT 6 for 1-year mortality). The NNTs are similar when comparing organized care index=2 versus organized care index=0 (NNT=5). This is similar to the impact of highly effective interventions such as intravenous thrombolysis for acute stroke or carotid endarterectomy for patients with symptomatic and severe carotid stenosis.[36,37] More interestingly, the absolute number of patients that could benefit from high access to organized care is more dramatic, considering the attributable risk proportion of death and the population at risk. Our study serves to provide "real-world" evidence of the effectiveness of organized stroke care.

There are some contradictions when comparing current available guidelines and recommendations. Despite scientific evidence available for more than a decade on the effectiveness of the stroke units, organized care (OT, PT, SLP, Stroke teams) is not fully implemented in practice in different hospitals receiving high stroke volumes. Furthermore, occupational therapy, physiotherapy, and speech language pathology are not mentioned as part of the "stroke team" or as a key element for primary stroke centers in the AHA/ASA Guidelines for the early management of acute ischemic stroke in adults.[1]

We hope that our study provides evidence that not only stroke team and the stroke units are crucial but, also, the expertise provided by physiotherapist and occupational therapists as part of the multidisciplinary team may help reduce stroke mortality and overall improve patients' outcomes.

Practical Implications and Future directions

Information on the processes of care in the first hours or days after stroke is critical, but limited. In agreement with previous studies, there is considerable scope for improving quality of stroke care by understanding the processes of care in the acute phase of stroke, irrespective of the age, gender, facility type, and expertise in stroke management. Interestingly, the "organized care index" may be a proxy measure of the resources available at each facility and an indicator of quality of hospital care. Moreover, the beneficial effect of escalating levels of care is probably not specific for stroke, but also to other neurological conditions. Although some aspects of acute care such as blood pressure control, use of lipid lowering therapy, or glucose management are more easily the subject of randomized controlled trials, it is more difficult to justify randomization of simple first aid measures such as physiotherapy or stroke team assessment.

Although no direct inferences about quality of care should be drawn from the data presented here, our study serves as a useful starting point to highlight issues or raise questions about outcomes and processes of stroke care.

In summary, escalating levels of access to care were associated with lower stroke mortality rates. Establishing well-organized systems aiming to improve the access to more specialized care for stroke patients is a major challenge for all hospitals, regions, and countries. Escalating levels of care may imply higher cost and subsequently redefinition of priorities in resource allocation. The understanding of processes of care and the mutual cooperation among professionals and health care providers may help develop more effective strategies to improve the quality of stroke care.

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Disclosures

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Table I. Correlation Matrix Among OT, PT, Stroke Team Assessment and Admission to the Stroke Unit

Intervention	Occupational Therapy	Physiotherapy	Stroke Team Assessment	Stroke Unit Admission
Occupational therapy	...			
Physiotherapy	0.72 (0.69–0.75)	...		
Stroke team assessment	0.31 (0.28–0.35)	0.27 (0.24–0.30)	...	
Stroke unit admission	0.15 (0.12–0.18)	0.07 (0.4–0.10)	0.15 (0.12–0.18)	...

Spearman rank correlation coefficients among variables included in the organized care index. This index was created based on these correlations in the research sample (n=3631). The creation of the index was designed to alleviate the statistical problem of variables that are "biologically" dependent (eg, OT and PT and Stroke Unit). The lack of independence among each component of the organized care index leads to statistical interpretation concerns with multivariable modeling using individual components as independent covariables. These concerns are ameliorated with the use of the index.

Note that physiotherapy and occupational therapy were highly correlated (spearman correlation coefficient [95% CI]=0.72 [0.69–0.75]). There was also a low correlation between stroke team assessment and admission to the stroke unit (spearman correlation coefficient [95% CI]= 0.15 [0.12–0.18]) suggesting that admission to stroke unit do not imply assessment by the OT, PT, or stroke team.