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## Stroke in the very elderly: hospital care, case fatality and disposition.

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# Stroke in the Very Elderly: Hospital Care, Case Fatality and Disposition

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## Key Words

Stroke • Socioeconomic status • Elderly • Nonagenarian •  
Mortality outcome research • Health services research •  
Health policy

## Abstract

**Background:** The worldwide growing number of older people represents a new phenomenon. Considering that the prevalence of stroke increases with age and higher life expectancy, the prevalence of stroke will likely rise in the next decade. However, limited information is available about the burden of stroke in individuals over 90. **Methods:** This is a subgroup analysis from a multicenter cohort study including individuals admitted with an ischemic stroke to a broad range of hospitals across Canada. Patients were identified from the Canadian Hospital Morbidity database (HMDB), which is a national database that contains patient-level sociodemographic, diagnostic and administrative information. Multivariable analysis was performed using logistic regression. Outcomes measures include risk-adjusted stroke fatality, ICU admissions, medical complications, length of hospital stay and discharge disposition. **Results:** Among 26,676 patients with ischemic stroke admitted to 606 hospitals, 2,015 (7.6%) were aged 90 years or older. Risk-adjusted fatality at discharge was 6.3% (age <69), 12.5% (age 70–79),

22.0% (age 80–89) and 36.1% (age ≥90) ( $p < 0.001$ ). Patients aged 90 and over were more likely admitted on weekends (28.1 vs. 24.6;  $p < 0.001$ ), and less likely to be admitted to the ICU (4.3 vs. 13.0%,  $p < 0.001$ ) and discharged to their pre-stroke residence (39.9% for those over 90 vs. 57.3% for patients younger than 90,  $p < 0.001$ ). In the multivariable analysis, nonagenarians and older were 5–8 times more likely to die after adjusting for covariates. **Conclusion:** In our study, stroke patients over 90 had higher risk-adjusted mortality, longer hospitalization, and were less likely to be discharged to their original place of residence. In view of these findings, strategies need to be implemented to facilitate equal access to specialized stroke care for the elderly.

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## Introduction

The growing number of senior citizens, known as population aging, is one of the most dramatic demographic trends in the world today. The economic effects of an aging population are considerable (fewer goods consumers, higher health users). This continuing epidemiological phenomenon is most noticeable in developed countries. According to Statistics Canada, it is estimated that there are currently 175,000 nonagenarians and by the year 2031,

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**Table 1.** Baseline characteristics by age groups

Characteristics	Age group				p value for trend
	<69 years (n = 8,086)	70–79 years (n = 8,419)	80–89 years (n = 8,156)	>90 years (n = 2,015)	
Gender					<0.001
Female	2,978 (36.8)	3,847 (45.7)	4,711 (57.8)	1,463 (72.6)	
Charlson comorbidity index score					0.40
0–1	5,632 (69.7)	5,814 (69.1)	5,825 (69.0)	1,356 (67.3)	
2	1,760 (21.8)	1,884 (22.4)	1,854 (22.7)	470 (23.3)	
≥3	694 (8.6)	721 (8.6)	677 (8.3)	189 (9.4)	
Facility type					<0.001
Academic	1,845 (22.8)	1,576 (18.7)	1,399 (17.1)	359 (17.8)	
Non-academic	6,241 (77.2)	6,843 (81.3)	6,757 (82.9)	1,656 (82.2)	
Hospital location					0.26
Rural	1,952 (24.1)	2,000 (23.8)	1,952 (23.9)	444 (22.0)	
Urban	6,134 (75.9)	6,419 (76.2)	6,205 (76.1)	1,571 (78.0)	
Most responsible physician					0.02
General practitioners	1,332 (16.5)	1,371 (16.3)	1,433 (17.3)	375 (18.6)	
Specialist	6,754 (83.5)	7,048 (83.7)	6,723 (82.4)	1,640 (81.4)	
Socioeconomic status (quintiles) <sup>1</sup>					0.01
1 (lowest)	1,802 (23.6)	1,820 (22.8)	1,691 (21.9)	439 (23.4)	
2	1,594 (20.9)	1,720 (21.5)	1,748 (22.6)	411 (21.9)	
3	1,620 (21.2)	1,669 (20.9)	1,598 (20.7)	358 (19.1)	
4	1,421 (18.6)	1,518 (19.0)	1,398 (18.1)	322 (17.2)	
5 (highest)	1,195 (15.7)	1,270 (15.8)	1,289 (16.7)	345 (18.4)	

<sup>1</sup> Socioeconomic status was estimated through an approach developed by Statistics Canada that assigns neighborhoods to equally-sized quintiles based on socioeconomic status data reported on the 2001 Census. A higher quintile value of a residential area is associated with higher median socioeconomic status of residents in that area. Socioeconomic status could not be determined in 1,448 (5.4%) of individuals. Values in parentheses represent percentages unless otherwise specified.

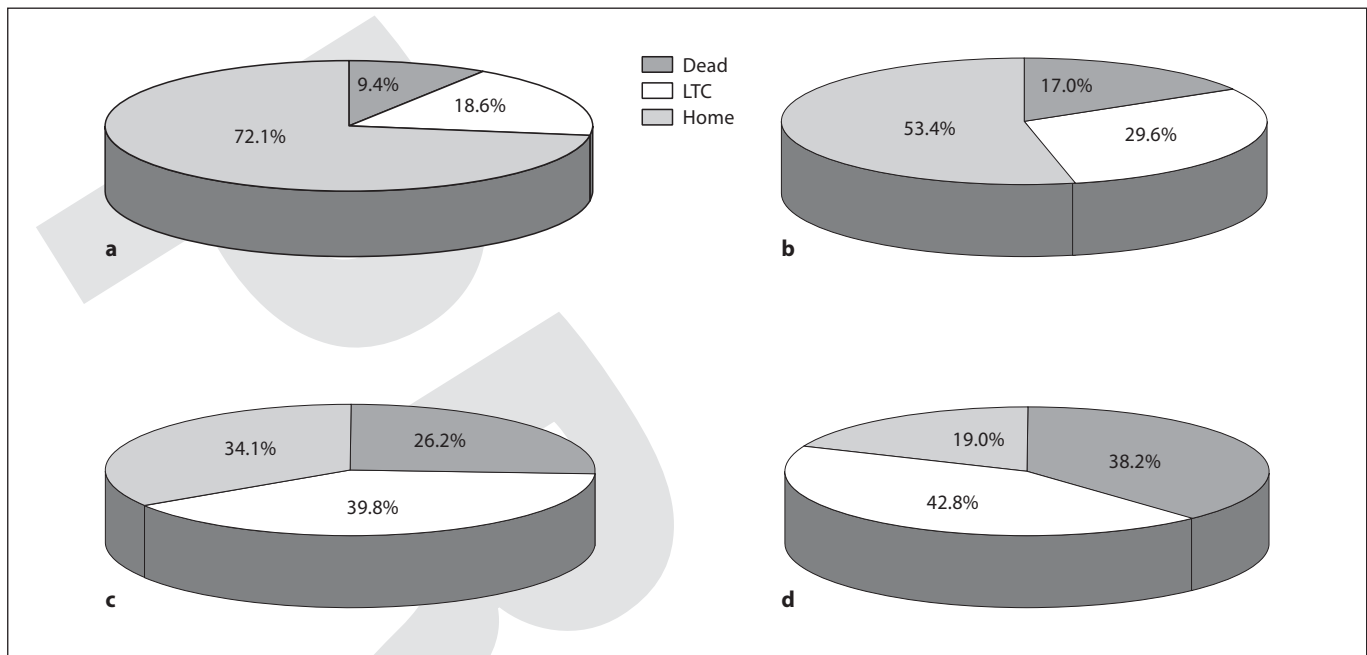
there will be approximately 401,000, representing a greater than 90% increase in the next 25 years (from 0.54% in 2006 to 1.03% in 2031) [1, 2]. Considering the higher comorbidities and the increase of stroke incidence with age, a rise in the number of strokes is to be expected in the older segment of the population [3]. This new scenario will likely affect healthcare providers, policymakers and subsequently stroke care delivery in different countries. Unfortunately, scarce data is available in a large population regarding stroke care in patients over age 90. Moreover, most clinical trials have excluded this age group with the consequence that there is limited evidence on the efficacy of different pharmacological options. In a previous publication, our group highlighted different aspects of stroke care in patients over the age of 80 [4].

In this subgroup analysis, we evaluated in-hospital care, length of hospital stay, complication rates, discharge disposition and case fatality for acute ischemic strokes in the subgroup of persons over age 90.

The findings can help guide expectations, different strategies in terms of clinical management, access to specialized care, and organized in-hospital stroke care in the older segments of our population.

## Methods

Patients with ischemic stroke who were admitted to acute care hospitals in Canada between April 1, 2003, and March 31, 2004 were identified through the Hospital Morbidity and Mortality Database (HMDB). The HMDB is a national database that contains patient-level sociodemographic, diagnostic, procedural and administrative information across Canada managed by the Canadian Institute for Health Information. All acute care facilities must report to the HMDB. Canada's healthcare system is government-funded including universal public provision of physician and hospital services with no co-payments or other patient charges [5]. A comprehensive range of facilities are included in this report (academic and community hospitals, urban and rural institutions, academic and non-academic from all provinces and territories) which cover over 99% of all acute care hospitals in



**Fig. 1.** Disposition by age group: **a** <69, **b** 70–79, **c** 80–89, and **d** >90 years. Disposition among stroke survivors after excluding interfacility transfers and unknown disposition. LTC includes discharge to a nursing home, chronic care, and palliative care institution. Note that in the age group <69 years, for every 100 patients admitted with an ischemic stroke, 9 died in hospital, 18 were discharged to a LTC (nursing home, chronic care or palliative care) institution and the great majority (72) were discharged home. In contrast, for every 100 patients aged 90 years or older admitted with an ischemic stroke, 38 died in hospital, only 19 were discharged home and the majority of survivors (43) were discharged to a LTC facility.

Canada. The inclusion criterion was an admission to an acute care facility with a principal diagnosis of ischemic stroke as according to the International Classification of Diseases, either the Ninth (ICD-9) or Tenth (ICD-10) Revision (ICD-9 codes 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, and ICD-10 codes I63, I64) [6, 7]. Rural location was defined according to the hospital postal code. Hospital academic status was defined according to the Association of Canadian Academic Healthcare Organizations (ACAHO) [8]. We used the Charlson-Deyo comorbidity index to quantify patients' comorbid conditions [9]. Socioeconomic status was estimated through an approach developed by Statistics Canada that assigns neighborhoods to quintiles [10]. A higher quintile value of a residential area is associated with higher median socioeconomic status of residents in that area.

The study protocol was approved by the Ethics Review Board at St. Michael's Hospital, University of Toronto. Further details of the study design and data quality has been published elsewhere [4].

#### Statistical Analysis

$\chi^2$  or Fisher's exact tests were used to compare categorical variables, while Student's *t* tests and ANOVA were applied to compare continuous variables. The Mann-Whitney test was used to compare median length of stay. A significance level of  $p < 0.25$  on univariate analysis was used as a screening cutoff for developing the models. Those factors achieving this level of significance were then included in a multivariable analysis. The final model in-

cludes variables achieving significance of  $p < 0.05$  associated with the outcome measures. Categories of age were included as the main covariate to determine the magnitude of the effect on stroke fatality after adjusting for other variables. We used the ADJUST command in STATA, to calculate risk-adjusted case-fatality rates as reported by other authors [11, 12]. Socioeconomic status was dichotomized according to the quintiles, where the two lowest quintiles represented low socioeconomic status. Admission to the ICU was used as a surrogate of stroke severity in the adjusted models. All statistical analyses were performed using a commercially available software package (SAS Statistical Software 1999, Version 8, Cary, N.C.: SAS Institute, Inc., and STATA Version 8.0, StataCorp LP, College Station, Tex., USA).

#### Outcome Measures

Main outcome measures include stroke case fatality (at 7-day, at discharge, and at risk-adjusted case fatality). Stroke fatality was defined as the proportion of ischemic stroke events that are fatal within a given period of time. Sex, comorbidities, most responsible provider, ICU admission, hospital academic status and location, and socioeconomic profile were considered in calculating risk-adjusted stroke fatality. Secondary outcomes included ICU admissions, medical complications, length of hospital stay and discharge disposition [pre-stroke place of residence, long-term care (LTC) facility, death]. Discharge to a LTC included nursing home, chronic care or palliative care institution.

**Table 2.** Primary and secondary outcome measures

Characteristics	Age group				p value for trend
	<69 years (n = 8,086)	70–79 years (n = 8,419)	80–89 years (n = 8,156)	>90 years (n = 2,015)	
<i>Primary outcome measures</i>					
7-day case fatality	325 (4.0)	578 (6.9)	834 (10.2)	302 (15.0)	<0.001
Risk-adjusted fatality at discharge (95% CI)	6.3 (5.8–6.8)	12.5 (11.8–13.2)	22.0 (21.1–22.9)	36.1 (33.9–38.3)	<0.001
<i>Secondary outcome measures</i>					
Medical complications					
Pneumonia	284 (3.5)	290 (3.4)	270 (3.3)	70 (3.5)	0.91
Urinary tract infection	247 (3.1)	275 (3.3)	277 (3.4)	73 (3.6)	0.54
Intracerebral hemorrhage	14 (0.2)	18 (0.2)	21 (0.3)	6 (0.3)	0.60
Pulmonary embolism	44 (0.5)	40 (0.5)	46 (0.6)	12 (0.6)	0.84
Decubitus ulcer	15 (0.19)	16 (0.19)	15 (0.18)	8 (0.40)	0.25
ICU admission	1,384 (17.1)	1,139 (13.5)	694 (8.5)	87 (4.3)	<0.001
Length of stay in days, median (IQR)	6 (3–13)	8 (4–18)	10 (5–22)	11 (5–24)	<0.001

IQR = Interquartile range. Values in parentheses represent percentages unless otherwise specified.

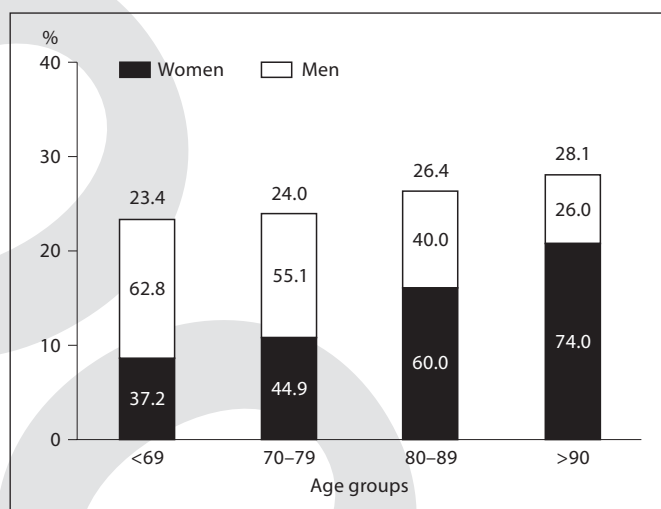
## Results

Among 26,676 patients with an ischemic stroke admitted to 606 hospitals across Canada, mean age ( $\pm$ SD) was  $74 \pm 13$  years. Of these, 2,015 (7.6%) were aged 90 years or older, in comparison to 5.1% under age 50. Baseline characteristics are summarized in table 1. Minor differences in gender, socioeconomic status and care facility type were observed in the over 90 age group compared to younger age groups.

Survival after stroke decreased with age. For example, stroke fatality at discharge was 5.7% (age <69), 8.6% (age 70–79), 13.4% (age 80–89) and 24.2% (age >90) ( $p < 0.001$ ). This holds true after adjusting for covariates.

There was a significant difference in hospital disposition (dead, home, LTC facility) among all age groups ( $p < 0.001$ ; fig. 1). For example, for every 100 patients aged 90 years or older admitted with an acute ischemic stroke, 38 died in-hospital, only 19 were discharged home and the great majority (43) were discharged to a LTC facility when interfacility transfers and unknown hospital disposition were excluded ( $n = 5,303$ ).

Those over 90 years had a 55% (95% CI 48–60%) decrease in the odds of being discharged home when compared with their counterparts aged 80–89 years. Table 2 summarizes the main outcome measures by age groups. Those over 90 years old had a longer length of hospital stay (median 8 days for younger vs. 11 days for older than age 90;  $p < 0.0001$ ), and were less likely to be admitted to



**Fig. 2.** Weekend admissions by age group and gender. This figure represents weekend admissions for ischemic stroke by age group. Numbers at the top of the bars represent the overall percentages for weekend admissions in each age group. Note the higher proportion of admissions on weekends for patients 90 years and over ( $p < 0.001$ ). Values in the bars represent gender distribution in percentages for weekend admissions in each age group.

the ICU. We found no significant differences in the medical complication rates between the older and younger groups.

Interestingly, nonagenarians were more likely to be admitted on weekends in comparison to their younger

**Table 3.** Multivariable analysis for stroke fatality<sup>1</sup>

	7-day stroke fatality			Stroke fatality at discharge		
	adjusted OR	95% CI		adjusted OR	95% CI	
Age						
<69	ref	–	–	ref	–	–
70–79	1.84	1.59	2.13	2.12	1.90	2.37
80–89	3.01	2.67	3.53	4.19	3.76	4.65
>90	5.15	4.31	6.15	8.48	7.40	9.71
Gender, women	1.05	0.95	1.15	0.98	0.91	1.05
Charlson index score $\geq 2$	1.09	0.97	1.23	1.01	0.92	1.11
Facility location						
Urban (reference)	1.00	–	–	1.00	–	–
Rural	1.17	1.04	1.30	1.00	0.92	1.09
Most responsible physician						
Specialist (reference)	1.00	–	–	1.00	–	–
General practitioner	1.06	0.94	1.20	1.12	1.02	1.23
Hospital status, non-academic	1.13	0.99	1.28	1.12	1.02	1.23
Low socioeconomic status <sup>2</sup>	1.16	1.05	1.27	1.16	1.08	1.25
ICU admission	3.10	2.76	3.48	3.12	2.84	3.43

CI = Confidence interval.

<sup>1</sup> Adjusted for sex, Charlson index, socioeconomic status, ICU admission, hospital location, academic status, and most responsible provider.<sup>2</sup> Socioeconomic status was estimated through an approach developed by Statistics Canada that assigns neighborhoods to equally-sized quintiles based on socioeconomic status data reported on the 2001 Census. For the multivariable analysis socioeconomic status was dichotomized as low (Q1+Q2) or high (Q3+Q4+Q5).

counterparts (28.1 for 90 and over vs. 24.6 for under 90 years old) (fig. 2). Gender distribution for weekend admissions was similar to the overall gender distribution in each age group.

In the multivariable analysis, stroke patients over 90 were 5–8 times more likely to die after adjusting for covariates. Admission to the ICU and low socioeconomic status were also associated with 7-day stroke fatality. Similar results were found for stroke fatality at discharge, including increased likelihood of being admitted to non-academic institutions and not having specialist care (table 3).

## Discussion

Population aging is a rapidly increasing phenomenon that will likely challenge the healthcare system [1]. According to Statistics Canada, the number of elderly will exceed the number of children (age 0–14) by around 2015 [2]. A better understanding of age differences in stroke care, length of stay, discharge disposition and mortality will help implement health promotion strategies and delivery of services. In this country-wide study,

we found that 7.6% of ischemic strokes across Canada occurred in individuals aged 90 or older. We observed a higher stroke fatality (at 7-day, at discharge and risk-adjusted), and a longer length of hospital stay in this age group. For example, risk-adjusted fatality at discharged among those over 90 years was 6 times higher than in the youngest age group and 1.5 higher than in those aged 80–89 years. Only 1 out of 5 individuals over 90 years were discharged home after an ischemic stroke in comparison with 1 out of 3 of aged 80–89 and 3 out of 4 in the youngest age group. More interestingly, there was a graded relationship between age and weekend admissions. The reasons for why nonagenarians were more likely to be admitted on weekends than the younger age groups (28.1 for those >90 vs. 24.6 for those <90) are not clear. The aforementioned findings highlight the distinctive characteristics of nonagenarians. Moreover, after adjusting for covariates, stroke fatality was 5–8 times higher among the over 90s (table 3) when compared with the younger group (<70 years old). Case fatality increased by 16% with low socioeconomic status. Non-specialist care was also associated with a 12% higher mortality at discharge.

The older segment of the world population is growing at an accelerating rate. Graying of the population, the so-called *silver tsunami*, is also driving up the prevalence of arterial hypertension, atrial fibrillation and dyslipidemia, comorbid conditions all of which increase with age [13–16].

Interestingly, the frequency of stroke in those over 90 is beginning to outnumber stroke in the young (7.6% for those >90 vs. 5.1% for those <50) but surprisingly little information is available on stroke outcomes in persons over age 90.

#### *What Makes This Age Group Different?*

A higher frequency of comorbidities, lower life expectancy, altered metabolism, and polypharmacy with lower medication compliance may all be contributory [17]. Not many nonagenarians have been included in clinical trials. For example, the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and the European Carotid Surgery Trial (ECST) demonstrated a greater benefit from carotid endarterectomy in elderly compared with younger patients (in NASCET, the absolute risk reduction for CEA during the 2-year follow-up was 9.7% for those <65 years, 15.1% for those aged 65–74 years, and 28.9% for those ≥75 years) [18, 19]. However, nonagenarians or older were not enrolled in these trials. Despite recent information about the feasibility and safety of the administration of thrombolytic therapy, limited information is available regarding the epidemiology, prevention and management of stroke in those over age 90 [20, 21].

The finding of poorer outcomes in elderly stroke patients is consistent with previous studies on stroke as well as other medical conditions [22–25]. Limited access to specialists or organized stroke care in some institutions may explain this phenomenon [4].

In a recent Canadian study from Quebec, the authors found an increase in median age and prevalence of comorbidities in patients with stroke. There was a 7% absolute increase (58% relative increase) in the proportion of patients 85 years and older with an ischemic stroke. During a 14-year period, 7-day case-fatality rate remained stable (range 11–14%) for those aged 85 and older [26]. In a longitudinal study of 168 patients over 65 years from Spain, 29% were older than 85 years. 52% gained more than 20 points on the Barthel index. Severe functional impairment on admission and post-stroke depression were the factors that were independently associated with moderate-severe disability at discharge [27].

Limitations of our study are common to those using administrative data, including: lack information on

stroke severity and imaging, miscoding or underreported medical complications and comorbid conditions. It is possible that prior directives might affect decision-making concerning the option of ICU care (e.g., very elderly may more commonly opt not to have intensive interventions).

Despite these limitations, our national, population-based study illustrates the value of assessing stroke outcomes including case fatality, disposition, and hospital care in specific age subgroups across Canada.

In our study, 70% of stroke occurred in those over 70 years. Given the high prevalence of stroke with aging and that the older seniors are the fastest-growing segment in our population, surprisingly little is known about stroke care and outcomes in this particular age subgroup. Our findings have practical implications for access to care, clinical management, and health policy. For example, 1 out of 3 stroke patients aged 90 years or older will not leave the hospital alive. The exponential effect of aging may cause longer length of hospital stay and more disabled stroke survivors, increasing the demand for more complex care (acute and LTC beds, specialized care, stroke units, ICU, etc.). We may expect that this phenomenon will likely change stroke care delivery and our routine practice.

The findings of our study should alert healthcare providers, policymakers and administrators to determine quality improvement strategies to facilitate access to specialized stroke care, and improve morbidity and mortality in this growing segment of the population.

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