Invasive cardiac procedure use and mortality among South Asian and Chinese Canadians with coronary artery disease

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BACKGROUND: Previous studies evaluated cardiac procedure use and outcome over the short term, with relatively few Asian patients included.

OBJECTIVES: To determine the likelihood of undergoing percutaneous coronary intervention and coronary artery bypass grafting, and survival during 10.5 years of follow-up after coronary angiography among South Asian, Chinese and other Canadian patients.

METHODS: Using prospective cohort study data from two large Canadian provinces, 3061 South Asian, 1473 Chinese and 77,314 other Canadian patients with angiographically proven coronary artery disease from 1995 to 2004 were assessed, and their revascularization and mortality rates during 10.5 years of follow-up were determined.

RESULTS: Compared with other Canadian patients, South Asian and Chinese patients were slightly less likely to undergo revascularization (risk-adjusted HR 0.94, 95% CI 0.90 to 0.98 for South Asian patients; and HR 0.94, 95% CI 0.88 to 1.00 for Chinese patients). However, South Asian patients underwent coronary artery bypass grafting (HR 1.00, 95% CI 0.94 to 1.07) and Chinese patients underwent percutaneous coronary intervention (HR 0.96, 95% CI 0.89 to 1.04) as frequently as other Canadian patients. Although the 30-day mortality rate was similar across the three ethnic groups, the mortality rate in the follow-up period was significantly lower for South Asian patients (HR 0.76, 95% CI 0.61 to 0.95) and marginally lower for Chinese patients (HR 0.80, 95% CI 0.60 to 1.07) compared with other Canadian patients.

CONCLUSIONS: South Asian and Chinese patients used revascularization slightly less but had better survival outcomes than other Canadian patients. The factors underlying the better outcomes for South Asian and Chinese patients warrant further study.

Key Words: Chinese Canadians; Coronary artery disease; Invasive cardiac procedure; South Asian Canadians

Le recours aux interventions cardiaques effractives et la mortalité chez les Canadiens d'origine sud-asiatique et chinoise atteints d'une coronaropathie

HISTORIQUE : Des études ont déjà porté sur le recours aux interventions cardiaques et sur leurs résultats à court terme, mais incluaient relativement peu de patients asiatiques.

OBJECTIFS : Déterminer la probabilité de subir une intervention coronaire percutanée et un pontage aortocoronarien ainsi que la survie pendant les dix ans et demi de suivi après une coronarographie chez des patients sud-asiatiques et chinois et d'autres patients canadiens.

MÉTHODOLOGIE : Au moyen des données d'une étude de cohorte prospective dans deux grandes provinces canadiennes, les chercheurs ont évalué 3 061 patients sud-asiatiques, 1 473 patients chinois et 77 314 patients canadiens ayant une coronaropathie démontrée par angiographie entre 1995 et 2004 et déterminé leur taux de revascularisation et de mortalité pendant les dix ans et demi de suivi.

RÉSULTATS : Par rapport aux autres patients canadiens, les patients sud-asiatiques et chinois étaient légèrement moins susceptibles de subir une revascularisation (risque relatif [RR] rajusté en fonction des risques 0,94, 95 % IC 0,90 à 0,98 chez les patients sud-asiatiques et RR 0,94, 95 % IC 0,88 à 1,00 chez les patients chinois). Cependant, les patients sud-asiatiques subissaient un pontage aortocoronarien (RR 1,00, 95 % IC 0,94 à 1,07) et les patients chinois, une intervention coronaire percutanée (RR 0,96, 95 % IC 0,89 à 1,04) aussi souvent que les autres patients canadiens. Même si le taux de mortalité au bout de 30 jours était similaire dans les trois groupes ethniques, le taux de mortalité pendant la période de suivi était considérablement moins élevé chez les patients sud-asiatiques (RR 0,76, 95 % IC 0,61 à 0,95) et légèrement plus faible chez les patients chinois (RR 0,80, 95 % IC 0,60 à 1,07) par rapport aux autres patients canadiens.

CONCLUSIONS : Les patients sud-asiatiques et chinois subissaient un peu moins de revascularisations, mais avaient une meilleure survie que les autres patients canadiens. Les facteurs sous-tendant ces résultats légèrement supérieurs chez les patients sud-asiatiques et chinois méritent une étude plus approfondie.

People have immigrated to Canada from all over the world to create a nation with many cultures. The 2006 Canadian population census (1) showed that 16.2% (n=5,068,095) of the Canadian population consider themselves to be visible minorities (nonwhite or non-Aboriginal). Among them, South Asians constituted the largest minority group (24.6%; n=1,262,865), followed by the Chinese (24.0%; n=1,216,565). A majority of these minorities reside in Ontario (62.9% for South Asian and 47.4% for Chinese) and British Columbia (20.8% for South Asian and 33.5% for Chinese). It has been predicted that these two ethnic groups will continue to be the fastest growing ethnic populations in Canada. The growing immigrant and refugee population of Canada has stimulated considerable

research and policy attention, with a specific interest in equal access without barriers to high-quality health care services for all citizens.

There are documented ethnic variations among American black, Hispanic, Asian and white patients in the use of invasive cardiac procedures, raising significant concerns over whether cardiac care is delivered equitably in various western countries (2,3). However, it is unclear whether this translates into equality in terms of procedure use and outcomes under the Canadian universal health care system.

Racial/ethnic variations in access to and use of cardiac procedures may be driven by factors related to the patient and social network, health care system and health care provider (4). Patient factors include sociodemographic and clinical characteristics such as severity

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of coronary disease, attitudes toward health care and treatment preferences. Factors related to the operation of health care systems include health insurance coverage, types of incentives in place to contain costs, availability of revascularization services and language interpretation services. Health care provider factors include physician biases, prejudices and uncertainty when treating minorities.

To date, there are conflicting reports on the use of and outcomes associated with percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) among Asian patients with coronary artery disease. Sekhri et al (5) followed up on 263 South Asian and 1112 white patients deemed appropriate for angiography in England, and reported that South Asian patients were less likely to receive angiography than white patients within three years. Feder et al (6) examined 345 South Asian and 2167 white patients undergoing coronary angiography in one health trust in London, England (UK). By three years of follow-up, they found that South Asian patients were marginally less likely to receive PCI and CABG, but had a similar mortality rate compared with white patients. Gupta et al (7) matched 553 South Asian patients with 553 white patients who were admitted to two Canadian hospitals for acute myocardial infarction (AMI). Both groups were similar in the use of coronary angiography, PCI and CABG, and mortality and complication rates during hospitalization. Comparing 249 Chinese and 569 white patients with AMI or unstable angina in the United States, Taira et al (8) reported that Chinese men were less likely to receive PCI but more likely to receive CABG, with higher in-hospital mortality rates than white men. However, there was no significant difference between Chinese and white women for procedure use or mortality.

Most of these studies evaluated cardiac procedure use and outcome in the short term, with relatively few Asian patients included, and failed to comprehensively address the multiple factors (such as socioeconomic status and extent of coronary disease) that may account for variations in use. To overcome these limitations, we linked data from two large provincial cardiac registries to establish a cohort of South Asian and Chinese Canadians with angiographically proven coronary artery disease. We analyzed PCI and CABG use and mortality rates during a follow-up period of 10.5 years after adjustment for factors related to both the patient and health care system.

METHODS

Study population

The present prospective cohort follow-up study derived data from the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) and British Columbia Cardiac Registry (BCCR) cohort databases in Canada. The APPROACH and BCCR registries include all patients undergoing coronary angiography in Alberta since 1995 and in British Columbia since 1999 (9). Patients residing in these provinces who were older than 20 years of age, and had angiographically proven coronary artery disease (defined as stenosis of at least one coronary vessel of 50% or greater) between 1995 and 2004 were included. Of the 3.3 million residents in Alberta, 3.2% are South Asian and 3.7% are Chinese. Of the 4.1 million residents in British Columbia, 6.4% are South Asian and 10.0% are Chinese (1). The Conjoint Health Research Ethics Board of the University of Calgary (Calgary, Alberta) approved the study.

Dependent (outcome) variables

Dependent variables included the use of PCI or CABG, mortality after coronary angiography, and length of time from coronary angiography to PCI or CABG. The APPROACH and BCCR registries follow patients from the time of coronary angiography to death or the end of the study period. The patients in the present study were followed until June 30, 2005, resulting in at least six months and a maximum of 10.5 years of follow-up to determine PCI or CABG and all-cause mortality rates. Deaths were determined by linking the registries with vital statistics using the following identifiers: personal health insurance number, name, date of birth and sex. Information on PCI and CABG was collected through hospital reports to the registries. Therefore, the

registries capture nearly all deaths and procedures that have occurred in the provinces of Alberta and British Columbia, and miss few patients who have died or who underwent procedures outside these two provinces.

Exposure variable (ethnicity)

Patients were categorized as being of South Asian (originating from India, Pakistan, Bangladesh and Sri Lanka) or Chinese (originating from Hong Kong, Taiwan, Macao, Singapore and mainland China) descent using validated surname algorithms (10,11). The surnames recorded in the database were merged with the surnames in the Nam Pehchan computer program (10) and Quan et al's Chinese name list (11) to define South Asian and Chinese ethnicity. The surname algorithms are known to be reasonably reliable and valid, with 90.5% sensitivity, 99.4% specificity and 63.2% positive predictive value for South Asian ethnicity (12); and 77.7% sensitivity, 99.7% specificity and 80.5% positive predictive value for Chinese ethnicity (11). Surname methodologies have been used in many previous studies assessing ethnicity in relation to health service use, population health status and risk factors for heart disease (6,13-17).

Potential confounding variables

The data sets contain detailed baseline information obtained at the time of coronary angiography including age, sex, clinical variables and angiographic results. Age was categorized into two groups: 20 to 64 years of age, and 65 years of age or older. Socioeconomic status and ethnicity are closely intertwined, and each may be associated with the use of invasive cardiac procedures and mortality. Socioeconomic status was measured using median neighbourhood household income based on postal code conversion. Median income reflects the area-level income and does not precisely measure an individual's actual income. It is a widely used method to impute individual socioeconomic status, and the resulting estimates of household income have been shown to be prognostically relevant (18-20). The postal codes for residents were converted into census enumeration areas using the Statistics Canada Postal Code Conversion File (2001) to obtain median income. The median incomes were categorized into quintiles based on the distribution of the variable in the study population. The straight-line distance from residence to the closest revascularization facility was also calculated.

Clinical variables of interest included the presence or absence of previous PCI, previous CABG, previous myocardial infarction, hypertension, hyperlipidemia, diabetes mellitus, congestive heart failure, chronic lung disease, peripheral vascular disease, cerebrovascular disease, cancer, gastrointestinal or liver disease, and dialysis. The extent of coronary disease was recorded and classified into five categories: one- to two-vessel disease, two-vessel disease with proximal left anterior descending artery (LAD) involvement, three-vessel disease, three-vessel disease with proximal LAD involvement, and left main disease according to the Duke Index (21). Left ventricular ejection fraction was also captured.

Statistical analysis

Proportions or mean statistics were used to describe the study population by ethnicity. In the analysis of the length of time (days) from coronary angiography to PCI or CABG, median times were calculated and presented because of the highly skewed distribution of these two continuous time variables. Also, the time variables were dichotomized and logistic regression was applied to model the risk-adjusted odds of undergoing PCI in fewer than seven days, and the odds of undergoing CABG in fewer than 30 days. Logistic regression was used to test statistical differences among the three ethnic groups for revascularization within six months and the 30-day mortality rate after adjustment for independent variables. Cox proportional hazards survival models were used to study events occurring over time (revascularization for procedure use, death for mortality analysis or censor) across ethnic groups, while controlling for sociodemographic and clinical variables. A category of missing data was created for median income and distance from residence to hospital variables, and was included in the models due to a relatively large number of patients with missing data. Survival time

Figure 1) Flow diagram of sample size. CABG Coronary artery bypass grafting; PCI Percutaneous coronary intervention

was calculated from the date of coronary angiography to the date on which the data were censored or an end point occurred. If a patient underwent more than one revascularization procedure, the first was analyzed as the index event. Data were censored if a patient did not undergo revascularization for procedure use, or was still alive for mortality at the end of the study (June 30, 2005). Ethnicity-specific risk factor-adjusted survival curves for mortality were generated using the corrected group prognosis method (22).

RESULTS

Sociodemographic and clinical characteristics

From January 1, 1995, to December 31, 2004, a total of 88,986 patients with coronary artery disease were identified in the two Canadian provinces. Of these, 7138 (8%) were excluded due to missing clinical data (Figure 1). Patients with missing data only for median income or distance from residence to hospital were not excluded due to the large number of cases. The final analysis included 3061 South Asian, 1473 Chinese and 77,314 other Canadian patients (Table 1). Compared with other Canadian patients, those of South Asian and Chinese descent tended to be male, to live closer to a hospital facility with revascularization capability and to have higher socioeconomic status. The proportion of patients 65 years of age or older was lower for South Asian patients (43.0%) than for Chinese patients (56.5%) or other Canadian patients (52.9%). South Asian and Chinese patients had higher frequencies of diabetes and hypertension than other Canadian patients. Cerebrovascular disease, gastrointestinal or liver disease, and dialysis were more prevalent among Chinese patients than among South Asian and other Canadian patients.

South Asian patients had more extensive coronary disease and systolic dysfunction than other patients at the time of coronary catheterization (Table 1). Three-vessel disease with and without LAD involvement, and left main disease were more prevalent among South Asian patients (61.0%) than among Chinese (57.9%) or other Canadian patients (54.1%).

Revascularization rate and duration from coronary angiography to revascularization

As shown in Table 2, crude rates of PCI, CABG and revascularization use were similar across the three ethnic groups at six months follow-up. After adjustment for factors listed in Table 1, South Asian patients were less likely to undergo PCI (risk-adjusted OR 0.86, 95% CI 0.79 to 0.93) and Chinese patients were less likely to undergo CABG (risk-adjusted OR 0.82, 95% CI 0.72 to 0.93) compared with other Canadian patients.

With a follow-up period of up to 10.5 years (mean 800 days, median 283 days for PCI; and mean 1039 days, median 762 days for

TABLE 1
Characteristics of patients with coronary artery disease

Characteristics	South Asian (n=3061)	Chinese (n=1473)	Other Canadian (n=77,314)
Men	77.7	77.8	75.0
Age, years			
20–34	0.5	0.4	0.3
35–44	4.9	2.7	4.1
45–54	19.1	15.8	16.0
55–64	32.5	24.6	26.7
65–74	29.2	37.1	31.9
≥75	13.8	19.4	21.0
Median income*			
Q1 (<25%, low income)	10.3	12.7	26.0
Q2 (25–49%)	17.6	17.0	25.3
Q3 (50–74%)	25.8	29.2	24.9
Q4 (≥75%, high income)	46.3	41.1	23.8
Distance from residence to revascularization-capable hospital (>50 km)†	26.9	25.9	55.9
PCI before coronary angiography	9.6	7.0	9.5
CABG before coronary angiography	8.4	5.6	8.7
Myocardial infarction before coronary angiography	41.1	33.5	46.2
Diabetes	37.6	30.6	23.3
Hypertension	60.4	66.7	57.4
Congestive heart failure	10.8	11.0	12.6
Chronic lung disease	6.6	6.7	10.9
Peripheral vascular disease	5.2	4.5	9.3
Cerebrovascular disease	6.0	8.3	7.7
Cancer	2.7	3.5	5.0
Gastrointestinal or liver disease	3.7	5.2	4.9
Dialysis	2.0	3.7	1.6
Coronary anatomy			
1- to 2-vessel disease	14.4	15.1	23.1
2-vessel disease and pLAD	24.6	27.0	22.7
3-vessel disease	31.8	29.0	27.2
3-vessel disease and pLAD	19.5	17.0	15.6
Left main disease	9.7	11.9	11.4
Ejection fraction, %			
>50	49.4	56.5	52.5
35–50	18.8	18.0	20.2
<35	5.5	4.8	5.8
Ventriculogram not performed	26.3	20.7	21.5
Indication for coronary angiography			
Acute coronary syndrome	45.2	42.4	40.7
Stable angina	33.0	35.2	29.1
Other	21.8	22.4	30.2
Length of follow-up among living patients, years, mean	3.9	3.8	4.3

Data presented as % unless otherwise indicated. *3325 were excluded due to missing data; †425 were excluded due to missing data. CABG Coronary artery bypass grafting; PCI Percutaneous coronary intervention; pLAD Proximal left anterior descending artery involvement; Q Quartile

CABG), the pattern of lower PCI rates in South Asian patients (risk-adjusted HR 0.95, 95% CI 0.90 to 1.00) and lower CABG rates in Chinese patients (risk-adjusted HR 0.90, 95% CI 0.82 to 0.99)

TABLE 2
Risk-adjusted ORs* for revascularization within six months after coronary angiography among patients with coronary artery disease

	South Asian (n=3061), %	Chinese (n=1473), %	Other Canadian (n=77,314), %	Risk-adjusted OR (95% CI)	
				South Asian versus other Canadian	Chinese versus other Canadian
Revascularization					
PCI	42.3	43.9	44.6	0.86 (0.79–0.93)	0.98 (0.87–1.10)
CABG	28.4	26.0	26.5	0.95 (0.87–1.04)	0.82 (0.72–0.93)
PCI or CABG	67.8	67.6	68.7	0.81 (0.75–0.88)	0.84 (0.74–0.94)
Revascularization among patients with 3-vessel disease, 3-vessel disease with pLAD, or left main disease					
PCI	30.3	32.2	32.7	0.81 (0.73–0.90)	1.00 (0.85–1.16)
CABG	41.6	40.5	41.6	0.95 (0.86–1.04)	0.89 (0.77–1.02)
PCI or CABG	68.0	69.3	71.0	0.75 (0.68–0.84)	0.85 (0.73–0.99)

*Risk factors adjusted for in this analysis included sex, age, median income (quartile, missing), distance from residence to hospital (50 km or less, more than 50 km, or missing), percutaneous coronary intervention (PCI) before coronary angiography, coronary artery bypass grafting (CABG) before coronary angiography, myocardial infarction before coronary angiography, diabetes, hypertension, congestive heart failure, chronic lung disease, peripheral vascular disease, cerebrovascular disease, cancer, gastrointestinal or liver disease, dialysis, coronary anatomy (one- to two-vessel disease, two-vessel disease and proximal left anterior descending artery involvement [pLAD], three-vessel disease, three-vessel disease and pLAD involvement, or left main disease), ejection fraction (greater than 50%, 35% to 50%, less than 35%, or ventriculogram not performed), and indication for coronary angiography (acute coronary syndrome, stable angina or other). A category of missing data was created for the variables of median income and distance from residence to hospital; these missing data were included in the risk adjustment model

TABLE 3
Outcome events and risk-adjusted HR* for revascularization during 10.5 years of follow-up after coronary angiography among patients with coronary artery disease

Outcome	South Asian (n=3061), n	Chinese (n=1473), n	Other Canadian (n=77,314), n	Risk-adjusted HR (95% CI)	
				South Asian versus other Canadian	Chinese versus other Canadian
Among patients with coronary artery disease					
PCI	1418	677	36,916	0.95 (0.90–1.00)	0.96 (0.89–1.04)
CABG	1015	458	23,701	1.00 (0.94–1.07)	0.90 (0.82–0.99)
PCI or CABG	2271	1077	57,144	0.94 (0.90–0.98)	0.94 (0.88–1.00)
Among patients with 3-vessel disease, 3-vessel disease with pLAD, or left main disease					
PCI	639	290	15,043	0.89 (0.82–0.97)	0.97 (0.86–1.09)
CABG	859	395	19,107	0.99 (0.93–1.07)	0.96 (0.87–1.07)
PCI or CABG	1384	645	31,963	0.89 (0.85–0.95)	0.97 (0.89–1.05)

*Risk factors adjusted for in this analysis included sex, age, median income (quartile, missing), distance from residence to hospital (50 km or less, more than 50 km, or missing), percutaneous coronary intervention (PCI) before coronary angiography, coronary artery bypass grafting (CABG) before coronary angiography, myocardial infarction before coronary angiography, diabetes, hypertension, congestive heart failure, chronic lung disease, peripheral vascular disease, cerebrovascular disease, cancer, gastrointestinal or liver disease, dialysis, coronary anatomy (one- to two-vessel disease, two-vessel disease and proximal left anterior descending artery [pLAD] involvement, three-vessel disease, three-vessel disease and pLAD involvement, or left main disease), ejection fraction (greater than 50%, 35% to 50%, less than 35%, or ventriculogram not performed), and indication for coronary angiography (acute coronary syndrome, stable angina or other). A category of missing data was created for the variables of median income and distance from residence to hospital; these missing data were included in the risk adjustment model

persisted (Table 3). When the study population was restricted to patients with a high probability of being candidates for revascularization (ie, those with three-vessel disease, three-vessel disease plus proximal LAD involvement, or left main disease), South Asian patients were still significantly less likely to undergo PCI (risk-adjusted HR 0.89, 95% CI 0.82 to 0.97) and revascularization (risk-adjusted HR 0.89, 95% CI 0.85 to 0.95) compared with other Canadian patients. In contrast, differences in revascularization rates between Chinese and other Canadian patients were not statistically significant (risk-adjusted HR 0.97, 95% CI 0.89 to 1.05).

In patients undergoing revascularization procedures (Table 4), there were no significant ethnic differences in the likelihood of undergoing PCI within seven days (risk-adjusted OR 1.03, 95% CI 0.90 to 1.18 for South Asian; and risk-adjusted OR 1.17, 95% CI 0.96 to 1.43 for Chinese compared with other Canadian patients). In patients undergoing CABG, the median time from catheterization to CABG was 45 days for South Asian patients, 42 days for Chinese patients and 37 days for other Canadian patients. However, the proportion of

patients who underwent CABG within 30 days after coronary angiography was not significantly different among the three patient groups (risk-adjusted OR 0.92, 95% CI 0.79 to 1.06 for South Asian; and risk-adjusted OR 0.87, 95% CI 0.70 to 1.08 for Chinese compared with other Canadian patients).

Mortality

There were no significant differences in mortality at 30 days after coronary angiography across the three ethnic groups (Table 5; risk-adjusted OR 1.26, 95% CI 0.98 to 1.62 for South Asian; and risk-adjusted OR 1.16, 95% CI 0.80 to 1.67 for Chinese compared with other Canadian patients). However, survival up to 10.5 years (mean 1467 days, median 1308 days) was better for South Asian patients (risk-adjusted HR 0.76, 95% CI 0.61 to 0.95) and Chinese patients (risk-adjusted HR 0.80, 95% CI 0.60 to 1.07) than for other Canadian patients (Table 6 and Figure 2). This finding persisted across strata defined by sex, age and status of revascularization. Among patients who did not undergo either PCI or CABG and, therefore, were treated medically, Chinese

TABLE 4

Time from coronary angiography to revascularization, with risk-adjusted ORs* for undergoing percutaneous coronary intervention (PCI) in less than seven days and coronary artery bypass grafting (CABG) in less than 30 days

Duration	South Asian, %	Chinese, %	Other Canadian, %	Risk-adjusted OR (95% CI)	
				South Asian versus other Canadian	Chinese versus other Canadian
Days from angiography to PCI among patients undergoing PCI	n=1424	n=677	n=37,078		
<7	74.7	74.8	73.7	1.03 (0.90–1.18) [†]	1.17 (0.96–1.43) [†]
0	64.0	64.6	59.7		
1–6	10.7	10.2	14.0		
≥7	25.3	25.2	26.3		
Days from angiography to CABG among patients undergoing CABG	n=1023	n=462	n=23,828		
<30	45.2	46.1	47.7	0.92 (0.79–1.06) [†]	0.87 (0.70–1.08) [†]
0	1.1	2.1	1.8		
1–6	16.2	17.8	15.3		
6–29	27.9	26.2	30.6		
≥30	54.8	53.9	52.3		

*Risk factors adjusted for in this analysis included sex, age, median income (quartile, missing), distance from residence to hospital (50 km or less, more than 50 km, or missing), PCI before coronary angiography, CABG before coronary angiography, myocardial infarction before coronary angiography, diabetes, hypertension, congestive heart failure, chronic lung disease, peripheral vascular disease, cerebrovascular disease, cancer, gastrointestinal or liver disease, dialysis, coronary anatomy (one- to two-vessel disease, two-vessel disease and proximal left anterior descending artery involvement, three-vessel disease, three-vessel disease and proximal left anterior descending artery involvement, or left main disease), ejection fraction (greater than 50%, 35% to 50%, less than 35%, or ventriculogram not performed), and indication for coronary angiography (acute coronary syndrome, stable angina or other). A category of missing data was created for the variables of median income and distance from residence to hospital; these missing data were included in the risk adjustment model; [†]Risk-adjusted OR for PCI within seven days and CABG within 30 days after coronary angiography

TABLE 5

30-day mortality and risk-adjusted ORs* after coronary angiography among patients with coronary artery disease

Ethnicity	30-day mortality, n (%)	Risk-adjusted OR (95% CI)
South Asian	70 (2.3)	1.26 (0.98–1.62)
Chinese	33 (2.4)	1.16 (0.80–1.67)
Other Canadian	1604 (2.1)	1.00

*Risk factors adjusted for in this analysis included sex, age, median income (quartile, missing), distance from residence to hospital (50 km or less, more than 50 km, or missing), percutaneous coronary intervention before coronary angiography, coronary artery bypass grafting before coronary angiography, myocardial infarction before coronary angiography, diabetes, hypertension, congestive heart failure, chronic lung disease, peripheral vascular disease, cerebrovascular disease, cancer, gastrointestinal or liver disease, dialysis, coronary anatomy (one- to two-vessel disease, two-vessel disease and proximal left anterior descending artery involvement, three-vessel disease, three-vessel disease and proximal left anterior descending artery involvement, or left main disease), ejection fraction (more than 50%, 35% to 50%, less than 35%, or ventriculogram not performed), and indication for coronary angiography (acute coronary syndrome, stable angina or other). A category of missing data was created for the variables of median income and distance from residence to hospital; these missing data were included in the risk adjustment model

TABLE 6

Number of deaths and risk-adjusted HRs* for mortality during 10.5 years of follow-up among patients with coronary artery disease

	Deaths, n			Risk-adjusted HR (95% CI)	
	South Asians	Chinese	Other Canadians	South Asian versus other Canadian	Chinese versus other Canadian
Overall	313	186	11,579	0.76 (0.61–0.95)	0.80 (0.60–1.07)
Men	231	138	8308	0.85 (0.74–0.97)	0.93 (0.78–1.10)
Women	82	48	3271	0.75 (0.60–0.94)	0.81 (0.61–1.09)
Patients <65 years of age	105	47	2810	0.88 (0.72–1.07)	1.24 (0.93–1.66)
Patients ≥65 years of age	208	137	8769	0.80 (0.69–0.91)	0.87 (0.73–1.03)
Patients who underwent PCI	100	67	4007	0.76 (0.63–0.93)	1.07 (0.84–1.37)
Patients who underwent CABG	89	46	3027	0.90 (0.73–1.11)	1.00 (0.75–1.34)
Patients who did not undergo PCI or CABG	138	77	4893	0.81 (0.69–0.97)	0.78 (0.62–0.98)

*Risk factors adjusted for in this analysis included sex, age, median income (quartile, missing), distance from residence to hospital (50 km or less, more than 50 km, or missing), percutaneous coronary intervention (PCI) before coronary angiography, coronary artery bypass grafting (CABG) before coronary angiography, myocardial infarction before coronary angiography, diabetes, hypertension, congestive heart failure, chronic lung disease, peripheral vascular disease, cerebrovascular disease, cancer, gastrointestinal or liver disease, dialysis, coronary anatomy (one- to two-vessel disease, two-vessel disease and proximal left anterior descending artery involvement, three-vessel disease, three-vessel disease and proximal left anterior descending artery involvement, or left main disease), ejection fraction (greater than 50%, 35% to 50%, less than 35%, or ventriculogram not performed), and indication for coronary angiography (acute coronary syndrome, stable angina or other). A category of missing data was created for the variables of median income and distance from residence to hospital; these missing data were included in the risk adjustment model

patients were also less likely to die compared with other Canadian patients (risk-adjusted HR 0.78, 95% CI 0.62 to 0.98).

DISCUSSION

The present follow-up study of patients undergoing coronary angiography found that fewer South Asian and Chinese patients underwent revascularization than other Canadian patients. However, use varied by type of procedure, with fewer South Asian patients undergoing PCI and fewer Chinese patients undergoing CABG than other Canadian patients. Despite this, there was no difference across ethnic groups in mortality in these populations in the 30-day follow-up, and South Asian and Chinese patients had a substantially improved survival rate compared with other Canadian patients in the follow-up period.

The potential underlying reasons for the observed imbalances in the use of invasive cardiac procedures are important to consider. Zaman et al (23) recruited 2189 South Asian and 5605 white patients with chest pain in the United Kingdom, and found that South Asians were less likely to undergo coronary angiography and revascularization within three years. Ethnic disparities are theoretically explained by multiple factors related to the patient, the health care system and the physician. In Canada, the costs for PCI and CABG are fully covered in the universal health care system for all residents. Revascularization services are centralized at only selected hospitals, with language interpretation services typically available in the regions where these hospitals are located. Therefore, health care access factors are less likely to play a significant role in revascularization use.

We controlled for factors related to patients, including sociodemographic variables, comorbidities, and severity of coronary disease and ventricular dysfunction. The remaining variation in the use of invasive cardiac procedures may, in part, be due to bias in physician attitudes or patient preferences. If physician biases exist, one would expect a consistent underuse of PCI and CABG among the ethnic groups compared with other Canadian patients. Yet, the present study demonstrated that South Asian patients used PCI less and CABG equally, and Chinese patients used CABG less and PCI equally compared with other Canadian patients. The CABG use pattern differed when analysis was restricted to patients with extensive coronary artery disease; Chinese patients were, then, as likely as other Canadian patients to undergo CABG. The length of time from coronary angiography to PCI was similar across the three ethnic groups, but South Asian and Chinese patients had a longer length of time from coronary angiography to CABG than other Canadians. These findings suggest that, on average, Canadian physicians are not biased against South Asian or Chinese ethnic groups, but may consider patient ethnicity when deciding which procedure to recommend. The differences in procedure use might also be due to patient treatment preference, which is related to multiple factors such as risk tolerance, health literacy, and patient beliefs and attitudes toward PCI and CABG.

Our study findings support other Canadian studies that examined various types of health services use. Quan et al (24) analyzed a Canadian national survey and found that ethnic minorities were just as likely as white respondents to report seeing a family physician/general practitioner or a specialist physician, where a family physician referral is required. Hemmelgarn et al (25) compared the use of peritoneal dialysis among East Asian, South Asian and white patients with end-stage renal disease initiating dialysis therapy in Canada. After controlling for sociodemographic factors and comorbid conditions, East Asian and South Asian patients were significantly more likely to initiate dialysis therapy on peritoneal dialysis compared with white patients.

One striking finding was that, although there were no ethnic differences in 30-day mortality, South Asian patients had a significantly better survival rate than other Canadian patients. Most previous studies that evaluated mortality among these ethnic groups have been limited to short-term studies. Gupta et al (7) found a similar in-hospital mortality rate between South Asian and white Canadians with acute myocardial infarction. Similarly, Feder et al (6) reported a similar three-year mortality rate between South Asian and white patients

Figure 2) Risk-adjusted survival curves for South Asian, Chinese and other Canadians with coronary artery disease

undergoing coronary angiography. However, Brister et al (14) demonstrated higher in-hospital mortality for South Asian than for white patients undergoing CABG.

Chinese patients appeared to have a lower mortality rate than other Canadians, particularly among patients 65 years of age or older, and in those who did not undergo revascularization. We did not find sex differences in mortality between Chinese and other Canadian patients, which contradicts a previous study reporting higher mortality among Chinese men with AMI compared with American white men with AMI (8). This inconsistency might be related to fundamental differences in the health care systems of Canada and the United States.

Our findings of similar 30-day mortality rates across ethnicities and lower mortality rates in the period of up to 10.5 years among Asian patients suggest that disease management after discharge may contribute to the low mortality rate. King et al (26) conducted in-depth interviews of a series of multiethnic Canadian patients with coronary artery disease, and reported that, compared with other ethnic patients, Chinese patients “were extremely diligent in seeking information, obtaining care, and learning about cardiovascular disease”. King et al (26) also found that Chinese patients actively seek information and opinions on their disease management from multiple sources, attempt to maintain good relationships with health care providers, are able to rely strongly on their family (ie, spouse and children) for transportation and language translation, and nearly exclusively rely on mainstream medicine and rarely use traditional Chinese medicine for heart disease. Despite these insights, the underlying reasons for low mortality rates among South Asian and Chinese patients remain unclear and warrant further study.

Limitations

Our study has several potential limitations. First, we focused on patients undergoing coronary angiography. Therefore, we cannot exclude referral bias for this procedure. Second, we categorized patients into ethnic groups based on surname analysis. Although these algorithms are a relatively reliable and validated proxy for patient ethnicity (11,12), there is likely to be some degree of misclassification. Similarly, the other Canadian patient group was assumed to be largely comprised of patients of European descent, although other ethnic groups have also been included. However, our observation of a high prevalence of diabetes, hypertension and extensive coronary artery disease among South Asian patients is consistent with other studies (6), which suggests that misclassification would be less likely to significantly alter our conclusions. Third, we could not assess actual physician recommendations or patient treatment refusal. Fourth, there may be cultural subgroups within the South Asian and Chinese ethnic categories. Bhopal et al (27) found that the distribution of coronary artery disease risk factors varied across subgroups of South Asian descent. Our results may not be applicable to these subgroups and

other ethnic groups. Fifth, appropriateness of revascularization across ethnicities was not assessed. However, we adjusted for coronary anatomy, indication for catheterization and ejection fraction as a proxy of appropriateness of revascularization in our analysis. Sixth, cases with missing data were excluded from the study but were less likely to alter our findings. The rate of use of PCI or CABG was 64%, 64.2% and 66.7% for South Asian, Chinese and other Canadians, respectively, and mortality was much lower for South Asian (6.8%) and Chinese (6.9%) Canadians than for other Canadians (8.3%) among those who were excluded from the study due to missing data. Our study misclassified patients who died or underwent cardiac procedures outside of the provinces of Alberta and British Columbia. In Canada, there are no private hospitals with the capacity for revascularization and the public provincial insurance program covers health care services. Therefore, patients rarely underwent procedures outside of their provinces or countries. Finally, caution should be taken when generalizing these results from Canada to populations in other geographical areas. Variations in ethnic population composition and immigration history across countries should be considered.

CONCLUSION

Our study provides valuable insights on procedure use and survival across ethnic groups in patients with coronary artery disease. Despite a universal coverage single-payer health care system, South Asian and

Chinese patients with coronary artery disease were slightly less likely to undergo revascularization than other Canadian patients. However, the pattern of procedure use is nuanced in that it differs for PCI versus CABG, and does not follow the same pattern for South Asian patients relative to Chinese patients. This latter point suggests that physician bias is an unlikely mechanism for the observed findings. Rather, we infer that patient attitudes and beliefs about invasive procedures may contribute to the differences observed. The better survival rate seen in South Asian and Chinese Canadians is a phenomenon that warrants further study.

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