

Secondary prevention treatment after acute stroke in older South Asian, Chinese and other Canadians: a retrospective data analysis

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Abstract

Background: Little is known about whether there are differences in medication use between older patients of Chinese descent, those of South Asian descent and other Canadian patients after acute ischemic or primary intracerebral hemorrhagic stroke. The aim of this population-based study was to evaluate potential ethnic differences in secondary prevention pharmacotherapy after acute stroke.

Methods: Using health administrative data, we conducted a retrospective analysis of all patients aged 66 years or more admitted to hospital with acute stroke in Ontario (1997–2011) and British Columbia (1997–2009). We compared prescriptions filled for statins, warfarin, any antihypertensive agent, the recommended combination of angiotensin-converting-enzyme (ACE) inhibitor and diuretic, and the combination of ACE inhibitor, diuretic and statin within 1 year after ischemic or primary intracerebral hemorrhagic stroke.

Results: There were 118 362 patients with acute stroke (3430 Chinese, 2075 South Asian and 112 857 other Canadians). Among those with ischemic stroke ($n = 108\,699$), Chinese patients were less likely than other Canadian patients to fill prescriptions for the combination of ACE inhibitor, diuretic and statin (adjusted odds ratio [OR] 0.64 [95% confidence interval (CI) 0.55–0.74]) and, in those with atrial fibrillation, for warfarin (adjusted OR 0.75 [95% CI 0.59–0.95]). There were no differences in filling of prescriptions for antihypertensive therapy overall between the 3 groups. Among patients with intracerebral hemorrhagic stroke ($n = 9663$), Chinese patients were less likely than other Canadian patients to fill prescriptions for the combination of ACE inhibitor and diuretic (adjusted OR 0.51 [95% CI 0.38–0.69]), and South Asians were more likely than other Canadian patients to fill prescriptions for any antihypertensive agent (adjusted OR 1.73 [95% CI 1.21–2.49]).

Interpretation: We identified ethnic differences in filling of prescriptions for several secondary prevention medications after acute stroke. The reasons underlying these differences need to be investigated.

People of Chinese (originating from China, Taiwan or Hong Kong) and South Asian (originating from India, Pakistan, Bangladesh or Sri Lanka) descent are among the fastest-growing ethnic populations in North America.^{1–3} The burden of stroke and subsequent disability and death in these groups is likewise growing exponentially.⁴ Secondary prevention therapy after acute stroke is a core component of stroke care, essential to reducing the risk of recurrent stroke and death.^{5,6} As such, health care organizations aim to create equitable access to stroke care across all populations regardless of ethnicity.

However, it remains unknown whether there are differences in secondary prevention care after stroke in South Asian and Chinese populations. Studies indicate that South Asian and Chinese patients are less likely to meet targets for vascular risk reduction than their white counterparts.⁷ These groups may also hold a different understanding on vascular disease^{8,9} or may have communication barrier¹⁰ that affect use of sec-

ondary prevention therapies. The aim of this population-based study was to evaluate potential ethnic differences in secondary prevention pharmacotherapy after acute stroke. Specifically, we compared prescription filling for the guideline-recommended treatments within 1 year after hospital discharge for acute ischemic stroke and the combination of angiotensin-converting-enzyme (ACE) inhibitor and diuretic for primary intracerebral hemorrhagic stroke among South Asian, Chinese and other Canadian patients aged 66 years or more in Ontario and British Columbia.

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Methods

Setting

This was a retrospective population-based analysis using administrative data from Ontario (1997–2011) and British Columbia (1997–2009). We selected these 2 provinces as they include the largest nonwhite populations in Canada.^{1,2} The differing time periods reflect the maximally allowable data collection periods for the 2 provinces at the time of data request. To our knowledge, there were no major drug policy changes during 2010–2011 in Ontario.

Data sources

We used the Discharge Abstract Database, which includes all inpatient records with International Classification of Diseases, 9th revision (ICD-9) and 10th revision (ICD-10) diagnostic codes. The Ontario Drug Benefit and British Columbia's PharmaNet databases contain the Drug Identification Number used to identify all drug claims filled at nonhospital pharmacies. Novel orally administered anticoagulants were approved for atrial fibrillation only in October 2010 and so were not included in this analysis. Data on over-the-counter medications including acetylsalicylic acid were also not available. We obtained deidentified linked health data sets through the Institute for Clinical Evaluative Sciences in Ontario and Population Data BC with approval of relevant data stewards.¹¹

Stroke population

All residents aged 66 years or more discharged alive from hospital after acute ischemic or hemorrhagic stroke were included. Prescription data in Ontario are available only for those aged 65 years or more, and we looked back 6 months to determine medication prescriptions filled before the stroke. We identified stroke cases using validated, most responsible diagnosis coding with a positive predictive value of 85% or greater for ischemic stroke (ICD-9 434, 436, or ICD-10-CA I63, I64) and primary intracerebral hemorrhage (ICD-9 431 and ICD-10 I61.x).¹²

Pharmacotherapy for secondary prevention

Among patients with ischemic stroke, as the 2 primary aims, we determined the proportion who filled at least 1 prescription for the optimal medication bundle (diuretic, ACE inhibitor and statin^{13,14}) or, if they had atrial fibrillation, warfarin.¹⁵ The American Heart Association and Hypertension Canada guidelines for secondary prevention therapy of stroke recommend the combination of ACE inhibitor and diuretic as the preferred antihypertensive therapy for both ischemic and hemorrhagic stroke, statins for atherosclerotic ischemic stroke and warfarin in patients with ischemic stroke and atrial fibrillation.^{13,14} As secondary aims, we investigated the combination of any antihypertensive and statin, and individual medications including ACE inhibitors, angiotensin-receptor blockers, diuretics, calcium-channel blockers and β -blockers. For patients with primary intracerebral hemorrhage, the primary aim was to evaluate prescription filling for the combination of ACE inhibitor and diuretic, and, for the secondary aim, any antihypertensive

agent. We determined prescription filling in patients discharged alive and within 1 year of discharge from hospital.

Drug costs may influence the decision to fill a prescription. In Ontario and British Columbia, costs for medications are subsidized for low-income older people. In Ontario, those aged 65 years or more pay a \$100 deductible each year for medications and \$6.11, on average, for each approved prescription filled, depending on their income. Those with a low income can have their deductible waived and pay up to \$2 for each prescription. In British Columbia, an income-based deductible program was initiated in 2003 whereby patients pay a deductible based on income and pay 25% of medication costs thereafter.

Categorizing ethnicity

To determine Chinese and South Asian ethnicity, we used Quan and colleagues'¹⁶ surname list for Chinese names and the Nam Pehchan surname algorithm for South Asian names.¹⁷ Inter-marriage does not affect the categorization substantially.¹⁶ The remaining patients were categorized as "other Canadians;" this group encompassed white patients (93%) and non-Chinese, non-South Asian visible minority groups.

Other baseline characteristics

We obtained history of prior congestive heart failure, atrial fibrillation, hypertension, diabetes and myocardial infarction from the Discharge Abstract Database using validated ICD coding algorithms at the time of admission for acute stroke.^{12,18} We assigned socioeconomic status using median neighbourhood income based on each patient's postal code.

Statistical analysis

We compared categorical variables using the χ^2 test and continuous variables using one-way analysis of variance, where appropriate. We constructed hierarchical risk-adjusted logistic regression models for either stroke type to determine the association of ethnicity with prescription filling, adjusting for neighbourhood income quintile, age, sex, most responsible physician (family doctor v. specialist), prior medication use, and history of atrial fibrillation, hypertension, diabetes, dyslipidemia, myocardial infarction or congestive heart failure. We used multilevel modelling to account for potential clustering at the level of province and hospital. All analyses were conducted with SAS version 9.4.

Ethics approval

The study was approved by the research ethics boards of the University of Toronto and the University of British Columbia.

Results

There were 108 699 patients with acute ischemic stroke and 9663 patients with primary intracerebral hemorrhagic stroke aged 66 years or more. Ischemic stroke was more common than hemorrhagic stroke for all ethnic groups (Chinese 84.1%, South Asian 90.4%, other Canadians 92.1%). Of the 108 699 patients with ischemic stroke, 2884 were Chinese, 1875 were South Asian, and 103 940 were other Canadians. The corresponding values for primary intracerebral hemorrhagic stroke were 546, 200 and 8917.

Baseline characteristics

In the ischemic stroke subgroup, both Chinese and South Asian patients were more likely than other Canadian patients to occupy lower socioeconomic status quintiles, to have hypertension, to have diabetes and to be admitted by an Internal Medicine or Neurology (Table 1). Chinese patients were

less likely than South Asian or other Canadian patients to fill a prescription for an ACE inhibitor but more likely to fill a prescription for an angiotensin-receptor blocker. However, the proportion of patients filling prescriptions for antihypertensive medications was similar among 3 groups. Among patients with atrial fibrillation, other Canadian patients were more

Table 1: Baseline characteristics of older patients with acute ischemic stroke by ethnicity

Characteristic	Ethnicity; no. (%) of patients			p value
	Chinese n = 2884	Other Canadians n = 103 940	South Asian n = 1875	
Age, yr				
65–74	967 (33.5)	30 490 (29.3)	815 (43.5)	< 0.001
75–84	1328 (46.0)	48 468 (46.6)	775 (41.3)	
≥ 85	589 (20.4)	24 982 (24.0)	285 (15.2)	
Women	1592 (55.2)	56 072 (53.9)	943 (50.3)	0.003
Live in British Columbia	1050 (36.4)	18 677 (18.0)	716 (38.2)	< 0.001
Median neighbourhood income quintile*				
Q1 (lowest)	793 (27.5)	23 755 (22.8)	530 (28.3)	< 0.001
Q2	677 (23.5)	22 435 (21.6)	460 (24.5)	
Q3	515 (17.8)	20 084 (19.3)	406 (21.6)	
Q4	489 (17.0)	18 390 (17.7)	261 (13.9)	
Q5 (highest)	386 (13.4)	18 419 (17.7)	208 (11.1)	
Hypertension	675 (23.4)	20 598 (19.8)	477 (25.4)	< 0.001
Diabetes	337 (11.7)	8661 (8.3)	301 (16.0)	< 0.001
Acute myocardial infarction	76 (2.6)	4768 (4.6)	75 (4.0)	< 0.001
Heart failure	100 (3.5)	5073 (4.9)	101 (5.4)	0.001
Atrial fibrillation	363 (12.6)	12 368 (11.9)	151 (8.0)	< 0.001
Admitting physician				
Family physician	851 (29.5)	55 441 (53.3)	761 (40.6)	< 0.001
Internist	1291 (44.8)	24 795 (23.8)	627 (33.4)	
Neurologist	455 (15.8)	14 074 (13.5)	322 (17.2)	
Other	287 (10.0)	9630 (9.3)	165 (8.8)	
Medication(s) prescribed in 6 mo before stroke				
ACE inhibitor	762 (26.4)	37 309 (35.9)	687 (36.6)	< 0.001
β-blocker	840 (29.1)	31 066 (29.9)	548 (29.2)	0.6
Angiotensin-receptor blocker	451 (15.6)	8662 (8.3)	215 (11.5)	< 0.001
Calcium-channel blocker	864 (30.0)	28 407 (27.3)	558 (29.8)	0.006
Diuretic	593 (20.6)	32 328 (31.1)	504 (26.9)	< 0.001
Any antihypertensive	1970 (68.3)	72 111 (69.4)	1301 (69.4)	0.5
Acetylsalicylic acid	411 (14.2)	14 561 (14.0)	310 (16.5)	0.007
Statin	631 (21.9)	24 720 (23.8)	557 (29.7)	< 0.001
Warfarin†	71 (19.6)	3410 (27.6)	37 (24.5)	0.002

Note: ACE = angioten-converting-enzyme.

*Missing for 0.8% of patients.

†Among patients with atrial fibrillation.

likely to have filled a prescription for warfarin before stroke than Chinese or South Asian patients.

Among patients with primary intracerebral hemorrhagic stroke, South Asian and Chinese patients were more likely

than other Canadians to occupy lower socioeconomic status quintiles and to have diabetes (Table 2). Compared to South Asian and other Canadian patients, Chinese patients were more likely to be cared for by specialists rather than family

Table 2: Baseline characteristics among older patients with primary intracerebral hemorrhagic stroke by ethnicity

Characteristic	Ethnicity; no. (%) of patients			p value
	Chinese n = 546	Other Canadians n = 8917	South Asian n = 200	
Age, yr				
65–74	197 (36.1)	2982 (33.4)	89 (44.5)	0.01
75–84	255 (46.7)	4186 (46.9)	78 (39.0)	
≥ 85	94 (17.2)	1749 (19.6)	33 (16.5)	
Women	289 (52.9)	4665 (52.3)	102 (51.0)	0.9
Live in British Columbia	220 (40.3)	1421 (15.9)	71 (35.5)	< 0.001
Median neighbourhood income quintile*				
Q1 (lowest)	152 (27.8)	1829 (20.5)	59 (29.5)	< 0.001
Q2	120 (22.0)	1890 (21.2)	46 (23.0)	
Q3	110 (20.1)	1747 (19.6)	41 (20.5)	
Q4	102 (18.7)	1679 (18.8)	27 (13.5)	
Q5 (highest)	60 (11.0)	1705 (19.1)	27 (13.5)	
Hypertension	355 (65.0)	6118 (68.6)	123 (61.5)	0.02
Diabetes	62 (11.4)	830 (9.3)	28 (14.0)	0.03
Acute myocardial infarction	21 (3.8)	287 (3.2)	7 (3.5)	0.7
Heart failure	12 (2.2)	267 (3.0)	< 5 (< 1.0)	0.2
Atrial fibrillation	30 (5.5)	647 (7.2)	< 5 (< 1.0)	0.01
Admitting physician				
Family physician	149 (27.3)	3617 (40.6)	65 (32.5)	< 0.001
Internist	196 (35.9)	2129 (23.9)	50 (25.0)	
Neurologist	82 (15.0)	1360 (15.2)	34 (17.0)	
Neurosurgeon	72 (13.2)	1023 (11.5)	26 (13.0)	
Other	47 (8.6)	788 (8.8)	25 (12.5)	
Medication(s) prescribed in 6 mo before stroke				
ACE inhibitor	120 (22.0)	2699 (30.3)	75 (37.5)	< 0.001
β-blocker	111 (20.3)	2120 (23.8)	41 (20.5)	0.1
Angiotensin-receptor blocker	68 (12.4)	667 (7.5)	9 (4.5)	< 0.001
Calcium-channel blocker	122 (22.3)	1771 (19.9)	34 (17.0)	0.2
Diuretic	81 (14.8)	2006 (22.5)	38 (19.0)	< 0.001
Any antihypertensive agent	318 (58.2)	5181 (58.1)	114 (57.0)	1.0
Statin	122 (22.3)	2067 (23.2)	45 (22.5)	0.9
Acetylsalicylic acid	50 (9.2)	891 (10.0)	30 (15.0)	0.05
Warfarin†	17 (56.7)	358 (55.3)	–	0.3
Note: ACE = angiotensin-converting-enzyme. *Missing for 0.7% of patients. †Among patients with atrial fibrillation.				

physicians. Chinese patients were least likely to have filled prescriptions for antihypertensive therapy before the stroke, whereas South Asians were most likely to have filled such prescriptions.

Pharmacotherapy for secondary prevention

Unadjusted rates of filling of prescriptions for secondary prevention therapy within 1 year after discharge from hospital after acute stroke are presented in Table 3 and Table 4.

Table 3: Proportions of patients who filled prescriptions for secondary prevention therapy within 1 year after ischemic stroke by ethnicity

Medication	Ethnicity; no. (%) of patients			<i>p</i> value
	Chinese <i>n</i> = 2884	Other Canadians <i>n</i> = 103 940	South Asian <i>n</i> = 1875	
ACE inhibitor	1263 (43.8)	51 528 (49.6)	1015 (54.1)	< 0.001
Angiotensin-receptor blocker	574 (19.9)	10 785 (10.4)	269 (14.3)	< 0.001
ACE inhibitor or angiotensin-receptor blocker	1651 (57.2)	58 611 (56.4)	1176 (62.7)	< 0.001
Diuretic	746 (25.9)	39 651 (38.1)	580 (30.9)	< 0.001
Calcium-channel blocker	983 (34.1)	32 708 (31.5)	702 (37.4)	< 0.001
β-blocker	892 (30.9)	34 439 (33.1)	657 (35.0)	0.009
ACE inhibitor or diuretic	1583 (54.9)	66 196 (63.7)	1210 (64.5)	< 0.001
ACE inhibitor + diuretic	426 (14.8)	24 983 (24.0)	385 (20.5)	< 0.001
Any antihypertensive agent	2193 (76.0)	80 138 (77.1)	1494 (79.7)	0.01
Statin	1254 (43.5)	43 550 (41.9)	953 (50.8)	< 0.001
Statin or ACE inhibitor or diuretic	1988 (68.9)	75 846 (73.0)	1415 (75.5)	< 0.001
Statin + ACE inhibitor + diuretic	231 (8.0)	13 119 (12.6)	254 (13.5)	< 0.001
Statin or antihypertensive	2295 (79.6)	83 764 (80.6)	1551 (82.7)	0.03
Statin + antihypertensive	1152 (39.9)	39 924 (38.4)	896 (47.8)	< 0.001
Warfarin*	249 (8.6)	9014 (72.9)	109 (72.2)	0.2

Note: ACE = angiotensin-converting-enzyme.
*Among patients with atrial fibrillation.

Table 4: Proportions of patients who filled prescriptions for secondary prevention therapy within 1 year after primary intracerebral hemorrhagic stroke by ethnicity

Medication	Ethnicity; no. (%) of patients			<i>p</i> value
	Chinese <i>n</i> = 546	Other Canadians <i>n</i> = 8917	South Asian <i>n</i> = 200	
ACE inhibitor	200 (36.6)	3924 (44.0)	118 (59.0)	< 0.001
Angiotensin-receptor blocker	80 (14.6)	827 (9.3)	23 (11.5)	0.001
ACE inhibitor or angiotensin-receptor blocker	252 (46.2)	4428 (49.6)	127 (63.5)	0.001
Diuretic	109 (20.0)	2845 (31.9)	57 (28.5)	< 0.001
Calcium-channel blocker	185 (33.9)	2716 (30.4)	63 (31.5)	0.2
β-blocker	139 (25.4)	2682 (30.1)	64 (32.0)	0.1
ACE inhibitor or diuretic	253 (46.3)	4942 (55.4)	131 (65.5)	< 0.001
ACE inhibitor + diuretic	56 (10.2)	1827 (20.5)	44 (22.0)	< 0.001
Any antihypertensive	352 (64.5)	6125 (68.7)	155 (77.5)	0.003

Note: ACE = angiotensin-converting-enzyme.

Ischemic stroke

In the ischemic stroke subgroup, filling of prescriptions for statins was relatively low in all groups. Compared to the other groups, Chinese patients were less likely to fill prescriptions for ACE inhibitor and diuretic combination therapy ($p < 0.001$) and for the optimal bundle of ACE inhibitor, diuretic and statin ($p < 0.001$). South Asians were more likely than the 2 other groups to fill prescriptions for any antihypertensive ($p = 0.01$) and for statins ($p < 0.001$), but only 254 South Asians (13.5%) filled prescriptions for the optimal bundle of diuretic, ACE inhibitor and statin. Only 68.6%–72.9% of patients with atrial fibrillation filled prescriptions for warfarin after ischemic stroke; there was no difference between ethnic groups in the unadjusted analysis ($p = 0.2$).

In the adjusted analysis, there were no differences between groups in prescription filling for any antihypertensive among patients with ischemic stroke (Table 5). However, fewer Chinese patients than other Canadian patients filled prescriptions for the optimal therapy bundle of ACE inhibitor, diuretic and statin (adjusted odds ratio [OR] 0.64 [95% confidence interval (CI) 0.55–0.74]). Among patients with atrial fibrillation, fewer Chinese patients than other Canadian patients filled prescriptions for warfarin (adjusted OR 0.75 [95% CI 0.59–0.95]).

There was no difference in prescription filling of the optimal therapy bundle of ACE inhibitor, diuretic and statin between South Asian and other Canadian patients.

Primary intracerebral hemorrhagic stroke

For patients with primary intracerebral hemorrhagic stroke, the most commonly filled antihypertensive prescription was ACE inhibitor in all groups (Table 4). Antihypertensive prescriptions were filled by 64.5%–77.5% of patients, and few patients filled prescriptions for the optimal combination of ACE inhibitor and diuretic. In the unadjusted analysis, Chinese patients were less likely than South Asian or other Canadian patients to fill any antihypertensive agent prescriptions ($p = 0.003$), including optimal ACE inhibitor and diuretic combination therapy ($p < 0.001$). After adjustment for baseline characteristics, Chinese patients remained less likely than other Canadian patients to fill prescriptions for the optimal combination of ACE inhibitor and diuretic (adjusted OR 0.51 [95% CI 0.38–0.69]) (Table 5). South Asian patients were more likely than other Canadian patients to fill prescriptions for any antihypertensive agent (adjusted OR 1.73 [95% CI 1.21–2.49]) and for the optimal combination of ACE inhibitor and diuretic (adjusted OR 1.31 [95% CI 0.91–1.88]).

Table 5: Multivariable analysis of filling of prescriptions for secondary prevention therapy after acute stroke by ethnicity*

Stroke type; medication	Adjusted OR (95% CI)*	
	Chinese v. other Canadians	South Asian v. other Canadians
Ischemic		
ACE inhibitor or diuretic	0.70 (0.64–0.76)	0.96 (0.86–1.06)
ACE inhibitor + diuretic	0.63 (0.56–0.70)	0.88 (0.78–0.99)
ACE inhibitor or angiotensin-receptor blocker	0.97 (0.89–1.06)	1.05 (0.95–1.16)
Any antihypertensive	0.92 (0.83–1.02)	1.06 (0.93–1.20)
Statin	0.97 (0.88–1.07)	1.10 (0.98–1.24)
Statin, ACE inhibitor or diuretic	0.78 (0.71–0.86)	0.96 (0.85–1.07)
Statin + ACE inhibitor + diuretic	0.64 (0.55–0.74)	1.01 (0.87–1.17)
Any antihypertensive or statin	0.89 (0.80–0.99)	0.99 (0.87–1.14)
Any antihypertensive + statin	0.99 (0.91–1.09)	1.16 (1.03–1.29)
Warfarin†	0.75 (0.59–0.95)	0.88 (0.60–1.28)
Primary intracerebral hemorrhagic		
ACE inhibitor or diuretic	0.69 (0.57–0.83)	1.64 (1.20–2.24)
ACE inhibitor + diuretic	0.51 (0.38–0.69)	1.31 (0.91–1.88)
ACE inhibitor or angiotensin-receptor blocker	0.79 (0.65–0.96)	1.75 (1.28–2.40)
Any antihypertensive agent	0.82 (0.67–1.01)	1.73 (1.21–2.49)

Note: ACE = angiotensin-converting-enzyme.
 *Adjusted for income quintile, age, sex, admitting physician (family physician v. specialist), prior medication use, and history of atrial fibrillation, hypertension, diabetes, dyslipidemia, myocardial infarction or congestive heart failure.
 †Among patients with atrial fibrillation.

Interpretation

Although some prescriptions for secondary prevention therapy were filled by similar proportions of Chinese, South Asian and other Canadian patients, smaller proportions of Chinese patients filled prescriptions for the preferred combination of ACE inhibitor, diuretic and statin, and for anticoagulation therapy for atrial fibrillation following ischemic stroke. Similarly, after primary intracerebral hemorrhagic stroke, Chinese patients were less likely to fill prescriptions for preferred antihypertensive therapy with an ACE inhibitor and a diuretic. South Asian patients, in contrast, were just as likely as or more likely than other Canadian patients to fill prescriptions for secondary prevention treatment after acute ischemic stroke or intracerebral hemorrhagic stroke.

Our study provides new data on secondary prevention treatment among these ethnic groups and extends previous work that focused on other components of stroke care. Xian and colleagues¹⁹ identified similar or greater provision of in-hospital stroke care in Asian populations in the United States: Asian patients with intracerebral hemorrhage had higher odds of receiving deep vein thrombosis prophylaxis and dysphagia screening than white patients. In a previous study of 12 stroke centres in Ontario, we found similar receipt of rehabilitative services, admission to stroke units and brain imaging among ethnic groups.²⁰ In contrast, a community-based stroke study in New Zealand showed that Asian patients were less likely than white patients to be using antihypertensive medications before stroke.²¹ Our finding of lower use of some secondary prevention treatments is consistent with studies in hypertension, diabetes and acute myocardial infarction that uniformly showed lower rates of filling of prescriptions for ACE inhibitors in Chinese populations compared to other Canadians.^{22,23}

The reasons underlying ethnic differences in filling of prescriptions for secondary prevention treatment are likely multifactorial. There may be differences in health-seeking behaviours in Chinese populations. However, studies indicate that Chinese Canadians are just as likely to visit their family doctor as the general population.²⁴ There may also be cultural differences in the patient's willingness to fill prescriptions owing to cost, preference for alternative therapies, mistrust of Western medications²⁵ and differing beliefs regarding modifiers of stroke risk. Reasons may also include provider-patient communication barriers¹⁰ and provider bias. There may be also greater concern by physicians and patients regarding adverse medication side effects in some ethnic groups. Asian patients have been reported to have increased ACE-inhibitor-induced cough compared to other groups.²⁶ In the current study, there was no difference in prescription filling of either ACE inhibitor or angiotensin-receptor blocker (since the latter is a common alternative when patients do not tolerate ACE inhibitor) between Chinese and other Canadian patients in either the ischemic stroke subgroup or the intracerebral hemorrhagic subgroup. Our study also identified considerable underfilling of warfarin prescriptions after ischemic stroke among Chinese patients with atrial fibrillation despite the substantive reductions in recurrent stroke risk with this treatment. There may be reluctance to prescribe anticoagulants to Chinese patients

with atrial fibrillation given the potentially higher risk of intracranial hemorrhage with these agents.²⁷ More aggressive prescribing in South Asians may reflect health care providers' heightened concern for their high vascular risk.

Strengths and limitations

A strength of this study is the use of a large, unselected population for analysis of prescription filling for secondary prevention treatment after stroke across 3 ethnic groups. There are also several limitations. First, we used surname algorithms instead of self-reported ethnicity, and the remaining group "other" was heterogeneous, with about 90% being white. However, surname algorithms are fairly specific, which allowed for conservative estimates of ethnic differences. We did not have information on lipid levels, blood pressure, renal function, severity of stroke or residual deficits. However, previous analysis of patients with acute stroke did not identify any significant difference in baseline blood pressure or stroke severity scores (Canadian Neurological Scale) after acute ischemic stroke or intracerebral hemorrhage in these ethnic groups.²⁰ Finally, we were not able to identify medications purchased without a prescription (i.e., acetylsalicylic acid), medications purchased out of province or out of country, and prescriptions that were not filled by patients or, if filled, not consumed.

Conclusion

Although some prescriptions for secondary prevention treatment were filled to a similar extent across ethnic groups, Chinese patients were less likely than South Asian or other Canadian patients to fill prescriptions for the optimal therapy bundle of ACE inhibitor, diuretic and statin, or for warfarin. The clinical significance of these ethnic differences in provision of secondary prevention treatments is substantial. Combination treatment with an ACE inhibitor and a diuretic is associated with a reduction in recurrent stroke of 43% and a reduction in vascular events of 40%.⁶ Warfarin is associated with a reduction of risk of recurrent stroke of 47% among those with atrial fibrillation.²⁸ Statin therapy is associated with a vascular risk reduction of 25% following stroke. Given the substantial benefits associated with these treatments, there is urgent need to improve secondary medication prescribing and/or primary adherence in stroke populations, especially Canadians of Chinese descent. Further study is needed to understand the causal factors for the lower filling of prescriptions for these secondary prevention treatments among Chinese patients and whether choice of antihypertensive affects recurrent risk of stroke in Asian populations.

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