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Do All Age Groups Benefit From Organized Inpatient Stroke Care?

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Background and Purpose—Organized inpatient stroke care consists of a multidisciplinary approach aimed at improving stroke outcomes. It is unclear whether elderly individuals benefit from these interventions to the same extent as younger patients. We sought to determine whether the reduction in mortality or institutionalization seen with organized stroke care was similar across all age groups.

Methods—This was a case–cohort study of patients with acute ischemic stroke seen between July 2003 and March 2005 and captured in the Registry of the Canadian Stroke Network. After stratifying by age category, we assessed for evidence of effect modification by age on the reduction in stroke fatality associated with stroke unit/organized care.

Results—Among 3631 patients with ischemic stroke, stroke case-fatality at 30 days was lower for patients admitted to a stroke unit compared with those admitted to general medical wards (10.2% versus 14.8%; $P<0.0001$ with an absolute risk reduction=4.6%, number needed to treat=22). All age groups achieved a similar benefit of stroke unit care versus general medical ward care (absolute risk reduction for 30-day stroke fatality was 4.5% for <60 years; 3.4% for 60 to 69 years; 5.3% for 70 to 79 years; and 5.5% for those >80 years). Increasing levels of organized care were associated with lower stroke fatality or institutionalization. The beneficial effect of stroke units/organized care on survival was seen even after adjustment for multiple prognostic factors and after excluding patients on palliative approach. There was no evidence of effect modification by age in any analyses.

Conclusions—Stroke units and organized inpatient care reduce death or institutionalization with the same magnitude of effect across all age groups. **(*Stroke*. 2009;40:3321-3327.)**

Key Words: access to care ■ death ■ health policy ■ health services research ■ institutionalization ■ medicine ■ mortality ■ occupational therapy ■ organized care ■ outcome research ■ physiotherapy ■ stroke ■ stroke team ■ stroke unit

Organized inpatient care has been proven to decrease morbidity and mortality after stroke.[1,2] A meta-analysis published by the Stroke Unit Trialists' Collaboration confirmed reductions in death and disability with organized stroke care; however, it was noted that there is heterogeneity in the definitions and components responsible for such benefit.[3] According to the Stroke Unit Trialists' Collaboration, the most important components of organized stroke care are thought to be physiotherapy, occupational therapy, assessment by a stroke neurologist, and admission to a stroke unit with stroke-directed nursing care.[2] Previous research has shown that more intensive stroke care (including stroke unit admission, physiotherapy, occupational therapy, assessment by a stroke neurologist) is associated with reductions in stroke case fatality.[4] However, it is not known whether the benefits derived from organized stroke care are similar across all age groups in the "real world" and especially in the very elderly in whom the probability of death and disability after stroke is particularly high.[5,6]

An aging population[6–8] and a dearth of stroke units in Canada (and elsewhere) is expected to lead to a significant gap between the required and the available stroke services, particularly for elderly patients. Because stroke in the elderly has such a high mortality rate and poor prognosis compared with stroke in the young, we were interested to confirm whether there was a differential benefit of stroke unit and organized inpatient care by age.

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We used data from the Registry of the Canadian Stroke Network (RCSN) to evaluate the association between age and the magnitude of benefit from organized inpatient stroke care in the "real-world setting."

Methods

The RCSN collects detailed clinical data on patients with acute stroke and transient ischemic attack seen in the emergency department or admitted to a hospital in the provinces of Ontario and Nova Scotia, Canada.[9] Chart abstraction is performed during and after the hospital admission by trained neurology research nurses using custom software. Chart abstraction studies have shown excellent agreement within the RCSN database with κ scores of >0.8 for key variables (age, sex, stroke type, thrombolysis use, comorbid conditions).[9] For the present study, we used data from Phase 3 of the RCSN and included all consecutive patients with acute ischemic stroke seen at 11 Ontario stroke centers between July 1, 2003, and March 31, 2005. The RCSN database was linked to the Ontario Registered Persons Database to capture all-cause mortality after stroke both during and after hospitalization.[9–11]

For the analyses, age was categorized into 4 groups: <60 years, age 60 to 69 years, age 70 to 79 years, and age ≥80 years. We used the Charlson-Deyo index to quantify patients' comorbidities.[12] 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.[13,14] Stroke severity was assessed by using the Canadian Neurological Scale (CNS).[15,16] A 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). A stroke team was defined as a multidisciplinary group of stroke specialists, including physicians, nurses, occupational therapists, physiotherapists, and speech language pathologists.

Use of antithrombotic drugs was defined as an 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 radiographically. Palliative care was defined as a physician's order in the chart to provide comfort care rather than active medical management at any point during the hospitalization**.** 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.

Approval for the RCSN was obtained from the Research Ethics Board at each participating institution. The design of this study was approved by the Ethics Review Boards at St Michael's Hospital and Sunnybrook Health Sciences Centre as well as by the RCSN publications committee.

Assessment of Access to Organized Stroke Care

We used the organized care index to categorize exposure to various stroke services.[4] The organized care index is a summary score that assigns a similar weight (1 point) for receipt of each of the following services: occupational therapy/physiotherapy, stroke team assessment, and admission to a stroke unit. A score of zero indicates that patients with stroke received none of these services, and higher scores indicate access to more services. Higher organized care index scores are inversely associated with stroke fatality.[4]

Outcome Measures

The primary outcome was all-cause mortality at 30 days after stroke. Seven-day stroke case-fatality and the composite outcome of 30-day stroke fatality or institutionalization were secondary outcomes.

Statistical Analysis

First, we assessed the effect of admission to a stroke unit on stroke fatality in a univariable analysis stratified by age category (≤59, 60 to 69; 70 to 79, ≥80 years). We examined the organized care index, which is an ordered categorical scale (0 to 3), to assess the relative magnitude of effect by age category. We report relative risk (RR), relative risk reduction (RRR), absolute risk reduction (ARR), number needed to treat (NNT), and 95% CIs for these comparisons.

χ^2 tests were used to compare categorical variables; analysis of variance or Kruskal-Wallis tests were used to compare mean and median differences for continuous variables in baseline characteristics. Stroke severity was categorized a priori as mild (CNS >8), moderate (CNS 5 to 7), or severe (CNS ≤4) on the basis of previous studies.[17,18]

We used multivariable logistic regression modeling to evaluate the association between age group and mortality with adjustment for stroke unit admission, sex, Charlson index score, and CNS score. The analysis was repeated with the organized care index in place of stroke unit admission. Within each of these models, we assessed an age-by-stroke unit admission and an age-by-organized care index interaction term using a likelihood ratio test as the principal test of our hypothesis. In both models, we report the RR of death relative to the lowest age stratum. RRs were estimated from the predicted probabilities derived from the logistic regression model. CIs around the RR point estimates were calculated by bootstrapping.

Because some patients with very severe strokes, unconscious on arrival, or those with significant comorbid illness may be treated with a palliative approach, and be both less likely to receive organized care and more likely to die after stroke, secondary analyses excluded patients in whom the RCSN database indicated that they were treated with a palliative approach during their stroke hospitalization.

Statistical analysis was performed using a commercially available software package (SAS statistical software, 1999, Version 9.1.3; SAS Institute Inc, Cary, NC). All tests were 2-tailed, and probability values <0.05 were considered significant.

Results

The study sample included 3756 patients admitted with an acute ischemic stroke. Of these, 125 (3%) were excluded from the analysis due to invalid unique identifiers or missing data, leaving 3631 patients for analysis. Baseline patient characteristics are summarized in Table 1. The mean age was 72.0 years; 655 (18%) were <60 years, and 1219 (33.6%) were >80 years. The oldest group had more comorbid illness, a greater frequency of severe strokes, and a longer length of hospital stay compared with their younger counterparts. Overall, 1739 (47.9%) patients were admitted to a stroke unit. There were no significant differences in access to stroke units, assessment by the stroke team or physiotherapists, or in the mean organized care index score among different age groups (Table 1). Patients treated with a palliative approach were less likely than nonpalliative patients to be admitted to a stroke unit (40% versus 49%, $P=0.008$). The Supplemental Table, available online at http://stroke.ahajournals.org summarizes baseline characteristics by organized care index.

Stroke Outcomes by Age Groups: The Impact of Organized Care

Overall, 30-day stroke fatality was 6.7%, 7%, 10.9%, and 20.2% for age <59, age 60 to 69, age 70 to 79, and those >80 years, respectively. Thirty-day risk-adjusted fatality by stroke unit admission and organized care index is represented in Figure 1A–B.

Stroke fatality was lower for patients admitted to a stroke unit for all age groups (Figure 1A). There was also a gradient in survival according to escalating access to organized care. Thirty-day risk-adjusted stroke fatality was 16.6%, 21.9%, 29.1%, and 54.9% for organized care index scores of 3, 2, 1,

Table 1. Baseline Characteristics

Variable	Overall	Age Group <59	60–69	70–79	80+	*P* Value
Demographic (%)	(n=3631)	(n=655; 18.0)	(n=627; (17.3)	(n=1130; 31.1)	(n=1219; 33.6)	
Gender, female	47.8	37.6	32.7	46.4	62.3	<0.0001
Charlson index						
0–1	65.8	82.3	64.4	62.1	61.0	<0.0001
2	16.4	9.5	17.4	17.7	18.5	
3	17.8	8.2	18.2	20.2	20.5	
Clinical presentation						
CNS score group						
<4	12.6	8.0	8.6	13.6	16.4	<0.0001
5–7	31.7	27.0	34.5	31.1	33.4	
>8	55.7	64.9	57.0	55.3	50.2	
Organized care						
Physiotherapy	82.5	79.4	82.1	83.6	83.3	0.12
Assessment by stroke team	58.7	62.0	55.7	57.6	59.5	0.10
Admission to stroke unit	47.9	43.7	48.3	48.8	49.1	0.12
Organized care index (OCI)*						0.19
OCI=0	7.6	7.8	7.8	7.0	7.9	
OCI=1	23.4	24.3	22.8	24.0	22.6	
OCI=2	39.4	41.4	42.4	39.1	37.0	
OCI=3	29.7	26.6	27.0	29.9	32.5	
Stroke subtype						<0.0002
Lacunar stroke	19	19.9	22.1	19.8	16.1	
Nonlacunar	79.3	77.0	75.5	79.1	82.7	
Unknown	1.7	3.1	2.4	1.1	1.2	
Palliative care	9.9	4.7	5.4	9.0	15.8	<0.0001
Length of hospital stay, mean, days (SE)	16.7 (0.4)	12.1 (0.9)	14.6 (0.9)	18.0 (0.8)	19.0 (0.7)	<0.0001

Numbers in columns represent percentages unless otherwise specified. IQR represents interquartile range.

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 comorbidities.

The CNS is a validated score to assess stroke severity that range from 1.5 (severe) to 11.5 (mild).

The OCI is a summary score to represent different levels of access to care. 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. OCI of zero indicates that patients with stroke received none of the services, whereas higher scores indicate access to highly more services. Further explanation is provided in the text and elsewhere.[4]

Stroke classification according to the Oxfordshire Community Stroke Project classification, ie, TACS, total anterior circulation stroke; PACS, partial anterior circulation stroke; POCS, posterior circulation stroke; LACI, lacunar stroke.

and 0, respectively. The beneficial effect did not substantially differ across age groups (Figure 1). Similar beneficial results were observed for 7-day fatality and stroke mortality at discharge (data not shown). Tables 2, 3, and 4 summarize the magnitude of effect of stroke unit admissions or organized care expressed in ARR, NNT, and RRR by age group. We found similar benefit in stroke fatality (Tables 2 and 3) and for the composite outcome of 30-day stroke fatality/institutionalization (Table 4) among all age categories. There was no evidence of an interaction effect between age and stroke unit admission.

Of note, the beneficial effect in risk reduction for stroke units was more pronounced in younger patients with stroke (Table 2). Similar NNT estimates were observed for patients receiving higher access to organized care (organized care index 2 to 3 versus 0 to 1). For 7-day mortality, NNT was 10, 12, 8 and 6 for those <59, 60 to 69, 70 to 79, and >80 years, respectively (Table 3).

The secondary analysis showed consistent results on the benefit of stroke units and organized care after excluding patients who arrived unconscious or who were palliated (Figure 2). The benefit of organized care was also appreciated for patients with moderate/severe stroke (CNS ≤7; Figure 2) or mild stroke (data not shown) in all age groups.

In the multivariable analysis, stroke unit care remained an independent predictor of stroke fatality at 30 days (OR, 0.66; 95% CI, 0.52 to 0.84; c-statistics 0.80) and at 7 days (OR, 0.55; 95% CI, 0.40 to 0.77; c-statistics 0.79), after adjusting for age, sex, stroke severity, Charlson index, and an age-by-stroke unit interaction term. The interaction terms examining age-by-stroke unit were not significant ($P=0.98$ for 30-day stroke fatality and $P=0.80$ for 7-day stroke fatality).

Similar findings were observed for the organized care index score (organized care index 0 to 1 versus organized care

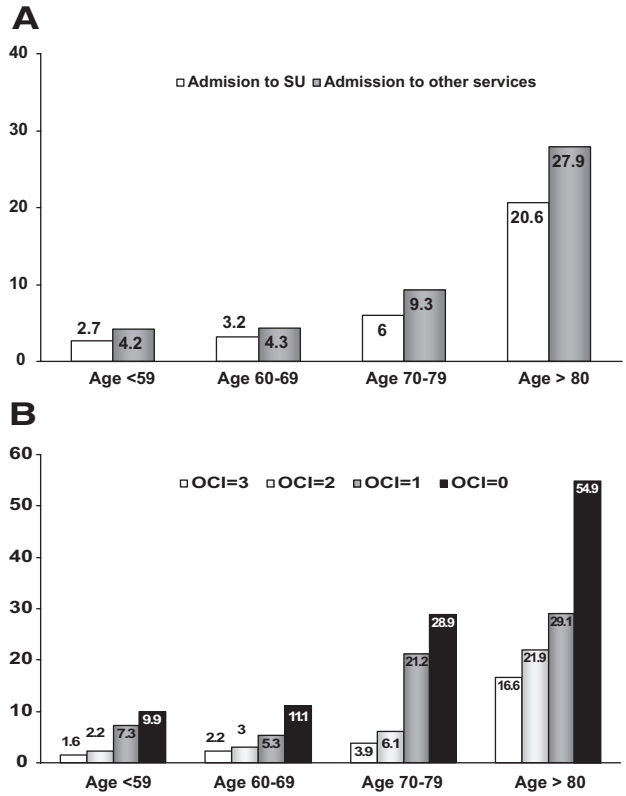

Figure 1. Thirty-day stroke fatality by stroke unit (SU) admissions (A) or by organized care index (B) adjusted for age, gender, and stroke severity. Bars represent the 95% CI. The "organized care" index (OCI) was classified as having received 0, 1, 2, or 3 of the following services: occupational therapy or physiotherapy, stroke team assessment, or admission to a SU. Organized care index of zero indicates that patients with stroke received none of the services, whereas higher scores indicate access to highly more services. Note a graded survival improvement with SU admission and higher levels of access to care (OCI=0 to OCI=3) for all age groups. Further explanation is provided in the text.

index 2 to 3). For example, higher level of access to organized care was associated with lower stroke fatality at 30 days (OR, 0.31; 95% CI, 0.24 to 0.40; c-statistics 0.82) and at 7 days (OR, 0.18; 95% CI, 0.13 to 0.25; c-statistics 0.83). The interaction terms examining age-by-organized care index effect were again not significant ($P=0.29$ for 30-day stroke fatality and $P=0.46$ for 7-day stroke fatality).

The benefit was also observed for the composite outcome of 30-day stroke fatality or institutionalization (for stroke units admission: OR, 0.79; 95% CI, 0.66 to 0.96; c-statistics 0.80 and for organized care index 2 to 3 versus 0 to 1: OR, 0.58; 95% CI, 0.47 to 0.71; c-statistics 0.82).

In the secondary analysis after the exclusion of patients treated with a palliative approach, there was no evidence of an age-by-stroke unit interaction effect, and the effect size estimates for stroke unit care were not substantially different (for risk-adjusted stroke fatality at 30 days: OR, 0.67; 95% CI, 0.47 to 0.85; c-statistics 0.75 and for risk-adjusted stroke fatality at 7 days: OR, 0.47; 95% CI, 0.27 to 0.82; c-statistics 0.76). Similar findings were observed for organized inpatient care.

Discussion

Organized care is the current paradigm to optimize stroke delivery and improve patient outcomes. Because stroke care is resource-intensive, it is important to identify populations most likely to benefit from this intervention. The older segments of the population are growing at an accelerated rate than that of the world's total population, a phenomenon called "population aging."[19] Our study is relevant by showing a consistent benefit in survival or institutionalization from stroke unit admission and organized inpatient stroke care across all age groups. In addition, there was a gradient effect between the organized care index and stroke fatality among all age groups (Figure 1). This held true in elderly patients with moderate/severe stroke (CNS score <7) and was not mitigated by excluding patients who arrived unconscious or were palliated.

Previous work has suggested a beneficial effect of specialized stroke care among elderly individuals.[20,21] In a recent meta-analysis published by the Stroke Unit Trialists' Collaboration, 6936 participants from 31 trials were analyzed to assess whether more organized care was consistently associated with improved outcomes.[2] Organized inpatient (stroke unit) care was characterized by: (1) coordinated multidisciplinary rehabilitation; (2) staff with a specialist interest in stroke or rehabilitation; (3) routine involvement of careers in the rehabilitation process; and (4) regular programs of education and training. The authors found that patients with stroke who receive organized inpatient care in a stroke unit are more likely to be alive, independent, and living at home 1 year after the stroke. Although the group reported that the benefit of stroke units was independent of age, the authors cautioned readers regarding the small number of outcomes,

Table 2. Effect of Stroke Unit Admission on Stroke Fatality and Organized Care on Stroke Outcomes by Age Group

	7-Day Stroke Fatality							30-Day Stroke Fatality						
	Event Rate (%)							Event Rate (%)						
Age Group	SU (+)	SU (−)	RR	ARR (95% CI)	RRR, %	ARR, %	NNT	SU (+)	SU (−)	RR	ARR (95% CI)	RRR, %	ARR, %	NNT
<59	2.8	7.0	0.40	0.64 (0.46–0.86)	60.3	4.2	24	4.2	8.7	0.48	0.68 (0.51–0.90)	51.6	4.5	22
60–69	3.3	6.8	0.49	0.53 (0.37–0.74)	51.4	3.5	29	5.3	8.6	0.61	0.72 (0.55–0.94)	38.9	3.4	30
70–79	3.6	8.8	0.41	0.44 (0.32–0.59)	58.8	5.2	19	8.2	13.5	0.61	0.65 (0.53–0.80)	39.4	5.3	19
>80	8.0	10.3	0.78	0.69 (0.51–0.88)	22.4	2.3	43	17.4	22.9	0.76	0.55 (0.53–0.80)	24.2	5.5	18
Overall	4.9	8.6	0.57	0.57 (0.40–0.76)	42.6	3.7	27	10.2	14.8	0.69	0.71 (0.59–0.85)	31.2	4.6	22

SU (+) represents stroke unit admissions; SU (−), other place admissions than stroke unit..

Table 3. Effect of Organized Care Index (OCI) on Stroke Fatality

	7-Day Stroke Fatality							30-Day Stroke Fatality						
	Event Rate (%)							Event Rate (%)						
Age Group	OCI 2–3	OCI 0–1	RR	ARR (95% CI)	RRR, %	ARR, %	NNT	OCI 2–3	OCI 0–1	RR	ARR (95% CI)	RRR, %	ARR, %	NNT
<59	3.0	11.9	0.17	0.18 (0.12–0.24)	83.4	9.9	10	3.4	13.8	0.24	0.26 (0.20–0.34)	75.6	10.4	10
60–69	2.5	10.9	0.23	0.24 (0.17–0.34)	76.9	8.4	12	4.4	13.0	0.34	0.40 (0.31–0.53)	66.5	8.7	12
70–79	2.6	14.6	0.18	0.16 (0.11–0.22)	82.4	12.0	8	6.8	20.0	0.34	0.33 (0.27–0.40)	66.0	13.2	8
>80	4.4	20.2	0.22	0.28 (0.22–0.36)	78.2	15.8	6	14.0	34.1	0.41	0.53 (0.46–0.60)	58.8	20.1	5
Overall	3.1	15.3	0.20	0.22 (0.16–0.29)	79.9	12.2	8	8.2	22.3	0.37	0.41 (0.34–0.50)	63.2	14.1	7

limited statistical power, and change in the results depending on the outcome chosen.[2] In another large study including 1847 patients with stroke (40% >75 years of age) from 13 hospitals in 10 European countries, organized stroke care provided no reduction in disability or mortality at discharge in those >75 years of age.[22] None of the aforementioned studies were specifically designed to determine the benefit of stroke units/organized care by age group.[2,22]

In the real world, different interventions (intravenous and intra-arterial thrombolysis, mechanical devices) and models of care (regionalized versus centralized, protocols to "bypass" local hospitals, remote access to specialized stroke management [telestroke], etc) are available for the management of patients with acute stroke. Our study provides new insight on the questioned effect of stroke units and organized stroke care among elderly individuals by providing evidence that the benefit is not limited to younger patients. Furthermore, this effect is not limited to simply care on a stroke unit or not, but to the intensity of care. More is better. Among those aged ≥80 years, stroke fatality was reduced approximately 3 times for organized care index 2 or 3 (highest levels of care) versus organized care index 0 (lowest level of care; Figure 1). The NNT to prevent one death if the oldest group received optimal care (organized care index=2 to 3 versus organized care index 0 to 1) is low (NNT=5 for 30-day stroke fatality and NNT=6 for 7-day stroke fatality). This NNT for 7-day stroke fatality is even more dramatic when comparing the beneficial effects of organized stroke care with other age groups (NNT=10 for those <59 years, NNT=12 for those aged 60 to 69, and NNT=8 for those aged 70 to 79; Table 3). Our study confirms the beneficial effects of organized care on stroke survival in the "real world" among all age groups.

There are some 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. Second, there is the possibility that those patients with the highest mortality were "too sick from onset" to receive stroke unit care or physiotherapy/occupational therapy before death. This would result in an overestimation of the mortality effect directly due to withholding of "organized care." Such patients likely had stroke team assessment but little else because they were palliated from onset or died shortly after admission to an intensive care unit or other neuro-stepdown unit. However, analyses excluding these patients did not significantly alter the results of the study. Third, unmeasured variables not included in the analysis (for example, time of physiotherapy/occupational therapy assessment, number of occupational therapy/physiotherapy consults, decision time for palliative care) may have influenced our results.

Finally, stroke unit care sits in the context of the health system. The Canadian system of provincially centralized care with universal access to hospital care differs from that available in the United States.[23,24] Stroke unit care in Canada often means an inpatient stay of ≥10 days depending on severity and includes early rehabilitation. Inpatient rehabili-

Table 4. Effect of Stroke Unit and Organized Care on 30-Day Stroke Fatality or Institutionalization

	Stroke Unit						Organized Care Index (OCI)					
	30-Day Stroke Fatality/Institutionalization						30-Day Stroke Fatality/Institutionalization					
	Event Rate (%)						Event Rate (%)					
Age Group	SU (+)	SU (−)	RR	RRR, %	ARR, %	NNT	OCI 2–3	OCI 0–1	RR	RRR, %	ARR, %	NNT
<59	4.5	9.5	0.48	52.1	4.9	20	3.8	14.8	0.26	74.1	10.9	9
60–69	10.2	13.6	0.75	24.7	3.3	29	9.9	16.7	0.59	40.7	6.8	15
70–79	20.1	22.1	0.91	8.9	2.0	51	18.7	26.6	0.70	29.6	7.9	12
>80	34.9	41.0	0.85	14.8	6.1	16	33.6	47.8	0.70	29.7	14.2	7
Overall	20.9	24.4	0.86	14.1	3.4	29	19.6	30.6	0.64	36.0	11.0	9

SU (+) represents stroke unit admissions; SU (−), other place admissions than stroke unit.

OCI indicates organized care index. For comparison purpose, OCI was dichotomized in 2–3 versus 0–1 in these analyses. Further details on the OCI are provided in the text.

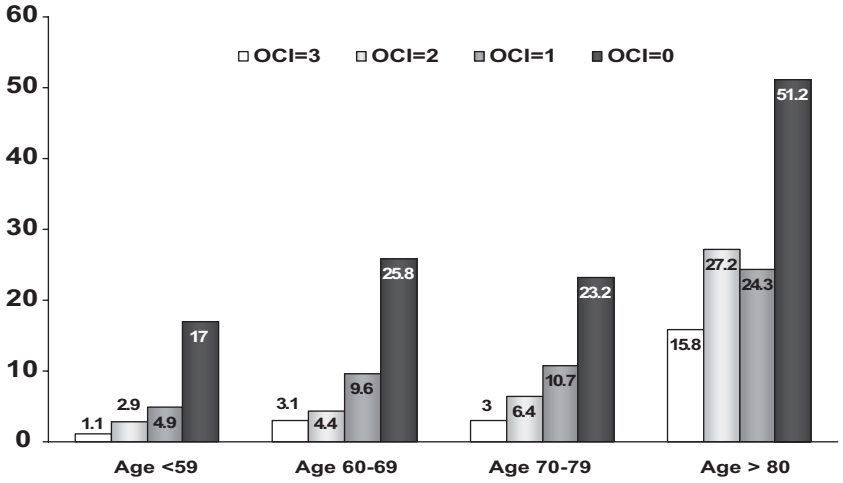

Figure 2. Thirty-day risk-adjusted fatality by organized care index in patients with moderate/severe stroke (CNS score <7). Patients on palliative care or unconscious are not represented in this figure (n=406). *$P<0.001$ when compared with organized care index=0. The "organized care" index (OCI) was 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 patients with stroke received none of the services, whereas higher scores indicate access to highly more services. Note a graded survival improvement with higher levels of access to care (OCI=0 to OCI=3) for all age groups. Further explanation is provided in the text.

tation on a rehabilitation ward may progress for 3 to 4 months for the most severely affected patients. In the United States, patients with stroke rarely stay in the hospital for 5 days and inpatient rehabilitation stays are rarely longer than 1 month.[25–27] Thus, these results should be interpreted with this context in mind. Our data provide real-world evidence of the effectiveness of collaborative, high-quality, standardized, and effective care in reducing poor outcomes for stroke victims regardless of age.

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Disclosures

None.

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