

## Hospitalization rates and length of stay for cardiovascular conditions in Canada, 1994 to 1999

Ruth E Hall PhD<sup>1</sup>, Jack V Tu MD MSc PhD<sup>1,2,3,4</sup>  
for the Canadian Cardiovascular Outcomes Research Team

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RE Hall, JV Tu. Hospitalization rates and length of stay for cardiovascular conditions in Canada, 1994 to 1999. *Can J Cardiol* 2003;19(10):1123-1131.

**BACKGROUND:** Cardiovascular diseases (CVDs) are a leading cause of hospitalization in Canada. An examination of recent trends in cardiovascular hospitalization rates across Canada is of considerable value and interest to health policy decision makers and administrators, clinicians and researchers.

**OBJECTIVES:** To examine temporal trends and regional variation in hospitalization rates and length of stay for CVD conditions in Canada.

**METHODS:** Hospital discharge data for fiscal years 1994/95 to 1999/2000 were used to identify all Canadians who were hospitalized with the most responsible diagnoses of acute myocardial infarction (AMI), congestive heart failure (CHF), angina and chest pain. Direct age- and sex-standardized hospitalization rates were calculated by province and health region. Length of stay (LOS) for episodes of hospital care were adjusted for age, sex and cardiac procedures using ordinary least squares regression.

**RESULTS:** Overall, AMI, angina and chest pain hospitalization rates increased 6%, 8% and 11%, respectively, between fiscal years 1994/95 and 1999/2000 and decreased by 7% for CHF in Canada. There was wide regional variation in cardiovascular hospitalization rates in Canada, with the greatest variation seen in CHF, chest pain and angina, and the least seen in AMI. There was a modest downward trend in adjusted LOS between fiscal years 1994/95 and 1999/2000. In general, patients hospitalized in provinces in western Canada and Ontario had shorter LOS for all conditions when compared with those in Quebec and the eastern provinces.

**CONCLUSIONS:** AMI, angina and chest pain hospitalization rates in Canada increased between fiscal years 1994/95 and 1999/2000, while CHF rates declined. There is considerable regional variation in the cardiovascular hospitalization rates across the country that may be amenable to further interventional strategies.

**Key Words:** Episodes of care; Health services; Hospitalization rates; Length of stay; Small area variation; Utilization

### Le taux et la durée d'hospitalisation en raison de maladies cardiovasculaires au Canada entre 1994 et 1999

**HISTORIQUE :** Les maladies cardiovasculaires (MCV) sont l'une des principales causes d'hospitalisation au Canada. L'examen des tendances récentes quant au taux d'hospitalisation pour des MCV au Canada revêt une valeur et un intérêt considérables pour les décideurs et les administrateurs en santé et pour les cliniciens et les chercheurs.

**OBJECTIFS :** Examiner les tendances temporelles et la variation régionale quant au taux et à la durée d'hospitalisation pour des MCV au Canada.

**MÉTHODOLOGIE :** Les données relatives aux congés des hôpitaux entre les exercices 1994-1995 et 1999-2000 ont permis de repérer tous les Canadiens hospitalisés pour un diagnostic responsable d'infarctus du myocarde aigu (IMA), d'insuffisance cardiaque congestive (ICC), d'angine et de douleur thoracique. Les taux d'hospitalisation normalisés selon l'âge et le sexe ont été calculés par province et par région sanitaire. La durée d'hospitalisation (DH) en cas de soins hospitaliers a été rajustée selon l'âge, le sexe et l'intervention cardiaque au moyen d'une régression par la méthode classique des moindres carrés.

**RÉSULTATS :** Dans l'ensemble, le taux d'hospitalisation imputable à l'IMA, à l'angine et aux douleurs thoraciques a augmenté de 6 %, de 8 % et de 11 %, respectivement, entre les exercices 1994-1995 et 1999-2000 et a chuté de 7 % en cas d'ICC au Canada. Une importante variation régionale du taux d'hospitalisation pour des MCV s'observait au Canada, la plus grande étant constatée en cas d'ICC, de douleur thoracique et d'angine et la plus faible en cas d'IMA. Une modeste tendance à la baisse de la DH rajustée a été relevée entre les exercices 1994-1995 et 1999-2000. Règle générale, les patients hospitalisés dans l'Ouest canadien et en Ontario l'étaient moins longtemps que ceux qui habitaient au Québec et dans les Maritimes.

**CONCLUSIONS :** Le taux d'hospitalisation imputable à l'IMA, à l'angine et aux douleurs thoraciques au Canada a augmenté entre les exercices 1994-1995 et 1999-2000, tandis que celui attribuable à l'ICC a diminué. On remarque une variation régionale considérable des taux d'hospitalisation pour des MCV au pays, laquelle pourrait justifier de nouvelles stratégies d'intervention.

Heart disease accounts for a substantial proportion of hospital admissions and inpatient resource utilization in Canadian hospitals, particularly among people aged 65 years and older (1,2). In Canada, cardiovascular diseases were the most common reason for hospitalization in 1993 and remained so in 2000 (1-3).

In 1999, the Institute for Clinical Evaluative Sciences (ICES) and the Heart and Stroke Foundation of Ontario published *Cardiovascular Health and Services in Ontario: An ICES Practice Atlas* (4). The atlas identified cardiovascular diseases, specifically, acute myocardial infarction (AMI) and congestive heart failure (CHF) to be the first and second most common

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<sup>1</sup>Institute for Clinical Evaluative Sciences Institution, Toronto, Ontario; <sup>2</sup>Division of General Internal Medicine and Clinical Epidemiology and Health Care Research Program, Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario; <sup>3</sup>Faculty of Medicine, University of Toronto, Toronto, Ontario; <sup>4</sup>Departments of Public Health Sciences and Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario

Correspondence and reprints: Dr Ruth Hall, G2-27 The Institute for Clinical Evaluative Sciences, 2075 Bayview Avenue, Toronto, Ontario M4N 3M5. Telephone 416-480-4055 ext 2975, fax 416-480-6048, e-mail ruth@ices.on.ca

Received for publication June 6, 2003. Accepted July 3, 2003

reasons for Ontario hospital admissions in fiscal year 1996/97. Furthermore, cardiac admissions accounted for almost 20% of all inpatient resource utilization in Ontario (4).

In 2000, the Heart and Stroke Foundation of Canada published trends in the use of cardiac interventions and health services as well as the outcomes of heart disease and stroke in Canada (5). Hospitalization rates for AMI, CHF and ischemic heart disease (ie, angina pectoris, AMI, chronic ischemic heart disease and sudden death) decreased in the late 1980s but the decline slowed in the early 1990s (5).

Although the per capita rates of cardiovascular hospitalization declined between 1985 and 1995 with the increasing size of the older population, the absolute actual number of hospitalizations has actually increased and is projected to continue increasing for the next 20 years (5). The present article examines recent trends in cardiovascular hospitalization rates and length of stay (LOS) between fiscal years 1994/95 and 1999/2000 to provide health care system managers, decision makers, clinicians and other interested stakeholders an opportunity to evaluate and compare national cardiovascular hospitalization rates using methods similar to the approach initially used in Ontario (4). Provincial and regional hospitalization rates are also reported so that those working in health regions can better understand the burden of cardiovascular disease in their local communities.

## METHODS

### Data sources

The Canadian Institute for Health Information (CIHI) Discharge Abstract Database (between fiscal years 1994/95 and 1999/2000) and the CIHI Hospital Morbidity Database (HMDB) for Quebec and Manitoba were used to determine the numerators for hospitalization rates (6). The type of hospitalization was identified using the International Classification of Diseases, 9th revision, (ICD-9) "most responsible diagnosis" code (7). All patients 20 years of age or more who had a diagnosis code for AMI, CHF, angina or chest pain (see list of diagnosis codes in Appendix 1) were included. Residents of the Northwest Territories, the Yukon and Nunavut were excluded because these territories typically had 50 or fewer hospitalizations per year. Newfoundland was also excluded from AMI analyses because their coding of AMI did not rely exclusively on ICD-9 code 410.

The denominators for the hospitalization rates were based on the 1991 Statistics Canada Census five-year age- and sex-specific regional populations (8). Regional level analyses were conducted using health region boundaries as defined by Statistics Canada in December 2001 (9). Patients were assigned to regions based on their postal codes (6).

## STATISTICAL ANALYSES

### Hospitalization rates and small area variation

Regional hospitalization rates were age- and sex-standardized, and reported per 100,000 population aged 20 years and older. Rates were calculated by direct standardization rates using the 1991 Canadian population as the standard population. This method allows all regional rates to be directly comparable, assuming they all had the same age and sex distribution structure (10). To produce a stable numerator, three fiscal years (1997/98, 1998/99 and 1999/2000) of data were combined and an average hospitalization rate per 100,000 population was calculated. Regional populations ranged from 626 to 1,920,675. The mean regional population was 162,415. Data were suppressed for regions with fewer than 50 hospitalizations over the three-year period. Four age/sex groups were calculated: 20 to 49 years, 50 to 64 years, 65 to 74 years and

75 years and older to examine age/sex group trends in cardiovascular hospitalizations. The extremal quotient (EQ), coefficient of variation (CV), and the systematic component of variation (SCV) statistics were calculated to evaluate the amount of regional variation in hospitalization rates (see Appendix 2 for definitions and relevance of these statistics in evaluating regional variation). The Spearman correlation coefficient was calculated to determine the degree of association between the four hospitalization conditions across health regions in Canada.

### LOS for episodes of cardiovascular care

To compare LOS across the country, 'episodes of care' were created to account for interhospital transfers that would otherwise contribute to inaccurate estimates of total length of hospital stay. A cardiovascular hospitalization episode was defined as either a direct admission to an acute care hospital from which the patient was subsequently discharged to his or her home, or a continuous sequence of hospitalizations (ie, a hospital discharge and admission within the same day was considered to all be part of the same episode of care). This approach is similar to that used in the Ontario Hospital Report Card in 2001 (11).

Ordinary least squares regression was used on trimmed LOS (excluding cases with episode LOS beyond the 97.5 percentile) to prevent extreme values from influencing the provincial estimates of differences in LOS for episodes of cardiovascular hospital care for each fiscal year from 1994/95 to 1999/2000. Adjustment was made for age, sex and whether an invasive cardiac procedure was performed during the episode of care (see Appendix 3 for list of procedures and corresponding procedure codes used). Regression analyses were performed separately for each fiscal year (from 1994/95 to 1999/2000). The adjusted provincial average LOS is the observed average provincial LOS divided by the predicted average provincial LOS then multiplied by Canada's yearly average LOS.

### Interpretative cautions

Regional hospitalization rates were determined using patients' place of residence, regardless of where the hospitalizations (or subsequent transfers) took place. Therefore, the unit of analysis is the hospitalization and the hospitalization rates apply to the individuals within a geographical region, not to the hospitals within a region. We wanted to estimate the total burden of hospitalization so individuals with multiple hospitalizations were counted within a given fiscal year.

Episodes of care were used to examine trends in LOS among the ten provinces. This methodology relies on the presence of a valid health card number and, therefore, records with invalid health card numbers were excluded from the analyses. This proved problematic for the data received for the province of Saskatchewan, resulting in approximately 50% of Saskatchewan's hospitalizations for all four conditions to be excluded from the analyses for 1994/95, 1995/96 and 1996/97. This methodology also assumes the first hospitalization in 1994/95 was the first episode of care. This was necessary because the institution transfer to/from variable may be inaccurately coded in the national CIHI database and is omitted from the HMDB (Quebec and Manitoba) data. Furthermore, index hospitalizations were not distinguished from recurrent hospitalizations in this analysis.

## RESULTS

### Trends in cardiovascular hospitalization rates

In Canada, rates of cardiovascular hospitalizations had modest yearly fluctuations over the six-year study period. CHF hospitalization rates were the only ones among those we studied that declined (7%) between fiscal years 1994/95 and 1999/2000,

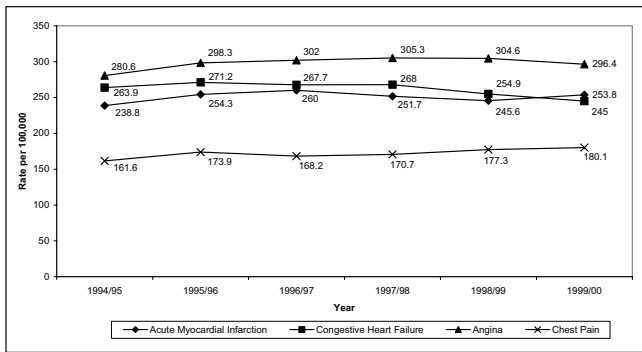


Figure 1) Age- and sex-standardized hospitalization rates for cardiovascular diagnoses in Canada, per 100,000 population aged 20 years and over, fiscal years 1994/95 to 1999/2000

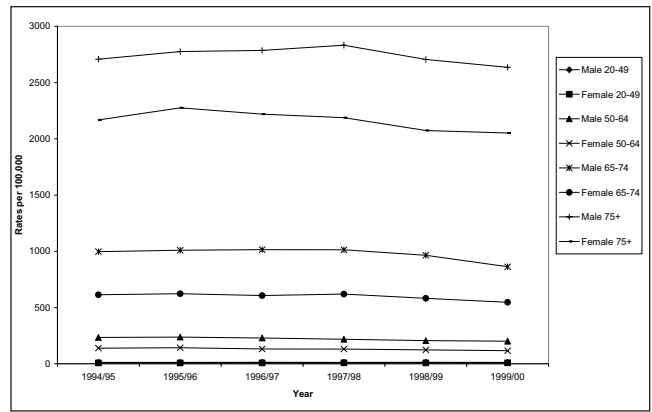


Figure 3) Age- and sex-specific hospitalization rates for congestive heart failure in Canada, per 100,000 population aged 20 years and older, fiscal years 1994/95 to 1999/2000

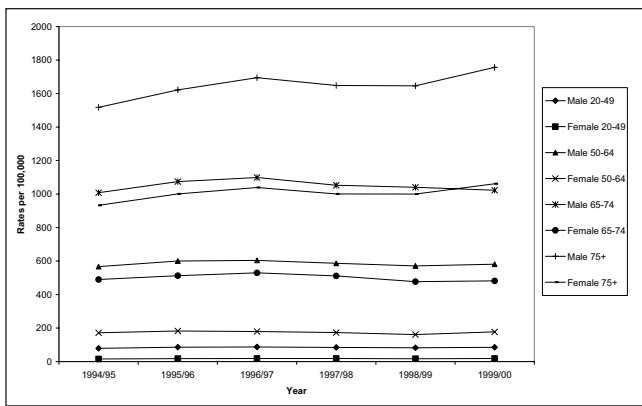


Figure 2) Age- and sex-specific hospitalization rates for acute myocardial infarction in Canada, per 100,000 population aged 20 years and over, fiscal years 1994/95 to 1999/2000

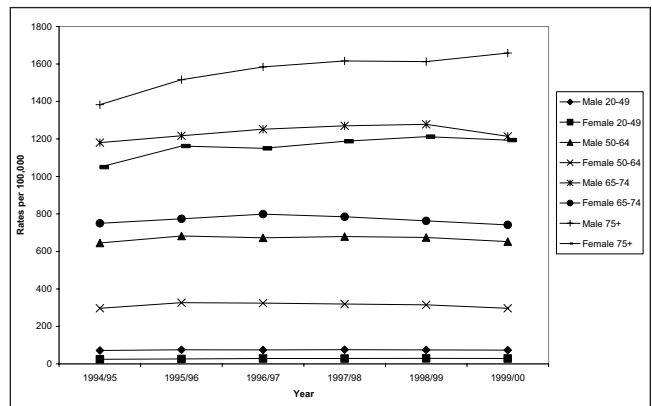


Figure 4) Age- and sex-specific hospitalization rates for angina in Canada, per 100,000 population 20 years and older, fiscal years 1994/95 to 1999/2000

declining dramatically since fiscal year 1997/98 (Figure 1). In contrast, overall hospitalization rates increased during the same time period for chest pain, angina and AMI by 11%, 8%, and 6%, respectively.

**Age- and sex-specific hospitalization rates**

The age- and sex-specific rates for the four cardiovascular hospitalizations revealed that the 20 to 49 year age group consistently experienced the lowest rate of hospitalization (Figures 2–5). In general, men experienced a higher rate of hospitalization than women, except for chest pain, where women 65 years of age and older experienced a higher rate than men.

**AMI**

For AMI hospitalizations, the 75 years of age and older group experienced the greatest increase in hospitalization rates (Figure 2). Hospitalization rates for men were about five times higher than women among the 20 to 49 year olds, and approximately three and a half times higher among the 50 to 64 years old.

**CHF**

All age groups experienced a slight decrease in the rate of CHF hospitalizations since the 1995/96 fiscal year, with the most dramatic decrease in those 75 years and older (Figure 3). Hospitalization rates for CHF for men 75 years of age and older

were three times higher than those aged 65 to 74. For women 75 years of age and older, CHF hospitalization rates were almost four times higher than those aged 65 to 74.

**Angina**

Angina hospitalization rates for men aged 20 to 49 years and the 75 years of age and older groups increased dramatically over the study period (13% to 19%) (Figure 4). Rates of hospitalization for women aged 50 to 64 years and men aged 65 to 74 years declined substantially in the most recent year of data (6% and 5%, respectively).

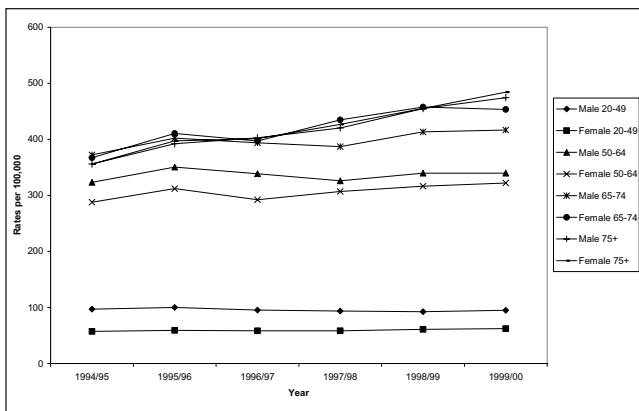
**Chest pain**

In general, chest pain hospitalization rates have been on the increase for both men and women 65 years of age and older, and most markedly for women 75 years and older (356 per 100,000 population in 1994/95 versus 484 per 100,000 population in 1999/2000) (Figure 5).

**REGIONAL VARIATION IN HOSPITALIZATION RATES**

**AMI**

The analyses of regional variation in hospital rates were conducted using the fiscal years 1997/98 to 1999/2000 data only. The average of the three years was used to



**Figure 5)** Age- and sex-specific hospitalization rates for chest pain in Canada, per 100,000 population 20 years and older, fiscal years 1994/95 to 1999/2000

determine regional rates (for regional age-sex standardized rates and rank, see Appendix 4 on the CCORT web site: <http://www.ccort.ca/CVDHospitalizationsLOS.asp>) and the results are presented in Figures 6-9. The actual rates for each health region are available on the CCORT web site (<http://www.ccort.ca/CVDHospitalizationsLOS.asp>). For AMI, the national age- and sex-standardized hospitalization rates for fiscal years 1997/98 to 1999/2000 among the 130 regions included in the analysis was 250 per 100,000 population. Health District 5 in Nova Scotia had the highest hospitalization rate (405 per 100,000 adults) and Vancouver, British Columbia had the lowest (135 per 100,000 adults) (Figure 6). The lowest hospitalization rates for AMI were among five urban/metropolitan regions in British Columbia, as well as the Northwestern Regional Health Authority in Alberta, Weyburn Service Area in Saskatchewan and Winnipeg, Manitoba. The highest rates were in rural and northern regions of Ontario and rural New Brunswick (Regions 7 and 3).

### CHF

Between fiscal years 1997/98 and 1999/2000, the national CHF age- and sex-standardized hospitalization rate was 256 per 100,000 adults among the 136 regions included in the analysis. Keeweenaw Lakes Regional Health Authority in Alberta had the highest hospitalization rate (929 per 100,000 adults) while the Capital region in British Columbia had the lowest rate (154 per 100,000 adults) (Figure 7). The lowest hospitalization rates for CHF were in urban/metropolitan regions of British Columbia, Alberta, Ontario and Quebec while the highest rates were found in rural Alberta, Manitoba, Saskatchewan and Newfoundland.

### Angina

For angina, the national age- and sex-standardized hospitalization rate was 302 per 100,000 adults among the 136 regions. Region de la Côte-Nord in Quebec had the highest hospitalization rate (855 per 100,000 adults) and the Calgary Health Region had the lowest rate (55 per 100,000 adults) among 136 regions (Figure 8). The lowest hospitalization rates for angina were in the urban regions of Alberta, British Columbia and Ontario, while the highest rates were found in the remote regions of Quebec, New Brunswick, Newfoundland and Ontario.

### Chest pain

The national chest pain age- and sex-standardized hospitalization rate was 176 per 100,000 adults. The rates of hospitalizations for chest pain varied from 502 per 100,000 adults in Grenfell Regional Health Services Board in Newfoundland to 63 per 100,000 adults in the Region de Laval in Quebec (Figure 9). The lowest hospitalization rates for chest pain were in the urban/metropolitan regions of Quebec, Ontario, Manitoba and Alberta, while the highest rates were found in four of the seven regions of New Brunswick, rural/remote Newfoundland, Ontario and Alberta.

There was only a modest correlation among the regional hospitalization rates. For example, regions that had high hospitalization rates for AMI tended to also have high rates of hospitalization for angina and CHF ( $R^2=0.28$ ,  $P<0.0001$ ,  $R^2=0.20$ ,  $P<0.0001$ , respectively). Regions that had high hospitalization rates for CHF tended to have high hospitalization rates for chest pain ( $R^2=0.26$ ,  $P<0.0001$ ).

### Summary

CHF, angina and chest pain hospitalization rates have a substantive degree of regional variation. The EQ, CV and SCV small-area variation statistics were 6, 27.5%, and 614, respectively, for CHF, 15.6, 45% and 248, respectively, for angina, and 26, 47% and 416, respectively, for chest pain. AMI hospitalization rates demonstrated a modest amount of variation across the country with an EQ of 5, a CV of 19% and a SCV of 39.

## LENGTH OF STAY FOR EPISODES OF CARDIOVASCULAR HOSPITALIZATIONS

### AMI

Table 1 illustrates the comparison in the adjusted mean LOS for cardiovascular hospitalizations in Canada between fiscal years 1994/95 and 1999/2000. Mean LOS for AMI hospitalizations in Canada decreased by 10% overall, from 9.8 days to 8.8 days. British Columbia consistently had the shortest adjusted mean LOS: 8.3 days in the 1994/95 fiscal year versus 7.5 days in the 1999/2000 fiscal year. Nova Scotia and Quebec had the longest mean LOS over the six years studied.

### CHF

The adjusted mean LOS for CHF hospitalizations decreased 9% overall for Canada, from 10.9 days to 9.9 days between fiscal years 1994/95 and 1999/2000. British Columbia has the shortest mean LOS: 9.4 days in the 1994/95 fiscal year versus 8.9 days in the 1999/2000 fiscal year. Nova Scotia had the longest mean LOS for CHF in 1994/95 (12.7 days) and Prince Edward Island had the longest mean LOS in 1999/2000, (12.0 days) (Table 1).

### Angina

On average, the mean LOS for angina hospitalizations decreased 11% over the six years from 6.7 days in the 1994/95 fiscal year to 5.9 days in the 1999/2000 fiscal year. Manitoba's mean LOS was 5.5 days in the 1994/95 fiscal year but it actually increased to 5.8 days in the 1999/2000 fiscal year. British Columbia had the shortest LOS: 4.9 days in fiscal year 1994/95 and 5.1 days in fiscal year 1999/2000. Newfoundland had the longest adjusted mean LOS in 1999/2000 at 7.5 days (Table 1). However, Nova Scotia and Prince Edward Island generally had longer adjusted mean LOS for the other years in the six-year study period.

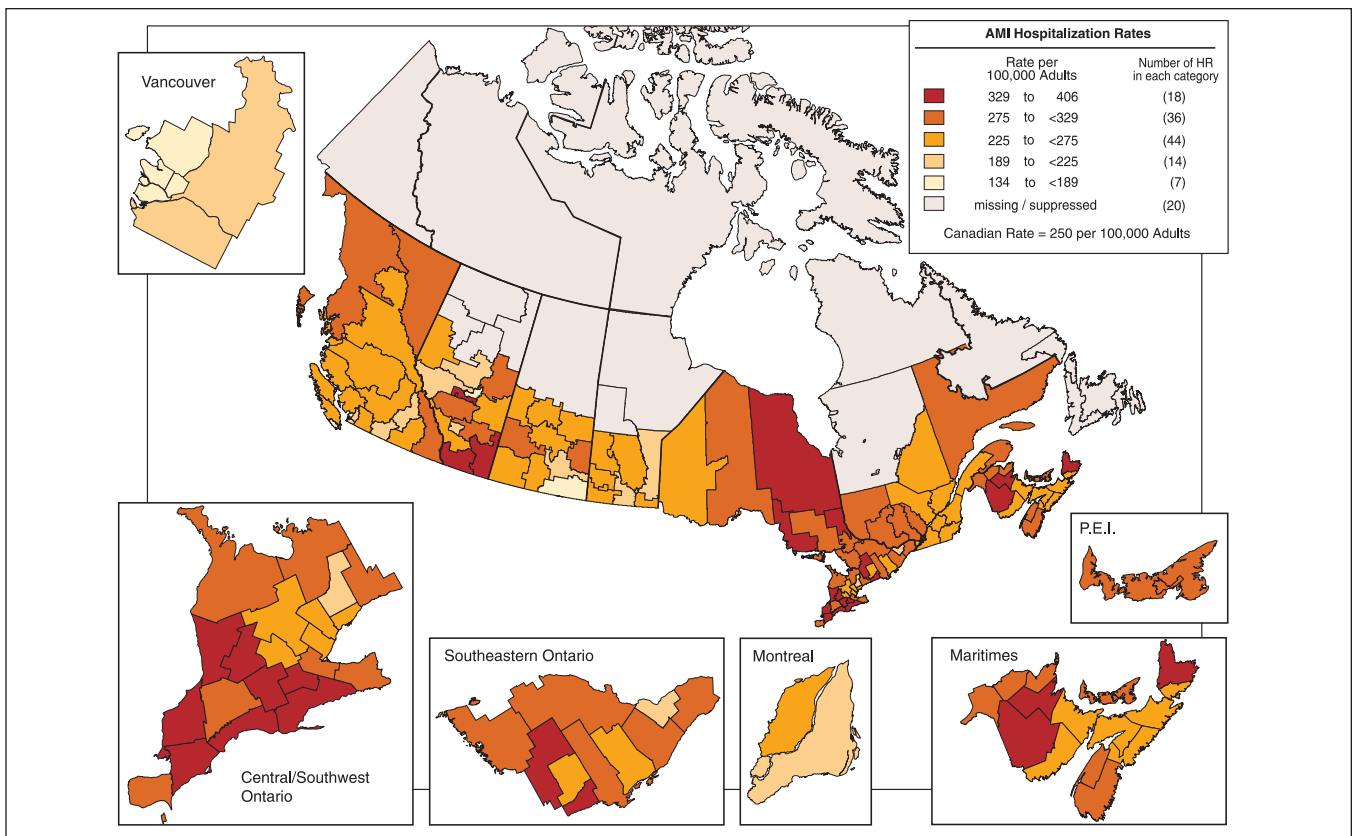


Figure 6) Age- and sex-standardized acute myocardial infarction (AMI) hospitalization rates per 100,000 adults, by health region (HR), fiscal years 1997/98 to 1999/2000. Source: Canadian Institute for Health Information. PEI Prince Edward Island

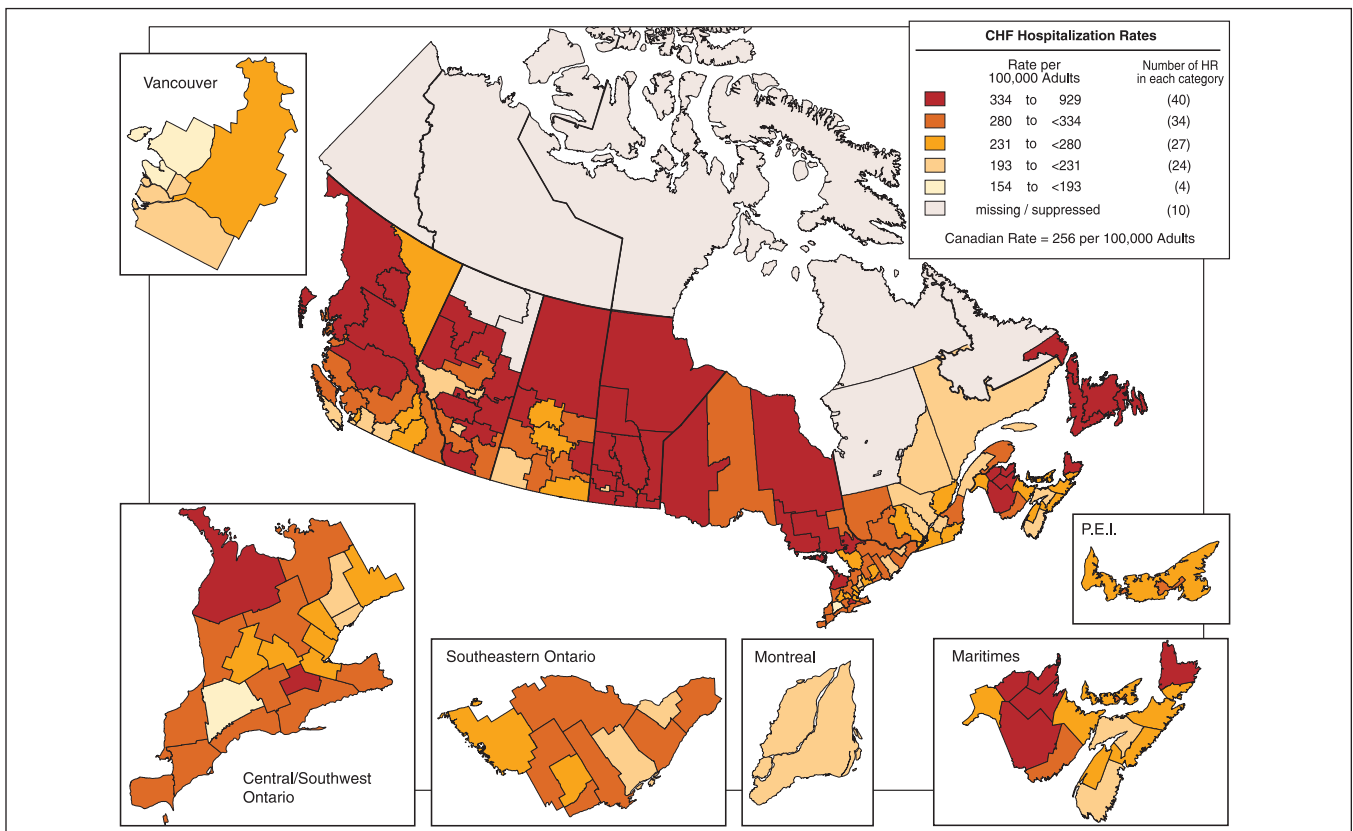


Figure 7) Age- and sex-standardized congestive heart failure (CHF) hospitalization rates per 100,000 adults, by health region (HR), fiscal years 1997/98 to 1999/2000. Source: Canadian Institute for Health Information. PEI Prince Edward Island

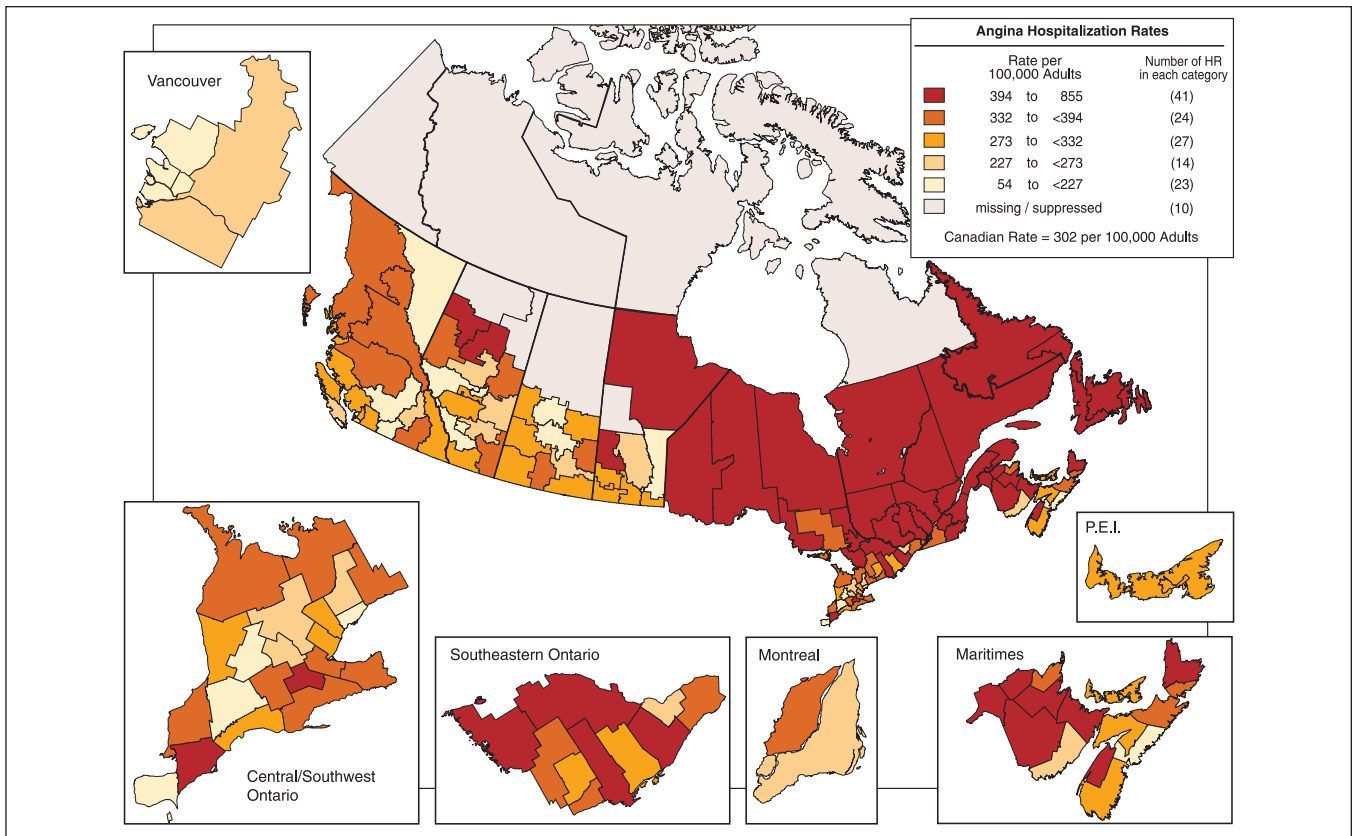


Figure 8) Age- and sex-standardized angina hospitalization rates per 100,000 adults, by health region (HR), fiscal years 1997/98 to 1999/2000. Source: Canadian Institute for Health Information. PEI Prince Edward Island

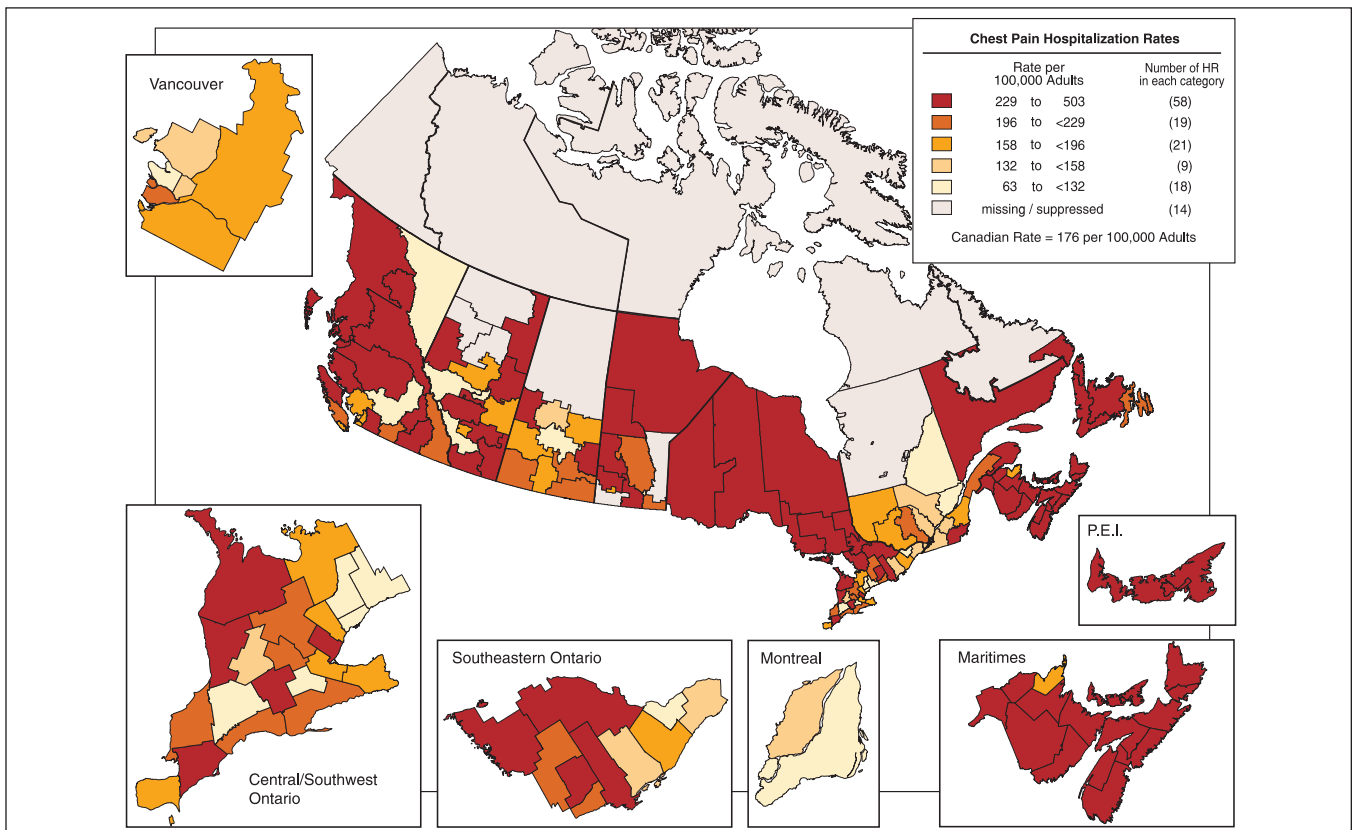


Figure 9) Age- and sex-standardized chest pain hospitalization rates per 100,000 adults, by health region (HR), fiscal years 1997/98 to 1999/2000. Source: Canadian Institute for Health Information. PEI Prince Edward Island

### Chest pain

There has been a 6% decrease in the mean LOS for chest pain hospitalizations between fiscal years 1994/95 and 1999/2000, from 3.2 days to 3.0 days. Saskatchewan and the Maritime provinces demonstrated the most dramatic decline in the adjusted mean LOS for chest pain hospitalizations. Again, British Columbia had the shortest adjusted mean LOS: 2.5 days in 1994/95 versus 2.4 days in 1999/2000. Prince Edward Island had the longest adjusted mean LOS: 4.4 days in 1994/95 and 3.8 days in 1999/2000.

### Summary

In general, provinces west of Quebec had shorter adjusted LOS than Quebec and the eastern provinces. Adjusting for whether an invasive cardiac procedure was performed during the episode typically increased the expected length of stay by three days for AMI ( $P<0.001$ ), five days for CHF ( $P<0.0001$ ), two days for angina ( $P<0.0001$ ) and half a day for episodes of chest pain hospitalizations.

## DISCUSSION AND CONCLUSIONS

This is the first national study to examine regional variations in cardiovascular inpatient hospitalization rates across Canada. The Heart and Stroke Foundation of Canada has previously published national and provincial trends on hospitalization rates for cardiovascular disease in Canada (5), but up to this point no studies have been conducted at the regional level. This study found an overall decline in the hospitalization rates for CHF, whereas an increase in hospitalization rates for AMI, angina and chest pain was found across the country over the six years. Greater regional variation in hospitalization rates was found for CHF, angina, and chest pain than was found for AMI, which suggests that some of these admissions may have been discretionary, and potentially avoidable. The LOS for all these conditions has gradually decreased throughout the 1990s, suggesting a more efficient utilization of acute hospital resources is occurring.

We observed a moderate increase in AMI hospitalization rates between fiscal years 1998/99 and 1999/2000 whereas at the same time, angina hospitalization rates decreased. This could reflect the introduction of troponin testing in Canada around that time, with a gradual increase in the number of small AMIs detected and a corresponding decrease in the number of angina patients coded, although more recent data (ie, 2000 onwards) would be required to confirm this hypothesis.

### Hospitalization rates for cardiovascular diagnoses – Small area variation

There is a moderate to high degree of variation in hospitalization rates across the regions of Canada. Wennberg et al (12) have suggested classifying variation from low to very high using the systematic coefficient of variation (a statistical measure) and defined variation accordingly: low=17; moderate=39; high=90; very highI=190; very highII=506. The SCV permits comparisons between regions of different sizes because it removes the amount of variation between regions that would be expected by chance alone and is a less biased estimate of relative variation (13).

AMI hospitalization rates demonstrated a moderate degree of variability by all measures of variation (EQ=4.8, CV=19.5%, SCV=38.7), perhaps reflective of AMI being a nondiscretionary admission, and having well-developed and

**TABLE 1**  
Adjusted\* mean length of stay for cardiovascular hospitalizations in Canada 1994/95 and 1999/2000

	Acute myocardial infarction		Congestive heart failure		Angina		Chest pain	
	1994/95	1999/2000	1994/95	1999/2000	1994/95	1999/2000	1994/95	1999/2000
<b>NFLD</b>	-	-	10.9	10.1	8	7.5	3.9	3.5
<b>PEI</b>	9.9	9.8	11.9	12.0	8	6.8	4.4	3.8
<b>NS</b>	10.3	9.6	12.9	11.4	7.7	7.0	4.2	3.6
<b>NB</b>	10.4	9.3	11.6	11.1	7.3	6.8	3.8	3.2
<b>QC</b>	11.2	9.7	12.8	10.9	8.1	6.5	4.2	3.7
<b>ONT</b>	9.4	8.7	10.4	9.3	6.0	5.5	2.9	2.6
<b>MB</b>	9.2	8.6	10.8	10.0	5.5	5.8	2.9	2.9
<b>SK</b>	11.3	8.1	11.6	9.5	7.9	5.3	3.5	3.0
<b>AB</b>	9.0	8.6	10.5	10.5	5.5	5.2	3.0	3.1
<b>BC</b>	8.3	7.5	9.4	8.9	4.9	5.1	2.5	2.4
<b>Canada</b>	9.8	8.8	10.9	9.9	6.7	6.0	3.2	3.0

\*adjusted for age, sex, and cardiac procedures. AB Alberta; BC British Columbia; MB Manitoba; NB New Brunswick; NFLD Newfoundland; NS Nova Scotia; ONT Ontario; PEI Prince Edward Island; QC Quebec; SK Saskatchewan

disseminated guidelines emphasizing the need for hospitalization and treatment of all cases of AMI (14,15).

CHF, chest pain and angina hospitalization rates demonstrated more regional variation. The SCV for CHF, chest pain and angina were 614.6, 416.2 and 247.7, respectively, reflecting the more discretionary nature of many of these admissions. This high degree of variation suggests that despite the development and dissemination of specific guidelines for the treatment of CHF, angina and chest pain, there is less consensus among providers about the need for hospitalization in these patients (16-18).

Variations in hospitalization rates for these four cardiovascular diagnoses could in part be a result of differences in coding practices for these conditions, although we believe that is unlikely to be the major explanation. A more plausible suggestion is that regional differences in hospitalization rates are related to factors such as physician supply and practice styles, access to ambulatory care, community and institutional resources, the prevalence of effective primary and secondary prevention programs, and the socioeconomic status of various health regions (4,19).

Not surprisingly, the rural or more remote regions in the country had the highest hospitalization rates and the urban regions in the country had the lowest rates. This may be partially attributed to the small numbers producing unstable estimates, but also possibly reflective of their limited capacity to treat and/or manage these cardiovascular diagnoses requiring transfers to larger facilities, or perhaps reflective of a greater bed supply per capita, or higher incidence of risk factors for cardiovascular disease in rural regions than in urban ones. The finding that rural and remote regions had higher hospitalization rates for CHF, which is considered an ambulatory care sensitive condition, is consistent with the assumption that rural areas are underserved and do not have similar access to effective ambulatory care as urban regions (19).

For health regions with higher than expected hospitalization rates, a number of strategies to decrease their hospitalization

rates may be considered. For example, CHF hospitalization rates may be decreased through the establishment of multidisciplinary ambulatory CHF clinics and greater patient education and counseling, along with increased use of therapies such as angiotensin-converting enzyme (ACE) inhibitors and beta-blockers (20). Angina and chest pain hospitalization rates could be reduced through the development of short-stay chest pain evaluation units and the use of chest pain risk-stratification instruments. Reduction of AMI hospitalization rates would require attention to both community-based primary prevention programs focused on traditional risk factors (eg, smoking, hypertension, diabetes, etc) along with maximal use of secondary prevention medications (eg, aspirin, beta-blockers, ACE inhibitors, statins) and cardiac rehabilitation programs.

Interestingly, the urban regions within British Columbia and Alberta had the lowest rates of hospitalization for most of the cardiovascular conditions we examined. Data from the Statistics Canada Canadian Community Health Survey and Population Health Surveys also show that residents from these regions have a lower prevalence of risk factors such as smoking, self-reported hypertension and obesity (21). Although the correlation between risk factors and hospitalization rates was not evaluated in our study, it is quite likely that the better health status of these residents contributes to the lower hospitalization rates in those provinces.

#### LOS for hospitalizations for cardiovascular diagnoses

The mean LOS for most cardiovascular hospitalizations has decreased for most provinces since fiscal year 1994/95. Decreases are most dramatic for angina and for hospitalizations in the eastern provinces, although LOS is still greater in Eastern Canada than it is in Western Canada. Our LOS analyses were based on episodes of care, accounting for interhospital transfers for cardiac procedures and other reasons. Our results illustrate that the eastern provinces have longer episodes of acute hospital care for all the cardiovascular conditions we examined, both before and after adjusting for age, sex and cardiac procedures. The adjusted mean LOS reflects what would be expected if the provinces were caring for patient populations with similar age and sex composition and cardiac procedure intervention. Possible explanations for provincial differences in mean LOS include differences in underlying population characteristics, in access to cardiovascular monitoring/interventions, in acute-bed, rehabilitation and home care availability, in practice patterns and in severity of illness. The lower adjusted LOS in western Canada suggests that greater efficiencies in the use of hospital resources might be possible in Quebec and the eastern Canadian provinces. Studies from the United States have suggested that a three-day LOS for uncomplicated AMIs is safe for many patients, whereas the mean LOS for AMI in Canada was still around eight days in 1999/2000 (22).

In summary, acute inpatient hospitalization plays a central role in the management of cardiovascular disease in Canada. Our study has provided evidence of considerable provincial and regional variation in the utilization of acute inpatient hospital care for CHF, angina and chest pain, with less variation seen for AMI hospitalizations across regions in Canada. The next step will be to use this information to begin a dialogue among provincial policy makers, regional health authorities, clinicians and researchers to develop strategies to evaluate the

appropriateness of cardiovascular hospitalization rates across the country, as well as to gather additional data to better understand the factors contributing to all of the regional variation seen. Ongoing monitoring of hospitalization rates and length of stay for cardiovascular conditions has importance for both clinical and economic reasons. We hope that the provinces and health regions will use these data in a constructive manner to learn from one another and ultimately develop strategies that will improve the cardiovascular health of Canadians.

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**ACKNOWLEDGEMENTS:** The authors would like to acknowledge CCORT Research Coordinators Courtney Kennedy and Susan Brien for their work in the organization, editing and final production of this manuscript. Additional recognition is given to Brian Graves and Courtney Kennedy for producing and designing the maps featured in the manuscript. The authors also thank the Canadian Institutes of Health Information (CIHI) for the use of their databases in this study.

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**FUNDING:** The CCORT Canadian Cardiovascular Atlas Project was supported by Operating Grants to the Canadian Cardiovascular Outcomes Research Team from the Canadian Institutes for Health Research Interdisciplinary Health Research Team program and the Heart and Stroke Foundation. Dr Tu is supported by a Canada Research Chair in Health Services Research. Dr Hall is supported by a CCORT post-doctoral fellowship

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#### APPENDIX 1 Diagnostic codes for acute myocardial infarction (AMI), congestive heart failure (CHF), angina and chest pain

Diagnosis	ICD-9 code
AMI	410.0-410.9
CHF	428.0-428.9
Angina	411 and 413
Chest pain	786.5

*ICD-9 International classification of diseases, 9th revision*

#### APPENDIX 2 Definition of small area variation statistics

##### Extremal quotient (EQ)

The EQ is a measure of the highest regional age-sex standardized rate divided by the lowest. Because the underlying distribution of rates is unknown and the variance fluctuates from region to region due to differences in population sizes the EQ may give misleading results (23).

##### Coefficient of variation (CV)

The CV is the standard deviation of the rates among regions divided by the mean rate (national rate) weighted by the population in each region. The weakness of this statistic is that there are no tables to judge what is 'too large' (23).

##### Systematic coefficient of variation (SCV)

The SCV is a descriptive statistic developed by McPherson et al (24) and is an estimate of the amount of variation 'left' between the regions after the variation that would be expected by chance within the regions has been removed. It is obtained by subtracting the random component of variation from the estimate of total variance, and is a useful statistic because it is not correlated to the prevailing rates (13). Large values of the SCV indicate true differences among regions, and permit comparison among units of different sizes and different rates to determine if there is more variability in one region than in another. Negative values are possible, but acceptable in the null case, since true variability is zero (23).

### APPENDIX 3 Cardiac procedure codes for length of stay analyses

PROCEDURE	CCP CODES	ICD-9 CODES
Coronary angiography*	48.92 – 48.98	88.52 – 88.54
Cardiac catheterization†	49.95 – 49.97	37.21 – 37.23
Percutaneous transluminal coronary angiography	48.02, 48.03, 48.09	36.01, 36.02, 36.05
Coronary artery bypass surgery (CABG)	48.11 – 48.19	36.10 – 36.19

\*for acute myocardial infarction (AMI) and angina, Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures (CCP) code 48.93 or International Classification of Diseases, 9th Revision (ICD-9) code 88.52 was excluded; †for AMI and angina, CCP code 49.95 or ICD-9 code 37.21 was excluded. CABG Coronary artery bypass graft

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