

## Chapter 13: Community factors, hospital characteristics and inter-regional outcome variations following acute myocardial infarction in Canada

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**BACKGROUND:** While various community and hospital characteristics have been demonstrated to have an impact on individual cardiovascular outcomes, the extent to which such factors account for inter-regional and interhospital outcome variations following acute myocardial infarction (AMI) remains unknown.

**OBJECTIVES:** To examine the impact of community and hospital factors on individual AMI outcomes and procedure use, and to determine the extent to which such characteristics account for inter-regional and interinstitutional AMI outcome and procedure variations across Canada.

**METHODS:** Patients hospitalized with AMI between April 1, 1997, and March 31, 2000, across Canada were examined. The community and hospital characteristics studied included three indicators of socioeconomic status, two indicators of ethnicity, rural-urban status of residence, hospital academic affiliation, and the presence or absence of on-site angiography or revascularization capabilities at the admitting institution. Outcomes included in-hospital mortality, one-year cardiac readmissions and 30-day revascularization rates post-AMI. All analyses were adjusted for age, sex and age-sex interaction. The relationships between community/hospital factors and individual outcomes were examined using random-effects hierarchical logistic regression analysis, while the relationships between community/hospital characteristics and inter-regional/hospital risk-adjusted outcomes were examined using least squares regression and the coefficient of determination ( $r^2$ ).

**RESULTS:** After adjusting for demographic factors, a patient's neighbourhood socioeconomic status was inversely correlated with the likelihood of death and downstream cardiac readmissions ( $P < 0.001$ ); patients residing in lower educated regions were less likely to receive revascularization post-AMI ( $P < 0.001$ ). Patients living in regions with higher concentrations of new immigrants and/or visible minorities, as well as those admitted to academically affiliated hospitals or hospitals with on-site procedural capacity, had fewer cardiac readmissions ( $P < 0.001$ ) and greater use of revascularization post-AMI ( $P < 0.001$ ) after adjusting for age and sex. Despite their associations with outcomes on an individual patient level, community and hospital factors explained no more than 7% of the variation in the risk-adjusted outcomes across hospitals or regions. Finally, adjustments

for community and hospital factors and procedure use, beyond adjustments for age and sex alone, had marginal impact on a province's risk-adjusted outcomes.

**CONCLUSIONS:** While community and hospital factors are important determinants of individual outcomes after AMI, they account for only a minimal degree of outcome variation across regions. Further studies are required to examine whether AMI outcome variations in Canada are explained by differences in patient clinical profiles and/or by differences in the decision-making behaviours of providers across jurisdictions.

**Key Words:** *Acute myocardial infarction; Canada; Community factors; Hospital factors; Outcomes; Regional variations*

### Facteurs propres aux communautés et aux hôpitaux et variations interrégionales du pronostic post-IAM au Canada

**HISTORIQUE :** Bien que l'on ait démontré l'existence de caractéristiques propres aux communautés et aux hôpitaux et leur impact sur le pronostic cardiovasculaire individuel, la portée de ces facteurs sur la variation des pronostics post-infarctus aigu du myocarde (IAM) entre les régions et entre les hôpitaux demeure inconnue.

**OBJECTIFS :** Mesurer l'impact des facteurs propres aux communautés et aux hôpitaux sur le pronostic post-IAM individuel et le recours aux interventions, et déterminer dans quelle mesure ils peuvent expliquer la variation des pronostics et du recours aux interventions entre les régions et les hôpitaux du Canada.

**MÉTHODES :** On a passé en revue les dossiers de patients hospitalisés pour IAM entre le 1er avril 1997 et le 31 mars 2000. On a retenu les facteurs suivants pour ce qui est des caractéristiques des communautés et des hôpitaux : trois indicateurs du statut socio-économique, deux indicateurs raciaux, le statut de résidence en milieu rural ou urbain, l'affiliation à un hôpital universitaire et l'accès à la coronarographie ou à la revascularisation dans les établissements où les patients étaient admis. Les pronostics incluaient : mortalité durant l'hospitalisation, réhospitalisations à l'intérieur d'un an et taux de revascularisation dans les 30 jours suivant l'IAM. Toutes les analyses ont été ajustées selon l'âge, le sexe et l'interaction âge-sexe. Les rapports entre les facteurs communautaires/hospitaliers et le pronostic individuel ont été étudiés par analyse de régression logistique hiérarchique à effet aléatoire, alors que les liens entre les caractéristiques communautaires et hospitalières et les pronostics ajustés selon le

*suite à la page suivante*

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risque d'une région et d'un hôpital à l'autre ont été analysés par régression des moindres carrés et coefficients de détermination ( $r^2$ ).

**RÉSULTATS :** Après ajustement pour tenir compte des facteurs démographiques, on a observé que le statut socio-économique du voisinage d'un patient était en corrélation inverse avec la probabilité de mortalité ou de réadmission en cardiologie ( $p < 0,001$ ). Les patients qui résidaient dans des secteurs où le niveau de scolarité était moins élevé avaient moins de chance d'avoir accès à la revascularisation post-IAM ( $p < 0,001$ ). Les patients des zones à forte concentration de nouveaux immigrants ou de minorités visibles, de même que les sujets admis dans des hôpitaux universitaires ou affiliés à des universités, dotés de laboratoires d'électrophysiologie, présentaient moins de réadmissions en cardiologie ( $p < 0,001$ ) et une utilisation plus fréquente de la revascularisation post-IAM ( $p < 0,001$ ) après ajustement pour tenir compte de l'âge et du sexe. Malgré leurs liens

avec les pronostics individuels, les facteurs communautaires et hospitaliers n'ont pas été en cause dans plus de 7 % des variations de pronostic ajusté selon le risque entre les hôpitaux ou les régions. En dernier lieu, les ajustements pour tenir compte des facteurs communautaires et hospitaliers et le recours aux interventions, outre les ajustements selon l'âge et le sexe seulement, ont eu un impact marginal sur les pronostics provinciaux ajustés selon le risque.

**CONCLUSION :** Bien que les facteurs propres aux communautés et aux hôpitaux soient d'importants déterminants du pronostic post-IAM individuel, ils ne représentent qu'un degré minime de la variation des pronostics entre les régions. D'autres études devront être entreprises pour vérifier si les variations du pronostic post-IAM au Canada s'expliquent par la variété des profils cliniques des patients et par les différents processus décisionnels des prestataires de soins de santé d'une juridiction à l'autre.

Canada is well recognized for its social, ethnic and geographical diversity. Its socialized 'Medicare' program is heralded internationally for ensuring that all citizens receive universal health care for medically necessary services without user fees, regardless of affluence, race or culture (1). However, available evidence has demonstrated that community and hospital characteristics significantly affect the outcomes and care that patients receive (2,3). For example, neighbourhood income levels are inversely related to cardiovascular mortality and morbidity (2,4). Patients residing in lower socioeconomic neighbourhoods receive fewer specialized services than do those residing in highly affluent communities (5,6). Geographical proximity to tertiary care facilities and its effect on specialty service intensity further underscore the importance of regional capacity distribution and its implications on access to specialized cardiac services in Canada (5,7,8).

Accumulating evidence has recently demonstrated the presence of significant inter-regional and interhospital treatment and outcome variations across Canada (9-11). Indeed, acute myocardial infarction (AMI) mortality and cardiac readmission rates have been shown to vary at least twofold across provinces, with a geographical east-west gradient observed for angina readmissions (9). Given their importance as determinants of individual patient outcomes (4,7), characteristics related to resident communities or admitting hospitals have been hypothesized by some researchers to play a central role in accounting for variations in outcomes in institutions and/or regions across Canada (10). Others, in turn, may argue that such higher level 'area' characteristics (herein termed 'contextual factors') may have little impact in explaining inter-regional outcome variations, especially if the sociocultural diversity of patients who present with cardiovascular disease is insufficiently large between high and low mortality rate communities (12). No study has systematically evaluated whether contextual factors, such as neighbourhood socioeconomic status, ethnicity and specialty cardiac service capacity, explain AMI treatment and outcome disparities across Canada.

Accordingly, the objective of the present study was threefold: first, to examine the impact of contextual neighbourhood and hospital factors on individual cardiovascular outcomes and on the use of cardiac interventions; second, to examine the extent to which inter-regional and interinstitutional outcome variations can be explained by contextual neighbourhood and hospital characteristics, respectively; and third, to explore the impact of adjustments for contextual characteristics on province-specific risk-adjusted outcomes.

We limited our examination to patients with AMI for several reasons. First, the incorporation of an inception cohort

rather than an entire population attenuates the heterogeneity in patient factors across regions, and therefore allows one to better separate the effects of contextual factors from patient-level attributes when examining the relationship for each characteristic on cardiovascular outcomes. Second, inter-regional variations in post-AMI cardiac outcomes and procedure use have been well-documented (9,13-15). While the magnitude of variation in post-AMI cohorts is small when compared with that in the general population, the pattern of variations, particularly for selected outcomes (eg, cardiac readmissions), appears to mirror the trends in cardiovascular death rates for the general population (9,10). Third, the inverse relationship between cardiac service intensity and cardiac readmission rates post-AMI allows us to explore a potential intermediary causal pathway among contextual factors, intervention rates and cardiovascular outcomes (8,16). Consequently, an ancillary objective of the present study was to examine whether variations in procedure rates alone can account for previously described east-west gradients in cardiac readmission rates post-AMI.

## METHODS

### Data sources

A cohort of new AMI patients hospitalized in all Canadian provinces (except Newfoundland and Labrador, Yukon, Northwest Territories and Nunavut) between April 1, 1997, and March 31, 2000, was examined. AMI patients were identified using the most responsible diagnosis of AMI (*International Classification of Diseases, 9th Revision [ICD-9]* code 410 [17]) in the Canadian Institute for Health Information (CIHI) database. The cohort's eligibility has been previously described (9). The following patients were excluded from the study: those younger than 20 years of age or older than 105 years of age; those whose AMI was coded as an in-hospital complication; those with invalid health card numbers; those with total length of stay of less than three days; and those who had had a previous AMI admission within the preceding year. Patients were assigned to the hospital of initial (index) AMI presentation, regardless of downstream in-hospital transfers; the total duration of hospitalization included all days spent at both the presenting and the transferring institutions (where applicable). The rationale for the eligibility criteria is described elsewhere (18). Mortality outcomes were identified using the Discharge Abstract Database from the CIHI for all provinces except Quebec and Manitoba, which incorporated the Hospital Morbidity Database. Except in British Columbia, patients who died in the emergency room were not classified as having in-hospital events and were, therefore, ineligible for study. Given that the intent of the present study was to explore the associations between ecological factors and outcomes rather than to

compare death rates among provinces, mortality data from British Columbia were included in the analyses. Readmission and revascularization procedures were identified using CIHI data.

Neighbourhood socioeconomic and ethnicity characteristics were identified by linking postal code data (using the Forward Sortation Areas [ie, the first three digits of the postal code]) to 2001 Census data (4), while the rural-urban status of the patient's residence was identified using a postal code conversion file (19). Information on admitting hospital characteristics (eg, academic status and on-site procedural capacity) was identified by contacting each institution individually.

### Patient factors

Given the differences in the coding of comorbidity among the provinces (eg, morbidity databases in Quebec and Manitoba do not differentiate between those comorbid factors that exist before AMI and those arising from complications subsequent to admission but still within the index AMI hospitalization), the assessment of patient factors was restricted to the following demographic variables: age, sex and age-sex interaction. While age and sex were the only patient factors used for risk-adjustment purposes, available evidence has demonstrated that a region's risk-adjusted AMI outcome using age-sex standardization alone is strongly correlated with its corresponding outcome when incorporating age, sex and comorbidity into the risk-adjustment model (9).

### Contextual factors

Six neighbourhood and three hospital contextual characteristics were examined. The neighbourhood factors were chosen to reflect socioeconomic and ethnic diversity, and were as follows: median household income, and the proportions of individuals who completed less than grade 9 education, were impoverished (defined as living at the poverty threshold and adjusted for family size and metropolitan density), were members of a visible minority, were new immigrants and resided in rural communities. The hospital factors examined in the present study were academic affiliation, and on-site cardiac catheterization and revascularization capacity. Most of the factors examined had been shown to be important determinants of cardiovascular treatment, outcomes or both (4,7,10).

Not surprisingly, the correlations between education, household income and poverty were high, ranging from  $r=-0.73$  (for median household income versus poverty) to  $r=0.49$  (for education versus poverty), as were the correlations between ethnicity measures (eg,  $r=0.87$  for new immigrants versus visible minorities). However, ecological socioeconomic indicators were only modestly correlated with ethnicity (ie, ranging from  $r=0.16$  for the correlation between visible minority and median household income, and  $r=0.38$  for the correlation between new immigrants and being impoverished).

### Outcomes

Three outcomes were examined: in-hospital mortality, one-year readmission rate (for angina, AMI or congestive heart failure) and revascularization procedures (ie, percutaneous transluminal coronary angioplasty or coronary artery bypass surgery) at 30 days post-AMI. In-hospital mortality was defined as a death that occurred at any time during the index AMI hospitalization. Readmission rates were examined only for those who survived until discharge from the index AMI hospitalization, while mortality and revascularization were assessed in the entire AMI cohort. Data on recurrent MI (ICD-9 code 410), angina (ICD-9 codes 411 and 413) and congestive heart failure (ICD-9 code 428) were obtained from the

CIHI database. Percutaneous transluminal coronary angioplasty was identified using Canadian Classification of Procedures codes 48.02, 48.03 and 48.09, while coronary artery bypass surgery was identified using Canadian Classification of Procedures codes 48.11 to 48.19.

### Statistical analyses

Three distinct multivariate analyses were conducted to examine the impact of contextual factors on AMI outcomes at the patient, regional/hospital and provincial levels.

The first analysis examined the importance of each contextual characteristic on individual patient outcomes. Hierarchical analysis was used to examine the relationship between each factor and patient outcomes for all AMI patients in Canada, after adjusting for age, sex and age-sex interaction. This analysis modelled the hierarchical nature of the data, which consisted of patients nested in communities or hospitals, with characteristics measured at different levels of the hierarchy (20). A traditional regression model tends to underestimate standard errors for characteristics measured at higher levels of the hierarchy, thereby producing CIs that are artificially narrow. Given the concerns regarding cross-classification (patients from two or more neighbourhoods hospitalized within the same institution, or patients from one neighbourhood hospitalized at two different institutions), analyses examining neighbourhood factors were kept distinct from those examining hospital factors. To examine whether the relationships between contextual factors and outcomes were consistent across jurisdictions, hierarchical analyses were repeated for each of five provincial regions: the Maritimes (ie, New Brunswick, Prince Edward Island and Nova Scotia), Quebec, Ontario, the Prairies (ie, Manitoba, Saskatchewan and Alberta) and British Columbia.

The second analysis examined the extent to which regional or hospital risk-adjusted outcomes (ie, risk-adjusted for age, sex and age-sex interaction) could be explained by their corresponding neighbourhood and hospital contextual characteristics, respectively. Risk-adjusted outcomes were derived using indirect standardization, and were adjusted for age, sex and age-sex interaction. Using least squares regression, the risk-adjusted outcomes were then regressed against each contextual factor across Forward Sortation Areas and hospitals to determine the coefficient of determination ( $r^2$ ). Once again, neighbourhood risk-adjusted outcomes were analyzed separately from hospital risk-adjusted outcomes to eliminate concerns regarding cross-classification.

The third analysis examined the extent to which a province's outcomes and outlier rankings were altered by sequential risk adjustment for age, sex, neighbourhood and hospital characteristics. Outlier status was determined by comparing a province's risk-adjusted outcomes with the overall Canadian rate. A 'low' outlier was defined if a province's upper 95th percentile fell below the provincial average, while a 'high' outlier was defined if a province's lower 95th percentile fell above the provincial average. Given that only nine provinces comprised the unit of analysis, risk-adjustment techniques incorporated indirect standardization and the use of nonhierarchical fixed-effects multiple logistic modelling rather than random-effects hierarchical models. Finally, to examine the extent to which procedures themselves affected outcomes, risk-adjusted provincial cardiac readmission rates were compared before and after adjustments for revascularization use post-AMI.

For each of the above analyses, stepwise regression techniques for variable selection were incorporated when examining the importance of two or more contextual factors within the same model. Statistical significance was defined as  $P<0.05$ . SAS Version 8.2

**TABLE 1**  
**Baseline characteristics of patients hospitalized with acute myocardial infarction in Canada between April 1, 1997, and March 31, 2000**

|   | BC                              | Alberta                         | Saskatchewan                    | Manitoba                        | Ontario                         | Quebec                          | Nova Scotia                     | PEI                             | New Brunswick                   | Total                           |
|---|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Sample size   | 15,059                          | 10,146                          | 4343                            | 5137                            | 57,965                          | 36,374                          | 5177                            | 835                             | 3781                            | 139,484                         |
| Demographics  |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| Median age, years (IQR)   | 70<br>(59–79)                   | 67<br>(56–77)                   | 72<br>(61–79)                   | 71<br>(59–79)                   | 69<br>(58–78)                   | 67<br>(56–77)                   | 68<br>(56–78)                   | 70<br>(59–78)                   | 69<br>(56–78)                   | 69<br>(57–78)                   |
| Female (%)  | 33.7                            | 31.7                            | 35.2                            | 36.3                            | 36.4                            | 34.5                            | 37.7                            | 36.1                            | 36.7                            | 35.3                            |
| Neighbourhood characteristics                                   |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| Median household income (IQR)                                   | \$41,174<br>(\$36,067–\$47,591) | \$40,097<br>(\$35,289–\$47,265) | \$33,778<br>(\$29,831–\$37,676) | \$36,341<br>(\$30,215–\$40,695) | \$42,681<br>(\$36,831–\$50,841) | \$33,481<br>(\$28,989–\$40,203) | \$33,216<br>(\$29,539–\$36,273) | \$36,108<br>(\$33,865–\$36,153) | \$33,297<br>(\$30,356–\$37,585) | \$38,629<br>(\$33,120–\$46,248) |
| Median % impoverished (IQR)                                     | 16.9<br>(14.0–22.6)             | 15.5<br>(13.8–22.9)             | 18.7<br>(14.1–19.9)             | 18.0<br>(13.6–24.8)             | 15.7<br>(11.6–22.3)             | 20.7<br>(16.2–28.8)             | 18.2<br>(15.9–22.3)             | 12.7<br>(12.5–22.2)             | 18.9<br>(15.9–22.9)             | 17.6<br>(13.6–23.9)             |
| Median % with less than grade 9 education (IQR)                 | 7.0<br>(5.1–9.4)                | 7.6<br>(4.6–11.4)               | 13.1<br>(10.3–18.4)             | 12.3<br>(7.0–19.1)              | 9.8<br>(7.5–12.8)               | 19.5<br>(14.0–23.6)             | 12.9<br>(8.2–14.7)              | 13.8<br>(8.4–13.8)              | 13.8<br>(10.6–23.2)             | 11.0<br>(7.6–16.8)              |
| Median % new immigrants (IQR)                                   | 2.0<br>(1.0–7.5)                | 1.5<br>(0.6–3.4)                | 0.3<br>(0.2–1.1)                | 1.1<br>(0.5–2.2)                | 1.8<br>(0.6–6.8)                | 0.4<br>(0.2–2.1)                | 0.3<br>(0.2–0.6)                | 0.3<br>(0.0–0.6)                | 0.2<br>(0.1–0.4)                | 1.0<br>(0.4–3.8)                |
| Median % of visible minorities (IQR)                            | 6.3<br>(3.6–20.8)               | 5.3<br>(1.7–12.3)               | 1.2<br>(0.7–4.6)                | 3.9<br>(0.8–7.5)                | 5.1<br>(1.6–20.1)               | 0.9<br>(0.5–7.4)                | 1.5<br>(1.1–3.6)                | 0.5<br>(0.5–2.7)                | 0.6<br>(0.3–1.8)                | 3.5<br>(0.9–11.5)               |
| Proportion residing in rural regions (%)                        | 18.3                            | 29.7                            | 45.9                            | 35.2                            | 17.9                            | 24.4                            | 50.0                            | 47.3                            | 49.7                            | 24.1                            |
| Admitting hospital characteristics                              |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| Proportion admitted to on-site catheterization facilities (%)   | 19.5                            | 33.8                            | 21.9                            | 18.4                            | 19.3                            | 27.2                            | 15.6                            | 0                               | 16.5                            | 22.1                            |
| Proportion admitted to on-site revascularization facilities (%) | 11.5                            | 24.4                            | 21.9                            | 18.4                            | 11.4                            | 20.2                            | 15.6                            | 0                               | 16.5                            | 15.6                            |
| Proportion admitted to an academically affiliated hospital (%)  | 7.9                             | 56.7                            | 44.8                            | 18.4                            | 19.5                            | 14.5                            | 33.8                            | 89.7                            | 43.5                            | 22.1                            |

BC British Columbia; IQR Interquartile range; PEI Prince Edward Island

(SAS Institute Inc, USA) and hierarchical linear model statistical software (Scientific Software International Inc, USA) was used.

## RESULTS

### Baseline characteristics

Table 1 illustrates the distribution of baseline patient demographics, and neighbourhood and admitting hospital characteristics stratified by province. The median age of patients admitted with AMI was lowest in Alberta and Quebec (67 years) and highest in Saskatchewan (72 years). Patients with AMI in Ontario resided in the most affluent and best-educated communities, while the converse was true for patients in Quebec. Patients in British Columbia and Ontario resided in the most ethnically diverse regions (as defined by the proportion of new immigrants and visible minorities), while patients in the Maritimes resided in areas with the lowest proportion of new immigrants and visible minorities. Nova Scotia and New Brunswick had the highest proportions of rural patients, while Ontario and British Columbia had the lowest. Finally, the proportions of patients hospitalized in institutions with on-site procedural facilities were highest in Alberta and Quebec, and lowest in the Maritimes.

### Determinants of individual outcomes

After adjusting for baseline demographics, both median income and level of education were inversely correlated with in-hospital mortality and with recurrent cardiac admissions at one year, while education was positively correlated with 30-day revascularization use following AMI (Table 2). With a few notable exceptions (eg, British Columbia), the relationships between median household income or education and outcomes were consistent (in direction) across provincial jurisdictions. However, the relationships between poverty and outcomes were not always consistent with the other socioeconomic indicators. For example, recurrent cardiac readmission rates were similar between impoverished and nonpoverty-stricken communities. Moreover, patients residing in impoverished communities were more likely to undergo revascularization following AMI than were those from average or affluent communities. Finally, the directionality of the relationships between poverty and outcomes varied among the provinces (Table 2).

Ethnicity (new immigrants and visible minorities) was not significantly associated with in-hospital mortality, but it was associated with fewer readmissions and a greater use of revascularization procedures after adjustment for patient factors

**TABLE 2**  
**Relationship between contextual factors and outcomes among patients hospitalized with acute myocardial infarction in Canada between April 1, 1997, and March 31, 2000, after adjustment for patient-level characteristics**

| Contextual factor  |                | Outcomes                |                  |                         |                  |                          |                  |
|--|----------------|-------------------------|------------------|-------------------------|------------------|--------------------------|------------------|
|  |                | In-hospital mortality   | P                | One-year readmissions   | P                | 30-day revascularization | P                |
| Neighbourhood characteristics                                  |                |                         |                  |                         |                  |                          |                  |
| Each \$10,000 increase in median household income              | <b>Overall</b> | <b>0.95 (0.94–0.97)</b> | <b>&lt;0.001</b> | <b>0.95 (0.94–0.97)</b> | <b>&lt;0.001</b> | <b>1.01 (0.98–1.04)</b>  | <b>0.57</b>      |
|  | Maritimes      | 0.97 (0.87–1.09)        | 0.62             | 0.79 (0.72–0.87)        | <0.001           | 1.20 (1.01–1.42)         | 0.04             |
|  | Quebec         | 0.94 (0.90–0.99)        | 0.02             | 0.93 (0.91–0.96)        | <0.001           | 1.03 (0.99–1.08)         | 0.18             |
|  | Ontario        | 0.96 (0.94–0.99)        | 0.005            | 0.94 (0.93–0.96)        | <0.001           | 1.09 (1.05–1.13)         | <0.001           |
|  | Prairies       | 0.95 (0.90–0.99)        | 0.03             | 0.89 (0.84–0.94)        | <0.001           | 1.11 (1.02–1.19)         | 0.01             |
| Each 10% increase in poverty                                   | <b>Overall</b> | <b>1.07 (1.05–1.10)</b> | <b>&lt;0.001</b> | <b>0.99 (0.97–1.01)</b> | <b>0.3</b>       | <b>1.10 (1.07–1.14)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 0.99 (0.86–1.13)        | 0.83             | 1.18 (1.04–1.33)        | 0.009            | 0.98 (0.79–1.21)         | 0.83             |
|  | Quebec         | 1.07 (1.03–1.11)        | 0.001            | 0.98 (0.95–1.00)        | 0.09             | 1.07 (1.03–1.11)         | 0.001            |
|  | Ontario        | 1.05 (1.02–1.08)        | 0.004            | 1.03 (1.00–1.06)        | 0.03             | 1.04 (0.99–1.10)         | 0.08             |
|  | Prairies       | 1.06 (1.01–1.11)        | 0.02             | 0.94 (0.89–1.00)        | 0.05             | 1.02 (0.94–1.10)         | 0.68             |
| Each 10% increase in patients with less than grade 9 education | <b>Overall</b> | <b>1.06 (1.03–1.10)</b> | <b>&lt;0.001</b> | <b>1.14 (1.11–1.17)</b> | <b>&lt;0.001</b> | <b>0.87 (0.82–0.92)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 0.98 (0.81–1.19)        | 0.86             | 1.19 (1.07–1.33)        | 0.002            | 0.57 (0.45–0.72)         | <0.001           |
|  | Quebec         | 1.06 (0.99–1.13)        | 0.10             | 1.19 (1.13–1.25)        | <0.001           | 0.84 (0.78–0.90)         | <0.001           |
|  | Ontario        | 1.03 (0.97–1.09)        | 0.35             | 1.12 (1.06–1.17)        | <0.001           | 0.72 (0.66–0.79)         | <0.001           |
|  | Prairies       | 1.11 (1.03–1.20)        | 0.004            | 1.32 (1.19–1.47)        | <0.001           | 0.64 (0.55–0.73)         | <0.001           |
| Each 10% increase in new immigrants                            | <b>Overall</b> | <b>1.02 (0.98–1.06)</b> | <b>0.38</b>      | <b>0.94 (0.90–0.97)</b> | <b>0.002</b>     | <b>1.19 (1.17–1.27)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 1.05 (0.49–2.28)        | 0.90             | 0.23 (0.07–0.71)        | 0.01             | 3.79 (1.30–11.12)        | 0.018            |
|  | Quebec         | 0.97 (0.86–1.10)        | 0.67             | 0.81 (0.73–0.91)        | <0.001           | 1.50 (1.33–1.70)         | <0.001           |
|  | Ontario        | 0.97 (0.92–1.02)        | 0.26             | 0.97 (0.93–1.01)        | 0.17             | 1.21 (1.14–1.29)         | <0.001           |
|  | Prairies       | 1.08 (0.84–1.37)        | 0.56             | 0.36 (0.25–0.51)        | <0.001           | 2.73 (1.86–4.02)         | <0.001           |
| Each 10% increase in visible minorities                        | <b>Overall</b> | <b>1.01 (0.99–1.02)</b> | <b>0.29</b>      | <b>0.97 (0.96–0.98)</b> | <b>&lt;0.001</b> | <b>1.06 (1.04–1.09)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 0.93 (0.72–1.20)        | 0.57             | 0.57 (0.47–0.69)        | <0.001           | 1.67 (1.08–2.58)         | 0.025            |
|  | Quebec         | 0.99 (0.95–1.04)        | 0.73             | 0.90 (0.86–0.94)        | <0.001           | 1.15 (1.10–1.20)         | <0.001           |
|  | Ontario        | 0.99 (0.97–1.00)        | 0.14             | 0.98 (0.97–1.00)        | 0.04             | 1.07 (1.05–1.09)         | <0.001           |
|  | Prairies       | 1.03 (0.98–1.09)        | 0.22             | 0.74 (0.69–0.79)        | <0.001           | 1.26 (1.13–1.40)         | <0.001           |
| Rural (versus urban) residence                                 | <b>Overall</b> | <b>0.95 (0.91–1.00)</b> | <b>0.03</b>      | <b>1.18 (1.13–1.23)</b> | <b>&lt;0.001</b> | <b>0.72 (0.65–0.78)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 1.06 (0.88–1.28)        | 0.53             | 1.08 (0.93–1.24)        | 0.31             | 0.66 (0.52–0.83)         | 0.001            |
|  | Quebec         | 0.87 (0.79–0.95)        | 0.003            | 1.30 (1.19–1.43)        | <0.001           | 0.68 (0.60–0.78)         | <0.001           |
|  | Ontario        | 0.90 (0.83–0.99)        | 0.23             | 1.13 (1.06–1.20)        | <0.001           | 0.75 (0.67–0.85)         | <0.001           |
|  | Prairies       | 1.05 (0.96–1.15)        | 0.31             | 1.50 (1.34–1.68)        | <0.001           | 0.72 (0.59–0.88)         | 0.002            |
| Admitting hospital characteristics                             | <b>Overall</b> | <b>0.95 (0.94–0.97)</b> | <b>0.27</b>      | <b>1.02 (0.92–1.14)</b> | <b>0.67</b>      | <b>0.56 (0.43–0.73)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 1.06 (0.88–1.28)        | 0.53             | 1.08 (0.93–1.24)        | 0.31             | 0.66 (0.52–0.83)         | 0.001            |
|  | Quebec         | 0.87 (0.79–0.95)        | 0.003            | 1.30 (1.19–1.43)        | <0.001           | 0.68 (0.60–0.78)         | <0.001           |
|  | Ontario        | 0.90 (0.83–0.99)        | 0.23             | 1.13 (1.06–1.20)        | <0.001           | 0.75 (0.67–0.85)         | <0.001           |
|  | Prairies       | 1.05 (0.96–1.15)        | 0.31             | 1.50 (1.34–1.68)        | <0.001           | 0.72 (0.59–0.88)         | 0.002            |
| On-site catheterization facilities                             | <b>Overall</b> | <b>1.06 (0.98–1.16)</b> | <b>0.16</b>      | <b>0.86 (0.79–0.93)</b> | <b>&lt;0.001</b> | <b>2.53 (1.66–2.25)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 1.01 (0.92–1.11)        | 0.82             | 0.69 (0.50–0.96)        | 0.03             | 3.77 (2.72–5.21)         | <0.001           |
|  | Quebec         | 1.09 (0.92–1.29)        | 0.34             | 0.79 (0.72–0.87)        | <0.001           | 2.55 (1.93–3.38)         | <0.001           |
|  | Ontario        | 1.06 (0.96–1.16)        | 0.26             | 0.91 (0.93–1.01)        | 0.07             | 2.40 (1.82–3.18)         | <0.001           |
|  | Prairies       | 1.18 (1.05–1.32)        | 0.006            | 0.71 (0.59–0.87)        | 0.001            | 3.06 (1.90–4.93)         | <0.001           |
| On-site revascularization facilities                           | <b>Overall</b> | <b>1.09 (0.98–1.21)</b> | <b>0.12</b>      | <b>0.84 (0.77–0.92)</b> | <b>&lt;0.001</b> | <b>3.12 (2.50–3.90)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 1.01 (0.92–1.11)        | 0.82             | 0.69 (0.50–0.96)        | 0.03             | 3.77 (2.72–5.21)         | <0.001           |
|  | Quebec         | 1.09 (0.99–1.35)        | 0.41             | 0.80 (0.72–0.88)        | <0.001           | 3.17 (2.52–3.99)         | <0.001           |
|  | Ontario        | 1.08 (0.96–1.22)        | 0.18             | 0.89 (0.80–0.99)        | 0.03             | 2.96 (2.19–4.01)         | <0.001           |
|  | Prairies       | 1.16 (1.01–1.33)        | 0.04             | 0.75 (0.61–0.92)        | 0.006            | 2.96 (1.70–5.17)         | <0.001           |
| Academic affiliations  | <b>Overall</b> | <b>1.03 (0.94–1.12)</b> | <b>0.57</b>      | <b>0.83 (0.77–0.90)</b> | <b>&lt;0.001</b> | <b>2.19 (1.76–2.75)</b>  | <b>&lt;0.001</b> |
|  | Maritimes      | 0.89 (0.77–1.03)        | 0.12             | 0.90 (0.72–1.11)        | 0.33             | 1.83 (1.00–3.35)         | 0.054            |
|  | Quebec         | 1.16 (0.92–1.46)        | 0.20             | 0.83 (0.75–0.92)        | 0.001            | 2.72 (2.01–3.69)         | <0.001           |
|  | Ontario        | 1.07 (0.96–1.18)        | 0.23             | 0.85 (0.78–0.92)        | <0.001           | 2.50 (1.88–3.34)         | <0.001           |
|  | Prairies       | 1.05 (0.94–1.17)        | 0.41             | 0.73 (0.60–0.89)        | 0.002            | 2.01 (1.24–3.27)         | 0.005            |
|  | BC             | 1.24 (0.89–1.71)        | 0.20             | 0.83 (0.64–1.07)        | 0.15             | 1.54 (0.88–2.70)         | 0.13             |

BC British Columbia

**TABLE 3**  
Percentage of variation in neighbourhood and hospital risk-adjusted outcomes explained by contextual characteristics

| Contextual factor                    | Risk-adjusted outcomes |        |                       |        |                          |        |
|--------------------------------------|------------------------|--------|-----------------------|--------|--------------------------|--------|
|                                      | In-hospital mortality  | P      | One-year readmissions | P      | 30-day revascularization | P      |
| Neighbourhood characteristics        |                        |        |                       |        |                          |        |
| Median household income              | 2.6                    | <0.001 | 2.5                   | <0.001 | 0.01                     | 0.96   |
| Poverty                              | 5.3                    | <0.001 | 0.3                   | 0.05   | 2.4                      | <0.001 |
| Less than grade 9 education          | 2.4                    | <0.001 | 6.6                   | <0.001 | 1.4                      | <0.001 |
| New immigrants                       | 0.8                    | <0.001 | 2.5                   | <0.001 | 4.2                      | <0.001 |
| Visible minority                     | 0.3                    | 0.05   | 4.0                   | <0.001 | 4.3                      | <0.001 |
| Rural (versus urban) regions         | 0.08                   | 0.26   | 2.9                   | <0.001 | 1.9                      | <0.001 |
| Admitting hospital characteristics   |                        |        |                       |        |                          |        |
| On-site catheterization facilities   | 0.1                    | 0.49   | 0.20                  | 0.35   | 1.2                      | 0.02   |
| On-site revascularization facilities | 0.06                   | 0.60   | 0.04                  | 0.67   | 0.6                      | 0.09   |
| Academic affiliation                 | 0.1                    | 0.41   | 0.5                   | 0.13   | 1.0                      | 0.03   |

Numbers reflect the proportion of variation in age- and sex-adjusted outcomes explained by each determinant ( $r^2$ ), expressed as a percentage

**TABLE 4**  
Impact of sequential risk adjustment for age, sex, neighbourhood socioeconomic, ethnicity, rurality and hospital factors on province-specific in-hospital mortality rates for patients presenting with acute myocardial infarction between April 1, 1997, and March 31, 2000

| Province         | Crude mortality | Age- and sex-adjusted mortality |           |         | Neighbourhood-adjusted mortality |           |         | Neighbourhood- and hospital-adjusted mortality |           |         |
|------------------|-----------------|---------------------------------|-----------|---------|----------------------------------|-----------|---------|--|-----------|---------|
|                  |                 | mortality                       | 95% CI    | Outlier | mortality                        | 95% CI    | Outlier | mortality                                      | 95% CI    | Outlier |
| New Brunswick    | 11.8            | 11.8                            | 10.9–12.7 |         | 13.7                             | 12.7–14.7 | High    | 13.6   | 12.6–14.7 | High    |
| PEI              | 10.8            | 10.8                            | 8.6–13.0  |         | 11.1                             | 8.9–13.3  |         | 11.6   | 9.4–13.8  |         |
| Nova Scotia      | 11.7            | 11.9                            | 11.1–12.8 |         | 11.9                             | 11.0–12.8 |         | 11.8   | 10.9–12.7 |         |
| Quebec           | 12.5            | 13.3                            | 12.9–13.6 | High    | 12.8                             | 12.4–13.1 |         | 12.9   | 12.6–13.2 | High    |
| Ontario          | 12.6            | 12.3                            | 12.0–12.6 |         | 12.6                             | 12.3–12.8 |         | 12.6   | 12.4–12.9 |         |
| Manitoba         | 12.7            | 11.8                            | 11.0–12.6 |         | 11.6                             | 10.8–12.4 | Low     | 11.6   | 10.7–12.4 | Low     |
| Saskatchewan     | 13.2            | 11.8                            | 10.9–12.7 |         | 11.8                             | 11.0–12.7 |         | 11.7   | 10.9–12.6 |         |
| Alberta          | 10.4            | 11.1                            | 10.5–11.8 | Low     | 11.2                             | 10.6–11.9 | Low     | 11.2   | 10.6–11.9 | Low     |
| British Columbia | 14.6            | 13.8                            | 13.3–14.3 | High    | 14.1                             | 13.6–14.6 | High    | 14.2   | 13.7–14.7 | High    |

PEI Prince Edward Island

(Table 2). Patients residing in urban regions, and/or those hospitalized in academically affiliated institutions or institutions with on-site catheterization/revascularization facilities were less likely to have a subsequent cardiac readmission in the forthcoming year and more likely to undergo revascularization procedures within the first 30 days of the index infarct than were patients residing in rural regions or hospitalized in nontertiary/nonacademically affiliated institutions (Table 2).

#### Explaining neighbourhood- and hospital-specific outcome variations

Table 3 illustrates that no single contextual factor accounted for more than 5.3% of the variation in risk-adjusted mortality (ie, poverty) or 6.6% of the variation in risk-adjusted cardiac readmissions (ie, level of education) across communities. While on-site revascularization facilities were associated with significantly higher risk-adjusted hospital-specific revascularization rates post-MI (ie, the median values [interquartile range] of risk-adjusted revascularization rates among hospitals with and without on-site revascularization facilities were 30.8 [20.2 to 40.2] and 12.1 [6.4 to 18.7], respectively), significant variations in revascularization rates persisted within each hospital subgroup. All remaining neighbourhood and hospital contextual factors accounted for negligible variations in

risk-adjusted hospital outcomes. When examining the impact of multiple factors combined, the results did not change significantly. No greater than 7% of the variation for any risk-adjusted outcome could be explained by multiple socioeconomic, ethnic and geographical variables combined within the same statistical model when using stepwise regression techniques.

#### Risk adjustment and province-specific outcomes

Tables 4 to 6 examine the impact of sequential risk adjustment on provincial mortality, cardiac readmissions and revascularization use post-AMI. With one exception (New Brunswick), sequential adjustment for neighbourhood and hospital contextual characteristics resulted in negligible absolute changes to a province's risk-adjusted mortality rate when compared with adjustments for age and sex alone. Notwithstanding the negligible absolute risk-adjusted mortality differences, sequential risk adjustment did alter the outlier statuses of three provinces: New Brunswick (from 'average' to 'high'), Manitoba (from 'average' to 'low') and Quebec (from 'high' to 'average' to 'high') (Table 4). Similar results emerged when examining cardiac readmission and revascularization outcomes (Tables 5 and 6). Again, with the exception of results from New Brunswick, sequential risk adjustment for contextual neighbourhood and

**TABLE 5**  
**Impact of sequential risk adjustment for age, sex, neighbourhood socioeconomic, ethnicity, rurality and hospital factors on province-specific one-year readmission rates for patients presenting with acute myocardial infarction between April 1, 1997, and March 31, 2000**

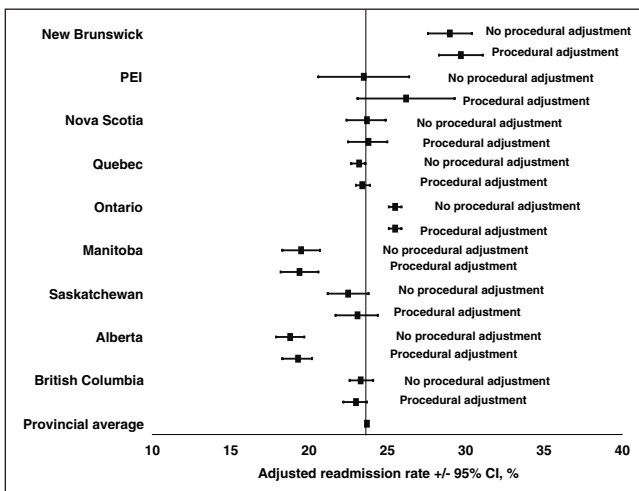
| Province         | Crude mortality | Age- and sex-adjusted readmission rate |           |         | Neighbourhood-adjusted readmission rate |           |         | Neighbourhood- and hospital-adjusted readmission rate |           |         |
|------------------|-----------------|--|-----------|---------|---|-----------|---------|---|-----------|---------|
|                  |                 | readmission rate                       | 95% CI    | Outlier | readmission rate                        | 95% CI    | Outlier | readmission rate                                      | 95% CI    | Outlier |
| New Brunswick    | 25.6            | 25.6                                   | 24.3–27.0 | High    | 29.0                                    | 27.6–30.4 | High    | 29.0  | 27.6–30.4 | High    |
| PEI              | 25.1            | 24.9                                   | 21.9–27.9 |         | 23.7                                    | 20.8–26.6 |         | 23.5  | 20.6–26.4 |         |
| Nova Scotia      | 23.7            | 23.8                                   | 22.6–25.0 |         | 23.8                                    | 22.5–25.0 |         | 23.7  | 22.4–24.9 |         |
| Quebec           | 23.5            | 24.0                                   | 23.6–24.5 |         | 23.1                                    | 22.6–23.6 | Low     | 23.2  | 22.7–23.6 | Low     |
| Ontario          | 25.4            | 25.2                                   | 24.8–25.6 | High    | 25.6                                    | 25.3–26.0 | High    | 25.5  | 25.1–25.9 | High    |
| Manitoba         | 20.0            | 19.6                                   | 18.4–20.8 | Low     | 19.5                                    | 18.3–20.8 | Low     | 19.5  | 18.3–20.7 | Low     |
| Saskatchewan     | 24.0            | 23.2                                   | 21.8–24.5 |         | 22.4                                    | 21.1–23.7 |         | 22.5  | 21.2–23.8 |         |
| Alberta          | 17.1            | 17.5                                   | 16.6–18.4 | Low     | 18.6                                    | 17.7–19.6 | Low     | 18.8  | 17.9–19.7 | Low     |
| British Columbia | 22.5            | 22.1                                   | 21.4–22.8 | Low     | 23.2                                    | 22.5–24.0 |         | 23.3  | 22.6–24.1 |         |

PEI Prince Edward Island

**TABLE 6**  
**Impact of sequential risk adjustment for age, sex, neighbourhood socioeconomic, ethnicity, rurality and hospital factors on province-specific 30-day revascularization rates for patients presenting with acute myocardial infarction between April 1, 1997, and March 31, 2000**

| Province         | Crude mortality | Age- and sex-adjusted mortality |           |         | Neighbourhood-adjusted mortality |           |         | Neighbourhood- and hospital-adjusted mortality |           |         |
|------------------|-----------------|---------------------------------|-----------|---------|----------------------------------|-----------|---------|--|-----------|---------|
|                  |                 | mortality                       | 95% CI    | Outlier | mortality                        | 95% CI    | Outlier | mortality                                      | 95% CI    | Outlier |
| New Brunswick    | 19.2            | 18.9                            | 17.8–20.0 |         | 23.7                             | 22.4–24.9 | High    | 21.8   | 20.6–22.9 | High    |
| PEI              | 4.3             | 4.4                             | 1.8–7.0   | Low     | 4.9                              | 2.1–7.6   | Low     | 5.1  | 2.3–7.9   | Low     |
| Nova Scotia      | 13.4            | 13.2                            | 12.1–14.2 | Low     | 13.3                             | 12.3–14.3 | Low     | 13.2   | 12.2–14.2 | Low     |
| Quebec           | 22.7            | 21.9                            | 21.5–22.2 | High    | 22.4                             | 22.0–22.7 | High    | 22.1   | 21.7–22.5 | High    |
| Ontario          | 12.7            | 12.9                            | 12.6–13.2 | Low     | 13.0                             | 12.7–13.3 | Low     | 13.6   | 13.2–13.9 | Low     |
| Manitoba         | 15.9            | 16.6                            | 15.6–17.7 | Low     | 16.3                             | 15.3–17.4 | Low     | 16.2   | 15.2–17.2 | Low     |
| Saskatchewan     | 20.4            | 22.0                            | 20.9–23.2 | High    | 23.1                             | 21.9–24.3 | High    | 20.8   | 19.7–21.9 | High    |
| Alberta          | 29.7            | 28.3                            | 27.6–29.0 | High    | 26.7                             | 26.0–27.4 | High    | 24.2   | 23.6–24.8 | High    |
| British Columbia | 24.0            | 25.0                            | 24.4–25.6 | High    | 24.0                             | 23.4–24.7 | High    | 26.3   | 25.7–26.9 | High    |

PEI Prince Edward Island



**Figure 1** The impact of revascularization procedures on province-adjusted recurrent cardiac admission rates at one-year following acute myocardial infarction (AMI). Adjusted readmission rates were evaluated at one year following AMI. All readmission rates were adjusted for age, sex and age-sex interaction. The impact of revascularization procedures on readmission rates was inferred by observing the extent to which the point estimates (±95% CIs) shifted with the additional adjustment for revascularization use at 30 days post-MI. PEI Prince Edward Island

hospital factors yielded a negligible effect on a province's risk-adjusted outcome rates.

Statistical adjustments for early revascularization procedure use had little effect on a province's risk-adjusted readmission rates post-AMI (Figure 1).

**DISCUSSION**

Our study demonstrated that while neighbourhood and hospital factors are associated with patient outcomes following AMI on an individual level, the extent to which such factors account for inter-regional or interhospital outcome variations across Canada is marginal or negligible.

Several studies have demonstrated the importance of contextual factors, such as neighbourhood income and the academic affiliation of a hospital, as determinants of individual-level AMI outcomes in Canada, as elsewhere. Indeed, our results reaffirm the inverse relationship between neighbourhood socioeconomic status and fatal/nonfatal outcomes after AMI (4,7). We also demonstrated that a community's ethnic diversity exerted protective effects on nonfatal outcomes post-AMI – a finding likely attributable to a 'healthy immigrant effect'. Patients living in less educated communities received fewer revascularization procedures, while those residing in neighbourhoods with high concentrations of visible minorities were just as likely to receive revascularization as were those residing in highly

Caucasian neighbourhoods. In contrast to findings in the United States (21,22), racial disparities in AMI treatment do not appear to exist in Canada.

The results of individual-level analyses generated several other interesting findings. For example, on-site procedural capacity was a consistent determinant of revascularization use across all regions of Canada – a reaffirmation that supply factors affect physician decision-making processes and specialty service referral patterns (5,7,8,13,15). Neighbourhood income level, while inversely correlated with mortality and readmissions, varied in its association with revascularization use across provinces. Furthermore, the relationship between poverty and revascularization use was discordant with the relationship between socioeconomic status and revascularization use when using neighbourhood income or education as indicators of socioeconomic status. For example, patients residing in less well-educated communities were less likely to receive revascularization, while the converse was true for patients residing in impoverished communities. Such inconsistencies suggest that the relationship between socioeconomic status and treatment may vary according to the socioeconomic indicator used.

While ecological factors are important determinants of individual-level outcomes, our results suggest that the effects of such factors on regional outcomes are significantly attenuated. In our study, no such factor accounted for more than 7% of the variation in regional or hospital-specific outcomes, after adjusting for age, sex and age-sex interaction. Similarly, sequential risk adjustment for additional factors exerted modest or negligible effects on a province's risk-adjusted outcomes or their outlier status. In this regard, our results are similar to those of other studies. For example, an Ontario study (12) of 50,000 AMI patients admitted to hospitals between 1994 and 1997 demonstrated that adjustments for socioeconomic status exerted little effect on a hospital's risk-adjusted mortality rates and rankings.

The apparent inconsistency between a contextual factor's impact on the patient and its corresponding impact on regional outcome variations may be explained by the fact that a variable must satisfy three requirements to be important for risk-adjustment purposes: first, it must be strongly associated with the outcome of interest; second, the variable cannot be highly correlated with other factors already represented in the model; and, third, the variable must be prevalent and vary sufficiently across jurisdictions. To summarize, contextual community and hospital characteristics exert modest effects at the individual-patient level but do not appear to vary substantially enough across communities to exert sufficient impact on regional outcome variations.

What, then, accounts for interjurisdictional variations in outcomes post-AMI? Several hypotheses exist. First, available evidence has demonstrated that variations in risk factor profiles may account for regional variations in cardiovascular outcomes across Canada. For example, cardiovascular researchers recently demonstrated that 42% of the regional variation in cardiovascular disease mortality in Canada is explained by variations in the prevalence of traditional cardiac risk factors – most notably, smoking and obesity (10). Indeed, the incremental effects of social and other community determinants of health on their ability to account for cardiovascular disease mortality variations, beyond traditional cardiac risk factors, were marginal and consistent in relative magnitudes with the corresponding variations explained by similar factors in our

study (10). Traditional cardiac risk factors, such as diabetes, have been shown to be important determinants of cardiovascular prognosis following AMI (23). Second, inter-regional outcome variations may be explained by differences in the prevalence of comorbidities or post-AMI complications, such as renal failure and congestive heart failure – two factors that have been demonstrated as important independent determinants of mortality and readmissions following AMI (7,23). Third, interjurisdictional outcome variations may be explained by differences in processes of care, such as delays in presentation, door-to-needle times or use of in-hospital pharmacotherapies (24), notwithstanding the fact that neither variations in specialty service supply (ie, as defined by the proportion of patients admitted to hospitals with on-site catheterization or revascularization capacity) nor variations in revascularization rates themselves accounted for the majority of outcome variations in readmission rates post-AMI in our study. Nonetheless, one might postulate that evidence-based therapies, such as beta-blockers and/or statins, may exert greater influence on inter-regional AMI outcome variations given that such therapies likely impact population survival more than interventions alone (11). To summarize, the regional AMI outcome disparities are likely attributable to a combination of patient and process factors, which include differences in risk factor profiles, health status, health care-seeking behaviours, compliance, health care delivery and random variation.

The present study has important health policy implications. Given the complexity associated with regional outcome variations, policy-makers must incorporate multiple factors into health care system funding and allocation processes. An over-reliance on macro-level community sociodemographic, ethnoracial, geographical and/or institutional characteristics, without adequate consideration given to more detailed patient-level and clinical provider-level factors, may jeopardize the validity of health system evaluation and planning exercises. It follows that improvements in data detail and quality (in regards to clinical detail and patient/provider perspectives) is imperative if policy-makers are to understand which initiatives are best required to target higher risk regions. For example, if post-AMI outcome variations were to be attributable to differences in the prevalence of traditional risk factors, then health promotion strategies that target risk factor prevention and modification may serve as the main policy initiative in both reducing the incidence of cardiovascular disease (10) and improving prognosis subsequent to the onset of cardiovascular disease.

#### Interpretative cautions

There are several noteworthy limitations to the present study. First, our analyses adjusted for only two patient factors (age and sex). Additional adjustment for differences in comorbidity may have altered our results. Nonetheless, available evidence has demonstrated a strong correlation between regional risk-adjustment techniques, which incorporate multiple comorbid factors, with those that include age and sex alone. Second, we limited our evaluation to a cohort of patients with AMI. One may reasonably hypothesize that the importance of contextual factors may differ following the establishment of cardiovascular disease, given that such factors exert differential effects on cardiovascular prognosis than they do on cardiovascular incidence. Notwithstanding, one recent study (10) demonstrated that most variations in cardiovascular mortality across health

regions were explained by variations in the prevalence of traditional risk factors (particularly smoking and obesity); only a modest variation (ie, less than 5%) was explained by a region's socioeconomic profile. Such results reaffirm the lack of importance of neighbourhood socioeconomic/ethnicity characteristics on inter-regional outcome differences (12). Third, AMI cohorts in British Columbia included patients who died in the emergency room before admission and, therefore, deviated in eligibility from the cohorts in other provinces. These differences in cohort design may partially explain some of the inconsistencies in the associations between ecological factors and outcomes in British Columbia when compared with the associations in other provinces.

## CONCLUSIONS

While community and hospital contextual characteristics are associated (to varying extents) with individual outcomes post-AMI, they collectively account for only a modest or negligible degree of outcome variations across jurisdictions. Further research is required to better elucidate which patient and provider factors best account for inter-regional outcome variations after AMI.

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