Call 911: Lower Ambulance Utilization Among Young Adults, Especially Women, with Stroke

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ABSTRACT: ***Background:*** Delayed presentation to the emergency department influences acute stroke care and can result in worse outcomes. Despite public health messaging, many young adults consider stroke as a disease of older people. We determined the differences in ambulance utilization and delays to hospital presentation between women and men as well as younger (18–44 years) versus older (≥45 years) patients with stroke. ***Methods:*** We conducted a population-based retrospective study using national administrative health data from the Canadian Institute of Health Information databases and examined data between 2003 and 2016 to compare ambulance utilization and time to hospital presentation across sex and age. ***Results:*** Young adults account for 3.9% of 463,310 stroke/transient ischemic attack/hemorrhage admissions. They have a higher proportion of hemorrhage (37% vs. 15%) and fewer ischemic events (50% vs. 68%) compared with older patients. Younger patients are less likely to arrive by ambulance (62% vs. 66%, p < 0.001), with younger women least likely to use ambulance services (61%) and older women most likely (68%). Median stroke onset to hospital arrival times were 7 h for older patients and younger men, but 9 h in younger women. There has been no improvement among young women in ambulance utilization since 2003, whereas ambulance use increased in all other groups. ***Conclusions:*** Younger adults, especially younger women, are less likely to use ambulance services, take longer to get to hospital, and have not improved in utilization of emergency services for stroke over 13 years. Targeted public health messaging is required to ensure younger adults seek emergency stroke care.

RÉSUMÉ : **Les jeunes adultes victimes d'un AVC, en particulier les femmes, ont moins tendance à appeler le 911.** ***Contexte :*** En cas d'AVC aigu, le fait de tarder à se présenter au service des urgences a un impact sur les soins donnés et peut entraîner une évolution moins favorable de l'état de santé des patients. En dépit de campagnes de santé publique, de nombreux jeunes adultes considèrent les AVC comme un phénomène qui affectent les personnes âgées. À ce sujet, nous avons cherché à déterminer les différences pouvant exister entre les hommes et les femmes en ce qui regarde le recours à une ambulance et les délais de présentation à un établissement hospitalier. Nous avons fait le même exercice en comparant des patients âgés de 18 à 44 ans victimes d'un AVC ans à des patients de 45 ans et plus victimes eux aussi d'un AVC. ***Méthodes :*** Nous avons ainsi effectué une étude populationnelle rétrospective au moyen de données administratives pancanadiennes de l'Institut canadien d'information sur la santé (ICIS) ou de données déjà analysées de 2003 à 2016. ***Résultats :*** Les jeunes adultes ont représenté 3,9 % des 463 310 admissions en lien avec des AVC, des AIT et des cas d'hémorragie cérébrale. Ils ont donné à voir une proportion plus élevée de cas d'hémorragie (37 % contre 15 %) et moins élevée d'incidents de nature ischémique (50 % contre 68 %) si on les compare à des patients plus âgés. Les patients plus jeunes étaient aussi moins susceptibles de se rendre au service des urgences en ambulance (62 % contre 66 % ; p < 0,001). Notons par ailleurs que les jeunes femmes étaient les moins susceptibles de recourir à un tel service (61 %) tandis que les femmes plus âgées étaient les plus susceptibles (68 %). Les délais médians d'arrivée au service des urgences à partir des débuts d'un AVC étaient de 7 heures pour les patients plus âgés et les hommes âgés de 18 à 44 ans mais de 9 heures dans le cas des femmes de ce groupe d'âge. Enfin, il est à noter, dans le cas des jeunes femmes, qu'il n'y a pas eu depuis 2003 d'amélioration en matière de recours à une ambulance, et ce, contrairement à tous les autres groupes. ***Conclusions :*** Les jeunes adultes, en particulier les jeunes femmes, sont moins susceptibles de recourir à une ambulance, vont nécessiter plus de temps avant de se présenter au service des urgences et n'ont pas augmenté leur fréquence d'utilisation des services d'urgence pour un AVC au cours de cette période de 13 ans. Des campagnes ciblées en santé publique sont donc nécessaires pour s'assurer que les jeunes adultes font davantage appel à des soins d'urgence en cas d'AVC.

Stroke is the second leading cause of death worldwide[1] and is becoming increasingly common in young adults.[2] In Canada, approximately 5% of strokes occur in adults under the age of 45 years[3] and 15%–20% occur under the age of 60.[4,5] Despite recent efforts at public education, many young adults consider stroke as a disease of elder people, which may contribute to

Table 1: Patient characteristics

	All (N = 463,310)	Younger (N = 17,859)	Older (N = 445,451)	Younger men (N = 9268)	Younger women (N = 8591)	Older men (N = 223,281)	Older women (N = 222,170)
Sex							
Men, n (%)	232,549 (50.2)	9268 (51.9)	223,281 (50.1)				
Women, n (%)	230,761 (49.8)	8591 (48.1)	222,170 (49.9)				
Median stroke onset to hospital arrival time (IQR)	6.8 (13.1)	8.3 (16.3)	6.8 (13.0)	7.5 (16.0)	9.2 (17.7)	6.9 (13.4)	6.6 (12.5)
Arrived by Ambulance, n (%)	305,723 (66.0)	11,069 (62.0)	294,654 (66.1)	5792 (62.5)	5277 (61.4)	142,638 (63.9)	152,016 (68.4)
Ischemic, n (%)	312,091 (67.4)	8842 (49.5)	303,249 (68.1)	4822 (52.0)	4020 (46.8)	154,487 (69.2)	148,762 (67.0)
ICH, n (%)	50,059 (10.8)	2579 (14.4)	47,480 (10.7)	1560 (16.8)	1019 (11.9)	24,698 (11.1)	22,782 (10.3)
SAH, n (%)	24,538 (5.2)	4032 (22.6)	20,506 (4.6)	1824 (19.7)	2208 (25.7)	7854 (3.5)	12,652 (5.7)
TIA, n (%)	75,065 (16.2)	1535 (8.6)	73,530 (16.5)	832 (9.4)	703 (8.2)	35,923 (16.1)	37,607 (16.9)
Other, n (%)	1557 (0.3)	871 (4.9)	686 (0.2)	230 (2.5)	641 (7.5)	319 (0.1)	367 (0.2)

decreased recognition of stroke symptoms and delays to seeking medical attention.[6] Previous studies have also reported sex differences in stroke knowledge, with young women having poor knowledge of stroke symptoms.[7] Hospital arrival is one of the first critical steps in early stroke management. Delayed presentation can lead to ineligibility for acute stroke treatments and worse stroke outcomes.[8,9] Current acute stroke treatments – thrombolytic therapy with alteplase[10] and endovascular therapy (EVT[11]) – are most effective when given early.[12–16] Indeed, younger patients are more likely to receive acute treatments if they arrive by ambulance.[17]

Public awareness campaigns, which include the international standard FAST (Face, Arms, Speech, Time to call 911) acronym,[18,19] have been established to increase stroke awareness in Canada, yet few studies have explored ambulance utilization and hospital arrival time in young patients with stroke symptoms, and fewer have compared the prehospital behavior of men and women as well as younger and older patients with stroke symptoms. We sought to investigate age and sex differences in arrival by ambulance, time to arrival and trends over time between 2003 and 2016 in Canada. We hypothesized greater ambulance utilization and faster time to hospital arrival among older adults.

METHODS

We conducted a population-based retrospective study using administrative health data from the Canadian Institute of Health Information databases. All Canadian citizens (population 37,058,856[20]) have access to medical care under a single-payer universal healthcare system, separately administered in each province. We used the Discharge Abstract Database (DAD)[21] database to obtain administrative, demographic, and diagnoses data from health encounters in the context of acute inpatient care across hospitals in Canada, except for the province of Quebec. This includes data from a dedicated stroke Special Project (CIHI # 340), which was implemented in 2009 to collect additional core stroke performance improvement indicators.[22] Reporting to Special Project 340 is mandatory for all
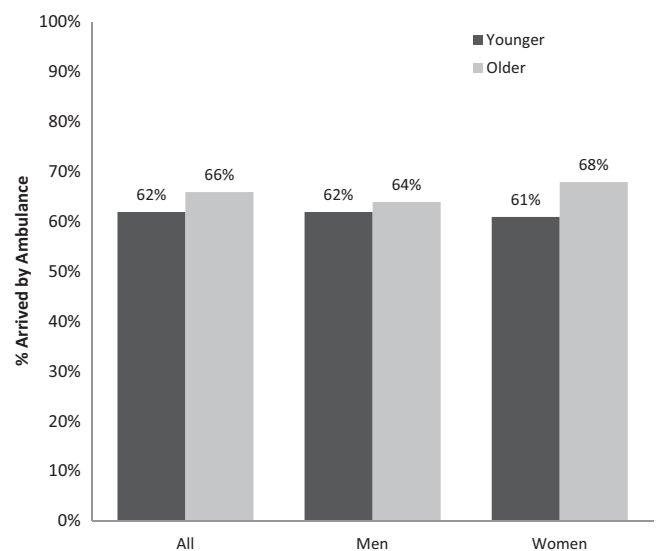

Figure 1: *Ambulance utilization by age and sex.*

stroke centers in Ontario and mandated in specific or all regions by most other provinces.[23,24] In these administrative datasets, the coding of stroke and vascular risk factors has been shown to have high sensitivity and specificity.[25] The current analysis included all patients admitted to any acute inpatient care unit between the fiscal years 2003/2004 to 2015/2016 with a primary discharge diagnosis of ischemic stroke (ICD-10 codes I63 and I64, H34.1), subarachnoid hemorrhage (SAH; I60), intracerebral hemorrhage (ICH; I61), transient ischemic attack (TIA; G45, H34.0 without G45.4), and cerebral venous sinus thrombosis (I67.6, G08). Multiple stroke subtypes (ischemic, SAH, ICH, TIA, venous thrombosis) were included since, at the onset of symptoms and when calling 911, people do not yet know which stroke type they have. Demographics, stroke subtype, and arrival by ambulance were obtained from DAD database between 2003/2004 to 2015/2016, and stroke onset to hospital arrival (emergency department triage time)
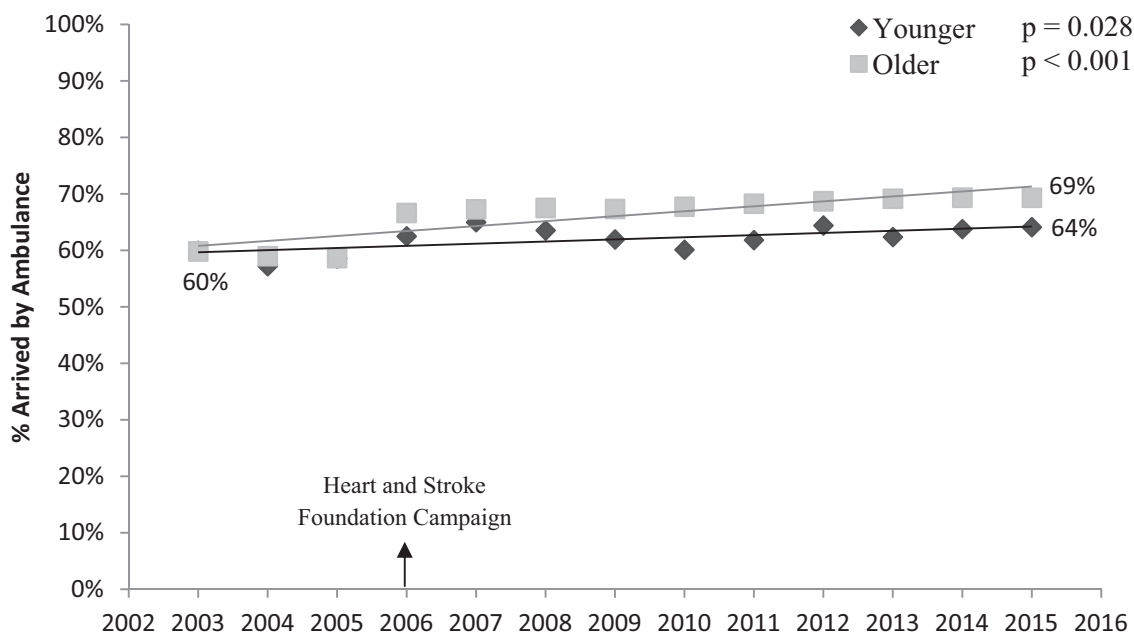
Figure 2: *Ambulance utilization over time by age.*

was obtained specifically from Project 340 data between 2009–2010 and 2015/2016. Within the administrative data, a significant increase in stroke risk factors and prevalence was observed at the age of 45 years; therefore, "young stroke" was defined as stroke occurring between 18 and 44 years of age.

STATISTICAL ANALYSIS

Our primary outcome was frequency of ambulance utilization and secondary outcome was time to hospital arrival. Age, sex, Charlson comorbidity index, and stroke type, arrival by ambulance and last seen normal (time from symptoms onset to hospital arrival), were examined and compared between young and older stroke patients and by sex using chi-squared tests and Wilcoxon rank-sum tests. Linear and logistic regression analyses were performed to examine trends over time in prehospital behavior and examine predictors of arrival by ambulance, respectively.

RESULTS

Data were analyzed from 547 hospitals in DAD excluding Quebec, representing 83% of all stroke cases in Canada admitted to emergency departments between 2003 and 2016. A total of 463,310 patients (50% men) were included, of whom 17,859 (3.9%) were less than 45 years of age. Ischemic stroke was more common among older patients than younger patients (68.1% vs. 49.5%), whereas ICH and SAH were more common among the younger patients (Table 1). Younger men, compared with younger women, were significantly more likely to have an ICH (16.8% vs. 11.9%, p < 0.001) and less likely to have SAH (19.7% vs. 25.7%, p < 0.001).

Arrival by Ambulance

Overall, 66% of patients arrived by ambulance. Older patients were more likely to arrive by ambulance than to younger patients (66.1% vs. 62.0%; p < 0.001; Figure 1). Older women were more likely to arrive by ambulance than older men (68.4% vs. 63.9%; p < 0.001); however, no differences were observed between younger men and women. Ambulance use increased significantly between 2003 and 2016 for both younger (β = 0.37, confidence interval [CI] 95% 0.05–0.69, p = 0.028) and older (β = 0.84, CI 95% 0.46–1.21, p < 0.001) patients (Figure 2) and for all groups (older men, younger men, older women, all p-values <0.05), except younger women (Figure 3). TIA patients were significantly less likely to arrive by ambulance compared with other stroke types (51.8% vs. 68.7%, p < 0.001). Ischemic stroke patients were less likely to arrive by ambulance compared with patients with hemorrhages (66.6% vs. 78.0%, p < 0.001).

Logistic regression analysis (Table 2), including age, sex, stroke type, and interaction terms, revealed that older age, male sex, and stroke type were all significant predictors of arrival by ambulance ($\chi^2(11) = 21930.17$, p < 0.0001). An age × sex × stroke type interaction was observed, with older females with ischemic stroke being more likely to arrive by ambulance (p < 0.001).

Arrival Time

Project 340 data were available for 59,894 patients. Between 2009 and 2016, median time from stroke onset to hospital arrival time was 6.8 h (interquartile range [IQR] = 13.1). Overall, older patients arrived significantly faster than younger patients (6.8 vs. 8.3 h; Z = 7.19, p < 0.0001, Table 2). Older women arrived to hospital faster than older men (6.6 vs. 6.9 h; Z = −4.52, p < 0.0001), whereas younger women arrive significantly later than younger men (9.2 vs. 7.5 h; Z = 2.90, p = 0.004).

DISCUSSION

Early hospital arrival is one of the most critical steps in acute stroke care.[12] Our results suggest that younger patients are less
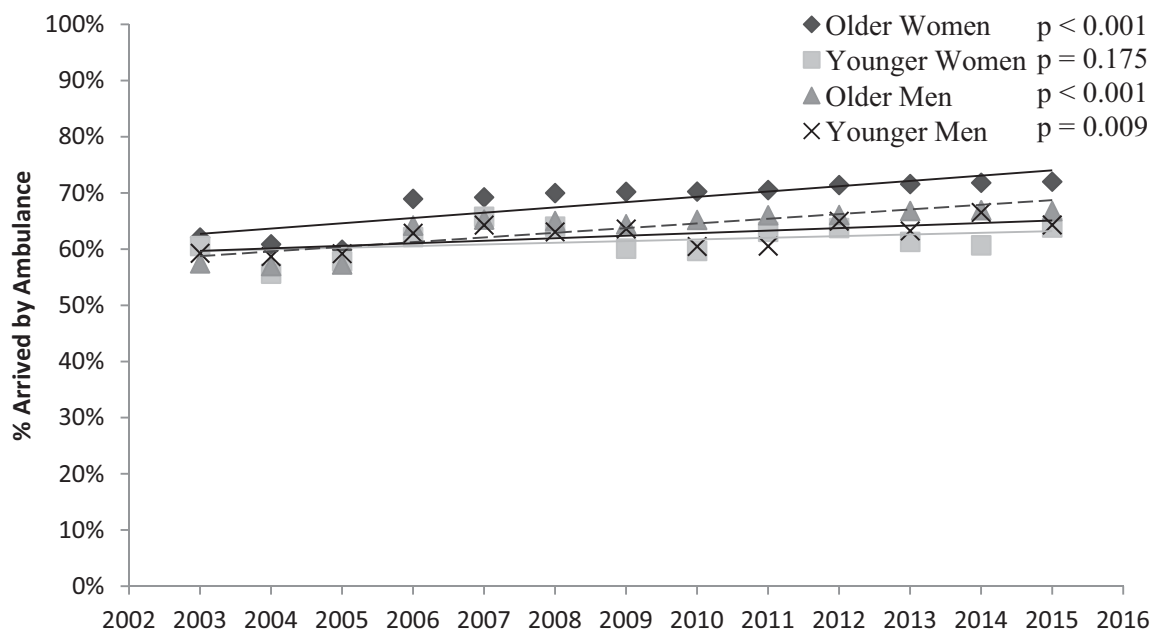
Figure 3: *Ambulance utilization over time by age and sex.*

Table 2: Predictors of arrival by ambulance

Analysis of maximum likelihood estimates

Parameter			Degrees of freedom (DF)	Estimate	Standard error	Wald chi-square	p-value
Intercept			1	−0.72	0.02	1153.55	<0.0001
Age			1	0.02	0.0003	4200.90	<0.0001
Sex	Female		1	−0.19	0.02	80.94	<0.0001
Stroke type	Hemorrhagic		1	1.66	0.03	2951.10	<0.0001
Stroke type	Ischemic		1	−0.32	0.02	168.31	<0.0001
Age*sex	Female		1	0.003	0.0003	120.67	<0.0001
Age*stroke type	Hemorrhagic		1	−0.01	0.0004	1047.28	<0.0001
Age*stroke type	Ischemic		1	0.005	0.0003	180.70	<0.0001
Stroke type*sex	Hemorrhagic	Female	1	0.22	0.03	50.17	<0.0001
Stroke type*sex	Ischemic	Female	1	−0.11	0.02	19.43	<0.0001
Age*stroke type*sex	Hemorrhagic	Female	1	−0.003	0.0004	35.46	<0.0001
Age*stroke type*sex	Ischemic	Female	1	0.002	0.0003	23.66	<0.0001

likely to utilize ambulance services and are more likely to experience delays to hospital arrival compared with older patients. Given that the ischemic brain ages 3.6 years each hour without treatment,[12] the median delay of 1.5 h among younger patients compared with older in time to hospital arrival is clinically significant. While ambulance use increased due to the 2006 and 2014 Canadian Heart and Stroke Foundation campaigns, the rate of ambulance use has since plateaued.[26] The gap between older and younger patients in using emergency services is increasing with time – older patients show more growth in utilization than younger ones (Figure 2), suggesting that public awareness messaging may be more successful for older patients and campaigns to improve stroke awareness and knowledge targeted toward younger patients are needed.[27,28] Moreover, the time to hospital arrival we observed in all groups is beyond the recommended treatment window of 4.5 h for acute thrombolytic therapy with intravenous alteplase.[29] While significant improvements have been made over the past decade in arrival by ambulance, ongoing public health messaging is warranted to increase awareness of the importance of early hospital arrival.

We also observed sex differences in ambulance utilization, with younger women being least likely to use ambulance services and older women being most likely. Interestingly,

there has been no increase in ambulance utilization among young women since 2003, whereas ambulance use increased in all other groups. Women overall have better knowledge of stroke signs than men, and more women know at least one FAST sign of stroke compared with men.[7,30] However, young women specifically may have poor knowledge of symptoms.[7] Previous studies examining stroke knowledge among younger and older women have reported inconsistent findings.[30,31] Ongoing public educational programs, especially targeting younger women may further improve awareness of stroke and the need to seek urgent medical attention within this population.[32]

This study has several unique strengths that facilitate analysis of prehospital use by age and sex, including the large sample size, with validated population level data and high external validity. One limitation of this study is that we used administrative health databases which only include data from hospitals and provinces that record and report such data, and do not have data available for analysis from the province of Quebec (where data are collected but not available for analysis), representing roughly 20% of strokes in Canada. Reporting these data is mandatory, so there are high rates of data capture for the rest of Canada. This study included patients with stroke symptoms who received a final stroke diagnosis. However, patients with other diagnoses may also experience stroke-like symptoms and were not included in this analysis. Therefore, we cannot comment on ambulance utilization among those with stroke-like symptoms who ultimately receive other diagnoses. In addition, given the large number of patients included in this analysis, we were powered to detect even small differences in ambulance utilization among the groups.

While beyond the scope of the current analysis, future work could examine how factors such as geographical location (urban vs. rural), socioeconomic status, current residence (e.g., home, long-term care, living alone or with family), and previous exposure to and knowledge of stroke impact timing and decision to call 911.

This study highlights that younger stroke patients, especially younger women, are less likely to utilize ambulance services and seek urgent medical attention for stroke. This may in part be due to limited stroke awareness and knowledge. Given the increasing incidence of stroke among young adults,[2] and the increasing evidence of disparities in stroke management for women,[32] targeted ongoing public health messaging as well as educational campaigns are required to ensure younger adults recognize stroke symptoms and seek timely care.

STATEMENT OF AUTHORSHIP

RHS and AK contributed to the literature search; RHS, MPL, AYXY, and AK designed the study and interpreted the data. RHS, CG, and AK analyzed the data. AK, RHS, MPL, CG, AYXY, SC, and PRV contributed to the writing of the manuscript and critical review and approval of the final manuscript.

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