Comparing the Ambulatory Care and Outcomes for Rural and Urban Patients With Chronic Ischemic Heart Disease
A Population-Based Cohort Study

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Background—Little is known about variations in the quality of ambulatory care between urban and rural communities for patients with stable ischemic heart disease. The objectives of this study were to understand the effect of rurality on variations of ambulatory processes of care and outcomes for patients with stable ischemic heart disease.

Methods and Results—A population-based cohort study was conducted, which included all Ontario patients with stable ischemic heart disease confirmed on cardiac catheterization between October 1, 2008, and September 30, 2011. Patients were categorized as rural or urban based on the Rurality Index for Ontario score. Ambulatory processes of care of interest were diagnostic testing, medication usage, and access to general/speciality physicians over a 1-year time-horizon. Primary outcome was 1-year mortality. Secondary outcomes included 1-year myocardial infarction, repeat cardiac/all-cause hospitalization, and emergency department visits. The cohort consisted of 38,804 patients, of whom 34,949 (90%) were urban and 3,855 (10%) were rural patients. After risk-adjustment, rural patients had lower rates of cholesterol assessment (odds ratios 0.41; 95% confidence interval [CI], 0.38–0.44; P<0.001), primary care (0.76; 95% CI, 0.70–0.84; P<0.001), and statin use (odds ratios 0.67; 95% CI, 0.57–0.79; P<0.001) compared with urban patients. Rural patients had fewer total ambulatory physician visits (rate ratio 0.76; 95% CI, 0.75–0.78; P<0.001), primary care (0.76; 95% CI, 0.74–0.78; P<0.001), and cardiology visits (0.71; 95% CI, 0.68–0.74; P<0.001) over 1 year. Emergency department utilization was higher among rural patients (odds ratios 1.82; 95% CI, 1.70–1.96; P<0.001), but myocardial infarction, hospitalization, and mortality rates were similar.

Conclusions—Despite variation in ambulatory processes of care between urban and rural patients with stable ischemic heart disease, there were no outcome differences. (Circ Cardiovasc Qual Outcomes. 2014;7:835-843.)

Key Words: ambulatory care ▪ coronary artery disease ▪ health services research ▪ quality improvement ▪ rural...
WHAT IS KNOWN

- Development of quality indicators has been an important driver of improvement in cardiovascular care.
- There is a previously described gap in quality of care for cardiovascular patients treated in rural centers compared with urban centers, but this has focused mainly on in-hospital management.

WHAT THE STUDY ADDS

- The ambulatory management of rural patients is similar to that of urban patients in both process of care measures and 1-year outcomes, despite fewer visits to primary care physicians and specialists.
- One-year mortality and hospitalization of rural patients is similar to urban patients, but emergency room use is significantly higher in rural patients compared with urban patients.
- Decisions about the selection of indicators to include in report cards should consider effect on clinical outcomes and not just on processes of care.

conceptual framework for quality of care typically consists of 3 domains – structural aspects, processes of care, and finally outcomes.13 To date, the quality of ambulatory care in rural and urban patients, in particular process of care measures, has not been well studied. Furthermore, the clinical consequences of any variation in ambulatory care quality between rural and urban patients have not been well established.

Accordingly, the objectives of the present study were to understand the effect of rurality on ambulatory processes of care for patients with chronic SIHD and to compare outcomes for patients in rural and urban areas. We hypothesized that there would be differences in ambulatory processes of care measures in rural patients relative to their urban counterparts, which would translate into poorer clinical outcomes.

Methods

Study Patients

Ontario patients ≥20 years of age who underwent outpatient cardiac catheterization between October 1, 2008, and September 30, 2011, for the assessment of SIHD were eligible for inclusion in the study cohort. Patients were included in the study cohort if they had angiographic evidence of coronary artery disease, which was defined as left main artery stenosis of ≥50% or stenosis of ≥70% in a main epicardial coronary artery. For patients who underwent multiple catheterizations, the first was considered the index event and subsequent catheterizations were not included in the analyses. Exclusion criteria included patients whose indication for angiography was MI or investigation of valvular/structural heart disease, those identified with normal coronary or nonsignificant SIHD, patients who suffered an MI within 90 days before catheterization, and patients with missing data.

Data Sources

Data from the Cardiac Care Network of Ontario (CCN) registry was used to identify individuals who underwent cardiac catheterization. The CCN is a network of the 18 hospitals that provide invasive cardiac care in Ontario; it maintains a prospective registry on all patients who undergo coronary angiography, as well as coronary revascularization procedures. One-year mortality and hospitalization of rural patients is similar to urban patients, but emergency room use is significantly higher in rural patients compared with urban patients.

Measure of Rurality

To quantify the degree of rurality for each patient in the cohort, the Rurality Index for Ontario (RIO) score was used.14 The RIO score was developed by the Ministry of Health and Long Term Care of Ontario as a method to fairly and consistently measure a community’s degree of rurality based on its postal code. A larger RIO score indicates a greater degree of rurality, to a maximum score of 100. Details on the derivation of the RIO score is provided in the Data Supplement. In brief, the RIO score consists of 3 components: (1) a measure of community population and density; (2) proximity to basic healthcare; and (3) proximity to tertiary care. Equations for the calculation of all 3 components are provided in Figure 1 in the Data Supplement. Rural patients were defined as having an RIO score of ≥40, which is the cut-off used to determine the eligibility of rural communities for physician recruitment incentives by the provincial government.

Processes of Care and Outcomes Measures

The processes of care selected as variables for analysis were based on the American College of Cardiology Foundation/American Heart Association/American Medical Association-Physician Consortium for Performance Improvement 2011 performance measures for adults with SIHD.15 Broadly, we assessed 3 categories of process measures over a 1-year period after the index angiogram. First, patients were assessed as to whether they received each of the following specific diagnostic tests or procedures: revascularization within 90 days after index angiogram; left ventricular ejection fraction assessment; stress, exercise, or nuclear stress test; repeat cardiac catheterization; hemoglobin A1C (HbA1c) measurement; and cholesterol assessment. Although diabetes mellitus screening was removed from the most recent SIHD guidelines, HbA1c was still assessed in this study because diabetes mellitus is an important comorbidity in patients with SIHD and is still a measure that may be important to compare in rural and urban patients. Second, access to physician care was measured by the total number of unique ambulatory physician visits, cardiology visits, primary care physician, and general internal medicine visits per patient within 1 year. Finally, in patients over the age of 65 years, we analyzed whether patients received the following medications within 12 months after the index angiogram: angiotensin converting enzyme inhibitor or angiotensin II receptor blocker, antplatelet agents, β-blockers, aldosterone receptors antagonists, and statins.

The primary outcome of interest was all-cause mortality at 1 year. Secondary outcomes were ascertained within 1 year of the index angiogram; they included MI, all-cause hospitalizations, ED visits, and...
and cardiac hospitalizations for acute coronary syndromes and heart failure.

Statistical Analysis
A comparison of baseline demographics, clinical characteristics, cardiac status/testing, and physician visits between the urban and rural group was performed using $t$ tests for continuous variables and $\chi^2$ tests for categorical variables.

To evaluate whether there were risk-adjusted differences in processes of care in rural patients, a multiple logistic regression analysis was performed. Variables that were used in the model included age, sex, socioeconomic status based on income level, cardiac risk factors (including diabetes mellitus, hyperlipidemia, smoking status, hypertension), comorbidities (including peripheral vascular disease, cerebrovascular disease, heart failure, dialysis), Canadian Cardiovascular Society angina classification, and high-risk ischemia evaluation on noninvasive imaging. In the assessment of medications, the analyzed sample was restricted to patients $\geq 65$ years of age. Because of overdispersion, a negative binomial regression model was used to analyze the number of physician visits in the rural and urban groups.

Kaplan–Meier curves were produced to compare unadjusted 1-year survival of urban and rural patients. Risk-adjusted primary and secondary outcomes were compared using multiple logistic regression. The presence of collinearity in the models was assessed by producing a variance-inflation factor for each independent factor evaluated. No collinearity was noted, with all variance-inflation factors $<5$. SAS v9.2 (SAS Institute, Cary, NC) was used to perform the statistical analyses and a 2-tailed $P$ value of $<0.05$ was used to define statistical significance.

Results
Study Cohort
A flow chart summarizing the creation of the cohort is presented in Figure 1. The final cohort included 38,804 patients with SIHD, with 34,949 patients from urban areas (RIO<40) and 3855 from rural areas (RIO$\geq$40). Of these, 17,587 urban patients and 2925 rural patients were $\geq 65$ years of age.

Demographic, Clinical, and Anatomic Characteristics of Patients
Information regarding the characteristics of the rural and urban patients is highlighted in Table 1. There was no significant difference between the mean age and gender composition between the urban and rural groups. In regards to medical comorbidities and cardiac risk factors, the rural group had a significantly greater proportion of patients with previous vascular disease (11.5% versus 9.2%; $P$<0.001), chronic obstructive pulmonary disease (10.4% versus 6.5%; $P$<0.001), hypertension (88.1% versus 86.5%; $P$=0.008), and smoking (35.5% versus 31.1%; $P$<0.001), although urban patients had a higher rate of diabetes mellitus (44.2% versus 41.5%; $P$=0.002). Rural patients also had a significantly greater mean Charlson index score ($P$<0.001), suggesting a higher degree of morbidity. Despite these statistically significant differences in patients, the overall absolute differences between the groups of patients is small. Urban patients had higher rates of left ventricular ejection fraction assessment, exercise, or nuclear stress test before cardiac catheterization than rural patients.

Processes of Care
Diagnostic Tests
A summary of 1-year diagnostic testing and procedures is provided in Table 2. In the unadjusted analysis, a significantly smaller proportion of rural patients had HbA1c (58.6% versus
Table 1. Baseline Demographic and Clinical Characteristics of the Urban and Rural CAD Patients

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total</th>
<th>Urban (RIQ&lt;40)</th>
<th>Rural (RIQ≥40)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>38,804</td>
<td>34,949</td>
<td>3,855</td>
<td></td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td>66.00 (10.31)</td>
<td>65.99 (10.37)</td>
<td>66.10 (9.81)</td>
<td>0.55</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>9,606</td>
<td>8,632 (24.7)</td>
<td>974 (25.3)</td>
<td>0.44</td>
</tr>
<tr>
<td>Medical comorbidities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal function, n (%)</td>
<td>1,289 (3.3)</td>
<td>1,171 (3.4)</td>
<td>118 (3.1)</td>
<td>0.34</td>
</tr>
<tr>
<td>Previous MI, n (%)</td>
<td>10,904</td>
<td>9,865 (28.2)</td>
<td>1,039 (27.0)</td>
<td>0.095</td>
</tr>
<tr>
<td>Previous stroke, n (%)</td>
<td>546</td>
<td>481 (1.4)</td>
<td>65 (1.7)</td>
<td>0.121</td>
</tr>
<tr>
<td>Previous vascular disease, n (%)</td>
<td>3,648 (9.4)</td>
<td>3,205 (9.2)</td>
<td>443 (11.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>COPD, n (%)</td>
<td>2,665 (6.9)</td>
<td>2,265 (6.5)</td>
<td>400 (10.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Charlson index, mean (SD)</td>
<td>0.86 (1.33)</td>
<td>0.85 (1.33)</td>
<td>0.95 (1.37)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Income (Quintiles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7,104 (18.3%)</td>
<td>6,215 (17.8%)</td>
<td>889 (23.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2</td>
<td>7,942 (20.5%)</td>
<td>6,978 (20.0%)</td>
<td>964 (25.0%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7,859 (20.3%)</td>
<td>7,095 (20.3%)</td>
<td>764 (19.8%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>8,053 (20.8%)</td>
<td>7,366 (21.1%)</td>
<td>687 (17.8%)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>7,846 (20.2%)</td>
<td>7,295 (20.9%)</td>
<td>551 (14.3%)</td>
<td></td>
</tr>
<tr>
<td>Risk factors, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>31,368</td>
<td>28,282 (80.9)</td>
<td>3,086 (80.1)</td>
<td>0.192</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>17,031</td>
<td>15,430 (44.2)</td>
<td>1,601 (41.5)</td>
<td>0.002</td>
</tr>
<tr>
<td>Hypertension</td>
<td>33,638</td>
<td>30,243 (86.5)</td>
<td>3,395 (88.1)</td>
<td>0.008</td>
</tr>
<tr>
<td>Smoking</td>
<td>12,234</td>
<td>10,866 (31.1)</td>
<td>1,368 (35.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiac status/testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian cardiovascular society angina score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>6,394 (16.5)</td>
<td>5,641 (16.1)</td>
<td>753 (19.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1</td>
<td>5,448 (14.0)</td>
<td>5,008 (14.3)</td>
<td>440 (11.4)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>14,842 (38.2)</td>
<td>13,274 (38.0)</td>
<td>1,568 (40.7)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11,041 (28.5)</td>
<td>10,042 (28.7)</td>
<td>999 (25.9)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1,079 (2.8)</td>
<td>984 (2.8)</td>
<td>95 (2.5)</td>
<td></td>
</tr>
<tr>
<td>Location of significant epicardial coronary artery stenosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left main coronary artery stenosis</td>
<td>5,056 (13.0)</td>
<td>4,571 (13.1)</td>
<td>485 (12.6)</td>
<td>0.38</td>
</tr>
<tr>
<td>LAD artery stenosis</td>
<td>12,896 (33.2)</td>
<td>11,614 (33.2)</td>
<td>1,282 (33.3)</td>
<td>0.98</td>
</tr>
<tr>
<td>Midle/distal LAD stenosis</td>
<td>19,272 (49.7)</td>
<td>17,511 (50.1)</td>
<td>1,761 (45.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Circumflex artery stenosis</td>
<td>19,985 (51.5)</td>
<td>17,970 (51.4)</td>
<td>2,015 (52.3)</td>
<td>0.32</td>
</tr>
<tr>
<td>Right coronary artery stenosis</td>
<td>23,579 (60.8)</td>
<td>21,232 (60.8)</td>
<td>2,347 (60.9)</td>
<td>0.88</td>
</tr>
<tr>
<td>Left ventricle function, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not tested</td>
<td>12,762 (32.9)</td>
<td>10,890 (31.2)</td>
<td>1,872 (48.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tested</td>
<td>26,042 (67.1)</td>
<td>24,059 (68.8)</td>
<td>1,983 (51.4)</td>
<td></td>
</tr>
<tr>
<td>&lt;20%</td>
<td>376 (1.0)</td>
<td>341 (1.0)</td>
<td>35 (0.9)</td>
<td></td>
</tr>
<tr>
<td>20% to 34%</td>
<td>1,722 (4.4)</td>
<td>1,589 (4.5)</td>
<td>133 (3.5)</td>
<td></td>
</tr>
<tr>
<td>35% to 49%</td>
<td>5,026 (13.0)</td>
<td>4,641 (13.3)</td>
<td>385 (10.0)</td>
<td></td>
</tr>
<tr>
<td>≥50%</td>
<td>18,918 (48.8)</td>
<td>17,488 (50.0)</td>
<td>1,430 (37.1)</td>
<td></td>
</tr>
<tr>
<td>Exercise ECG before cardiac catheterization, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Tested</td>
<td>17,459 (45.0)</td>
<td>15,658 (44.8)</td>
<td>1,801 (46.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tested</td>
<td>21,345 (55)</td>
<td>19,291 (55.2)</td>
<td>2,054 (53.3)</td>
<td></td>
</tr>
<tr>
<td>Uninterpretable</td>
<td>1,882 (4.9)</td>
<td>1,663 (4.8)</td>
<td>219 (5.7)</td>
<td></td>
</tr>
<tr>
<td>High risk</td>
<td>10,751 (27.7)</td>
<td>9,858 (28.2)</td>
<td>893 (23.2)</td>
<td></td>
</tr>
<tr>
<td>Low risk</td>
<td>8,712 (22.5)</td>
<td>7,770 (22.2)</td>
<td>942 (24.4)</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. Continued

<table>
<thead>
<tr>
<th>Functional imaging before cardiac catheterization, n (%)</th>
<th>Total</th>
<th>Urban (RIO&lt;40)</th>
<th>Rural (RIO≥40)</th>
<th>PValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not tested or unknown</td>
<td>17346 (44.7)</td>
<td>15132 (43.3)</td>
<td>2214 (57.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tested</td>
<td>21458 (55.3)</td>
<td>19817 (56.7)</td>
<td>1641 (42.6)</td>
<td></td>
</tr>
<tr>
<td>High risk</td>
<td>12480 (32.2)</td>
<td>11595 (33.2)</td>
<td>885 (23.0)</td>
<td></td>
</tr>
<tr>
<td>Low risk</td>
<td>8978 (23.1)</td>
<td>8222 (23.5)</td>
<td>756 (19.6)</td>
<td></td>
</tr>
</tbody>
</table>

Whether cardiac imaging before coronary catheterization or not was tested for statistical significance. Among patients tested, statistical significance was determined between high risk and low risk results.

COPD indicates chronic obstructive pulmonary disease; LAD, left anterior descending; MI, myocardial infarction; and RIO, Rurality Index for Ontario.

78.4%, P<0.001) and cholesterol levels (54.8% versus 75.9%, P<0.001) tested, but there were no other differences in terms of diagnostic testing and procedures after angiography. In diabetic patients, rural patients also had lower rates of HbA1c screening than urban patients (85.5% versus 64.7%; P<0.001).

After accounting for patient factors, both HbA1c measurement (odds ratio [OR]=0.41; 95% CI, 0.38–0.44; P<0.001) and cholesterol assessment (OR=0.41; 95% CI, 0.38–0.44; P<0.001) remained significant, with lower rates in rural patients. HbA1c measurement remained lower in diabetic patients even after adjustment (OR=0.33; 95% CI, 0.29–0.27; P<0.001). In addition, rural patients were more likely to undergo stress testing (OR=1.12; 95% CI, 1.04–1.20; P=0.002) than urban patients in the multivariable analyses. There were no differences in the rates of left ventricular ejection fraction assessment, repeat catheterization, or revascularization between rural and urban patients.

Physician Visits

Table 3 summarizes the 1-year postangiogram median ambulatory physician visits in the cohort. In the unadjusted analysis, rural patients were found to have significantly fewer total visits (9 versus 7; P<0.001), cardiology visits (2 versus 1; P<0.001), primary care visits (6 versus 5; P<0.001), and general internal medicine visits (1 versus 0; P<0.001) than urban patients per year. After adjusting for patient factors, the rate ratio for rural versus urban patients was overall visits (0.76; 95% CI, 0.75–0.78; P<0.001), primary care (0.76; 95% CI, 0.74–0.78; P<0.001), cardiology (0.71; 95% CI, 0.68–0.74; P<0.001), and general internal medicine (0.76; 95% CI, 0.74–0.78; P<0.001).

Medication

A summary of 1-year medication use in patients ≥65 years of age is found in Table 4. There was no significant difference in the use of angiotensin converting enzyme inhibitors or angiotensin II receptor blockers, antiplatelet agents, or β-blockers. However, rural patients had significantly greater rates of aldosterone receptor antagonists, such as spironolactone, use (7.8% versus 6.3%; P=0.012) and significantly lower rates of statin use (90.6% versus 93.7%; P<0.001). In the multivariable analysis, the differences remained significant for both aldosterone receptor antagonists (OR=1.24; 95% CI, 1.04–1.48; P=0.02) and statins (OR=0.67; 95% CI, 0.57–0.79; P<0.001).

Outcomes

Kaplan–Meier curves with 1-year survival curves are provided in Figure 2. The overall mortality for the entire cohort at 1-year postangiogram was 2.6%, and the unadjusted mortality was higher at 1 year for rural patients (3.2% versus 2.6%; P=0.017). After adjustment, however, there was no significant difference in 1-year mortality (OR=1.15; 95% CI, 0.94–1.41; P=0.163).

In terms of the secondary unadjusted outcomes, there was no difference between rural and urban patients in cardiac hospitalizations (47.2 versus 46.3%; P=0.25). However, a greater proportion of rural patients visited the ED (59.1% versus

Table 2. Summary of 1-Year Diagnostic Testing and Procedures Used by Rural and Urban CAD Patients

<table>
<thead>
<tr>
<th>Diagnostic Testing and Procedures, n (%)</th>
<th>Total</th>
<th>Rural (RIO≥40)</th>
<th>Urban (RIO&lt;40)</th>
<th>p-value</th>
<th>Adjusted Rural Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revascularization &lt;90 days after index</td>
<td>23795 (61.3)</td>
<td>2322 (60.2)</td>
<td>21473 (61.4)</td>
<td>0.144</td>
<td>0.96</td>
<td>0.89 1.03</td>
</tr>
<tr>
<td>LVEF assessment</td>
<td>18937 (48.8)</td>
<td>1829 (47.4)</td>
<td>17108 (49.0)</td>
<td>0.076</td>
<td>0.97</td>
<td>0.91 1.04</td>
</tr>
<tr>
<td>Stress testing, exercise or nuclear stress</td>
<td>16485 (42.5)</td>
<td>1687 (43.8)</td>
<td>14798 (42.3)</td>
<td>0.091</td>
<td>1.12</td>
<td>1.04 1.20*</td>
</tr>
<tr>
<td>Cardiac catheterization</td>
<td>6557 (16.9)</td>
<td>661 (17.1)</td>
<td>5896 (16.9)</td>
<td>0.66</td>
<td>1.00</td>
<td>0.91 1.09</td>
</tr>
<tr>
<td>HbA1c measurement</td>
<td>29677 (76.5)</td>
<td>2260 (58.6)</td>
<td>27417 (78.4)</td>
<td>&lt;0.001</td>
<td>0.41</td>
<td>0.38 0.44*</td>
</tr>
<tr>
<td>Cholesterol assessment</td>
<td>28632 (73.8)</td>
<td>2112 (54.8)</td>
<td>26520 (75.9)</td>
<td>&lt;0.001</td>
<td>0.41</td>
<td>0.38 0.44*</td>
</tr>
</tbody>
</table>

Variables adjusted for age, gender, renal dysfunction, previous MI, previous stroke, previous vascular disease, COPD, Charlson index, hyperlipidemia, diabetes mellitus, hypertension, smoking, Canadian Cardiovascular Society Angina Score, location of significant epicardial coronary artery stenosis, left ventricle ejection fraction, exercise ECG before cardiac catheterization, functional imaging before cardiac catheterization.

CI indicates confidence interval; COPD indicates chronic obstructive pulmonary disease; LVEF, left ventricular ejection fraction; MI, myocardial infarction; and RIO, Rurality Index for Ontario.

*P value <0.05.
We found some differences in the processes of care between urban and rural patients, in particular laboratory testing for diabetes mellitus and lipid levels and access to physicians. However, these did not translate into any differences in risk-adjusted mortality or hospitalization, although rural patient were significantly more likely to use the ED for care than urban counterparts. Understanding whether this pattern of healthcare utilization is associated with increased healthcare costs is an area for future research.

As previously mentioned, ambulatory cardiovascular care has been the subject of substantial quality improvement efforts, including the American Heart Association’s Get with the Guidelines program. Previous literature suggested rural patients faced challenges in accessing medical services and may receive suboptimal cardiac care as a result. Although our study does suggest less access to physicians, the overall clinical differences in process outcomes between urban and rural patients, in particular laboratory testing for diabetes mellitus and lipid levels, were not significantly different. One caveat worth mentioning is that laboratory data conducted in hospitals may not be captured through administrative data, and it is possible that the lower rates in rural patients may reflect patients having their testing done predominantly in hospitals compared with community-based laboratories, though this limitation cannot be substantiated. Furthermore, we recognize that given our large sample size, differences that are not clinically significant may be statistically significant.

### Discussion

The management of coronary artery disease has changed significantly in recent years, shifting from an acute condition, managed predominantly on an inpatient basis, to a chronic disease, managed in predominantly ambulatory setting. Therefore, outpatient management of patients with SIHD has become of critical importance and a focus of quality improvement efforts. In this study, we compared the ambulatory management of SIHD for Ontario patients in rural and urban areas.

We aimed to determine if any differences in care existed between patients in communities with an RIO score of 40 to 70 and patients in very remote communities with RIO scores of >70. Appendix 1 shows the baseline characteristics between patients in communities with an RIO score of 40 to 70 and >70. Appendix 2 shows a similar pattern of utilization in RIO >70 patients as in RIO 40 to 70. Appendix 3 shows that very rural patients have even fewer total physician visits, cardiology, primary care, and internal medicine visits than RIO 40 to 70 patients.

### Comparisons of Rural (RIO score 40–70) versus Very Rural Patients (RIO >70).

Within 12 mo

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total</th>
<th>Urban (RIO&lt;40)</th>
<th>Rural (RIO≥40)</th>
<th>P Value</th>
<th>Rate Ratio*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c testing</td>
<td>277 (93.7)</td>
<td>265 (93.4)</td>
<td>12 (77.8)</td>
<td>&lt;0.001</td>
<td>0.57</td>
<td>0.47–0.70</td>
</tr>
<tr>
<td>24-hour blood pressure monitoring</td>
<td>204 (96.4)</td>
<td>196 (96.4)</td>
<td>8 (90.9)</td>
<td>&lt;0.001</td>
<td>0.80</td>
<td>0.61–1.03</td>
</tr>
<tr>
<td>Exercise ECG before cardiac catheterization</td>
<td>19 (9.7)</td>
<td>17 (9.7)</td>
<td>2 (18.2)</td>
<td>0.022</td>
<td>1.31</td>
<td>0.79–2.28</td>
</tr>
<tr>
<td>Functional imaging before cardiac catheterization</td>
<td>22 (10.4)</td>
<td>20 (10.5)</td>
<td>2 (18.2)</td>
<td>0.089</td>
<td>1.76</td>
<td>0.90–3.40</td>
</tr>
</tbody>
</table>

### Table 3. Multiple Regression Analysis of the Association Between Rurality and Healthcare System Utilization

<table>
<thead>
<tr>
<th>Physician visits, median (IQR)</th>
<th>Total</th>
<th>Urban (RIO&lt;40)</th>
<th>Rural (RIO≥40)</th>
<th>P Value</th>
<th>Rate Ratio*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All physician visits</td>
<td>9 (6–13)</td>
<td>9 (6–14)</td>
<td>7 (4–10)</td>
<td>&lt;0.001</td>
<td>0.76</td>
<td>0.75–0.78†</td>
</tr>
<tr>
<td>Cardiology visits</td>
<td>2 (0–3)</td>
<td>2 (0–3)</td>
<td>1 (0–2)</td>
<td>&lt;0.001</td>
<td>0.71</td>
<td>0.68–0.74†</td>
</tr>
<tr>
<td>Primary physician visits</td>
<td>6 (3–9)</td>
<td>6 (3–10)</td>
<td>5 (2–7)</td>
<td>&lt;0.001</td>
<td>0.76</td>
<td>0.74–0.78†</td>
</tr>
<tr>
<td>Internal Medicine physician visits</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
<td>0 (0–2)</td>
<td>&lt;0.001</td>
<td>0.84</td>
<td>0.80–0.89†</td>
</tr>
</tbody>
</table>

Cl indicates confidence interval; COPD indicates chronic obstructive pulmonary disease; IQR, interquartile range; MI, myocardial infarction; and RIO, Rurality Index for Ontario.

*Variables adjusted for age, gender, renal dysfunction, previous MI, previous stroke, previous vascular disease, COPD, Charlson index, hyperlipidemia, diabetes mellitus, hypertension, smoking, Canadian Cardiovascular Society Angina Score, location of significant epicardial coronary artery stenosis, left ventricle ejection fraction, exercise ECG before cardiac catheterization, functional imaging before cardiac catheterization.

†P value <0.05.

### Table 4. Summary of Prescribed Medications in the Medication Cohort 12 Months of Index Angiogram

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total</th>
<th>Rural (RIO≥40)</th>
<th>Urban (RIO&lt;40)</th>
<th>P Value</th>
<th>Adjusted Rural Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACEI or ARB, n (%)</td>
<td>16625 (81.1)</td>
<td>1667 (80.3)</td>
<td>14958 (81.1)</td>
<td>0.36</td>
<td>1.00</td>
<td>0.89–1.13</td>
</tr>
<tr>
<td>Anti-platelet agents, n (%)</td>
<td>10723 (52.3)</td>
<td>1083 (52.2)</td>
<td>9640 (52.3)</td>
<td>0.92</td>
<td>1.01</td>
<td>0.92–1.11</td>
</tr>
<tr>
<td>β-blockers, n (%)</td>
<td>15909 (77.6)</td>
<td>1615 (77.8)</td>
<td>14294 (77.5)</td>
<td>0.79</td>
<td>1.03</td>
<td>0.92–1.15</td>
</tr>
<tr>
<td>Aldosterone antagonists, n (%)</td>
<td>1328 (6.5)</td>
<td>161 (7.8)</td>
<td>1167 (6.3)</td>
<td>0.012</td>
<td>1.24</td>
<td>1.04–1.48</td>
</tr>
<tr>
<td>Statins, n (%)</td>
<td>19158 (93.4)</td>
<td>1881 (90.6)</td>
<td>17277 (93.7)</td>
<td>&lt;0.001</td>
<td>0.67</td>
<td>0.57–0.79</td>
</tr>
</tbody>
</table>

Variables adjusted for age, gender, renal dysfunction, previous MI, previous stroke, previous vascular disease, COPD, Charlson index, hyperlipidemia, diabetes mellitus, hypertension, smoking, Canadian Cardiovascular Society Angina Score, location of significant epicardial coronary artery stenosis, left ventricle ejection fraction, exercise ECG before cardiac catheterization, functional imaging before cardiac catheterization.

ACEI indicates angiotensin converting enzyme inhibitor; ARB, angiotensin II receptor blocker; CI, confidence interval; and RIO, Rurality Index for Ontario.
In terms of medication use, only statins were used significantly less frequent in rural patients. However, the overall proportion of rural patients on statins was still over 90%, suggesting good uptake of these medications compared to previous studies looking at statin use.17-19 These findings suggested that the care gap between urban and rural patients was not as significant as initially thought, and that efforts to improve the quality of cardiovascular care have not only benefited patients in urban environments. The relatively low rate of antiplatelet use across both groups may be because aspirin is often purchased over the counter and may be underreported in administrative data.

Although there may be differences in the processes of care between urban and rural patients, we did not find these differences translated into differences in clinical outcomes, such as 1-year mortality or MI rates. One caveat to this is that cardiac event rates in this study were low and greater follow-up may be required to detect differences in outcomes.

The lack of a difference in clinical outcomes is significant from a public policy perspective, as quality improvement programs, including public report cards and performance-based initiatives, are becoming more widespread. These report cards tend to focus on improving process of care measures, as those are often the easiest to collect and affect through knowledge translation efforts.20-22 We would argue that in order for process of care measures to be relevant, they should have an effect on either clinical outcomes or improve the efficiency of healthcare delivery by improving economic outcomes. The link between processes of care and either clinical or economic, however, is uncertain in several disease conditions. A recent review of quality improvement reporting in cardiovascular disease found that the link between process measure improvement and improved outcomes is limited at best, and the evidence of this linkage is most commonly found in hospitalized patient, such as post-MI patients.23 There is currently a paucity of data on the effect of process measure improvement on outcomes in ambulatory cardiovascular care and as such should be the focus of further research.

Despite the equivalent clinical outcomes, we found that rural patients access health services differently than their urban counterparts. This is consistent with previous studies that have found increased use of EDs by rural patients compared with urban ones. Rural patients have been shown to have poorer access to primary care and specialty care than urban patients, and often this is because of a lower physician supply in rural areas compared with urban ones.24 In contrast, rural inhabitants were more likely to depend on the ED for their care. This was the most prominent difference between rural and urban patients. Our results, in contrast to previous studies, did not show a difference in hospital admissions for rural versus urban patients, despite higher ED use. This may be because stable coronary disease, in contrast to some ambulatory sensitive conditions, such as heart failure, has a lower hospitalization rate. Thus, although ED use is often looked at adversely, in many of these communities with scarce physician resources, the ED is often a place where some patients access primary care services. This may be appropriate in some areas like in remote, rural areas of the province. Although there is often an emphasis on achieving uniformity in access to healthcare resources, the results of this study showed that differences in the processes of care may not lead to poorer outcomes. Variations in care, therefore, may not be synonymous with a care gap and may actually be an appropriate difference in care because of the resources available in large diverse jurisdictions. These data are consistent with previous literature, suggesting a greater acceptance of variations in healthcare under specific contexts, as long as there is no adverse effect on patient outcomes in SIHD.25 So we would suggest that increased ED use itself, in the absence of data showing effect on patient outcomes of health system costs in this specific context, is not necessarily a marker of suboptimal care.26,27 As such, future research to evaluate the relationship between ED use and health system costs should be explored.

Our study complements the previous literature in this area. Most previous studies have suggested that quality of care gaps exist between urban and rural patients, both in terms of access to physicians and processes of care measures; however, these have focused on inpatients. In a study of patients discharged post MI, Vanasse and colleagues found similar rates of medication use, but fewer cardiology visits and higher cardiac readmission rates.26 Another study by Joynt and colleagues looked at a cohort of inpatients admitted to rural hospitals
for acute MI and found rural patients had significantly higher 30-day mortality rates. There is a paucity of data on ambulatory care in cardiovascular disease because the data available focused on different populations, such as heart failure or primary prevention cohorts. In one of the few studies of a secondary prevention cohort, a recent study by Shi and colleagues found no different in late outcomes between rural and urban patients who underwent coronary artery bypass surgery. Our study, similar to the study by Shi and colleagues, used a clearly defined population of patients with coronary disease, who were managed with medical therapy in contrast to revascularization.

Our study must be interpreted in the context of several limitations in this study. We used large, administrative databases that did not include some potentially important clinical information such as blood pressure or blood results, such as cholesterol levels. For ED visits, we were not able to ascertain whether the visit was a true emergency or whether the visit served as an adjunct for a nonurgent primary care visit. We could not assess physician or healthcare-specific factors, such as presence of cardiologists or other specialty clinics within a specific community that may disproportionately influence care in a specific area. Finally, though this is a large population-based study, it is possible that because of low event rates of the primary outcome, that the study was underpowered to determine differences in the primary outcome. Despite these limitations, this study has identified ambulatory patterns of care differences in a defined cohort that could be generalizable to other large and diverse jurisdictions.

In conclusion, we found variations in processes of care and access to health services between urban and rural patients, but these variations did not seem to affect clinical outcomes.

Disclosures

None.

References

Comparing the Ambulatory Care and Outcomes for Rural and Urban Patients With Chronic Ischemic Heart Disease: A Population-Based Cohort Study
Christopher Tran, Harindra C. Wijeysundera, Feng Qui, Jack V. Tu and R. Sacha Bhatia

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Supplementary Methods

Description of the Rurality Index of Ontario.

There are three components that make up the RIO score:

$$\text{RIO Score} = \text{POP} + \text{Time}_b + \text{Time}_a$$

The weights or contributions of POP, $\text{Time}_b$ and $\text{Time}_a$ to the overall RIO score are 28.6%, 23.8%, and 47.6%, respectively. The first component, POP, is a measure of community population and density (in persons/km$^2$). Communities with populations less than 45 000 are given points, with a linear increase for smaller populations. Additional points are also given to communities with densities that are smaller relative to the median population density for all the provincial CSDs. The second component, $\text{Time}_b$, is a measure of travel time (in minutes) to the nearest basic referral centre. This component is determined by the fastest route from the centroid of each CSD to a level 2 referral center, defined as a centre with a population greater than 10 000 with the following specialty services: General Practice/Family Practice, Anaesthesia, Diagnostic Radiology, General Internal Medicine, General Surgery, Obstetrics/Gynaecology, Orthopaedic Surgery, Paediatrics and Psychiatry. The third component, $\text{Time}_a$, is a measure of travel time from each CSD to the nearest advanced referral centre, which in Ontario includes Ottawa, Kingston, Toronto, Mississauga, Hamilton, Windsor, London, Greater Sudbury and Thunder Bay (1).
### Supplementary Table 1. Baseline demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>TOTAL</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>34 949</td>
<td>3 090</td>
<td>765</td>
<td>38 804</td>
<td></td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td>66.9 ± 10.4</td>
<td>66.2 ± 9.9</td>
<td>65.6 ± 9.6</td>
<td>66.0 ± 10.3</td>
<td>0.32</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>8 632 (24.7)</td>
<td>775 (25.1)</td>
<td>199 (26.0)</td>
<td>9 606 (24.8)</td>
<td>0.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medical Co-Morbidities</th>
<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>TOTAL</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal function, n (%)</td>
<td>1 171 (3.4)</td>
<td>104 (3.4)</td>
<td>14 (1.8)</td>
<td>1 289 (3.3)</td>
<td>0.07</td>
</tr>
<tr>
<td>Previous MI, n (%)</td>
<td>9 865 (28.2)</td>
<td>831 (26.9)</td>
<td>208 (27.2)</td>
<td>10 904 (28.1)</td>
<td>0.24</td>
</tr>
<tr>
<td>Previous stroke, n (%)</td>
<td>481 (1.4)</td>
<td>51 (1.7)</td>
<td>14 (1.8)</td>
<td>546 (1.4)</td>
<td>0.28</td>
</tr>
<tr>
<td>Previous vascular disease, n (%)</td>
<td>3 205 (9.2)</td>
<td>354 (11.5)</td>
<td>89 (11.6)</td>
<td>3 648 (9.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>COPD, n (%)</td>
<td>2 265 (6.5)</td>
<td>326 (10.6)</td>
<td>74 (9.7)</td>
<td>2 665 (6.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Charlson index, mean (SD)</td>
<td>0.85 ± 1.33</td>
<td>0.92 ± 1.36</td>
<td>1.07 ± 1.39</td>
<td>0.86 ± 1.33</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Factors, n (%)</th>
<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>TOTAL</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperlipidemia</td>
<td>28 282 (80.9)</td>
<td>2 465 (79.8)</td>
<td>621 (81.2)</td>
<td>31 368 (80.8)</td>
<td>0.29</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>15 430 (44.2)</td>
<td>1 269 (41.1)</td>
<td>332 (43.4)</td>
<td>17 031 (43.9)</td>
<td>0.004</td>
</tr>
<tr>
<td>Hypertension</td>
<td>30 243 (86.5)</td>
<td>2 703 (87.5)</td>
<td>692 (90.5)</td>
<td>33 638 (86.7)</td>
<td>0.003</td>
</tr>
<tr>
<td>Smoking</td>
<td>10 866 (31.1)</td>
<td>1 093 (35.4)</td>
<td>275 (35.9)</td>
<td>12 234 (31.5)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cardiac Status/Testing</th>
<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>TOTAL</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Cardiovascular Society Angina Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>5 641 (16.1)</td>
<td>642 (20.8)</td>
<td>111 (14.5)</td>
<td>6 394 (16.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1</td>
<td>5 008 (14.3)</td>
<td>374 (12.1)</td>
<td>66 (8.6)</td>
<td>5 448 (14.0)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>13 274 (38.0)</td>
<td>1 180 (38.2)</td>
<td>388 (50.7)</td>
<td>14 842 (38.2)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10 042 (28.7)</td>
<td>814 (26.3)</td>
<td>185 (24.2)</td>
<td>11 041 (28.5)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>984 (2.8)</td>
<td>80 (2.6)</td>
<td>15 (2.0)</td>
<td>1 079 (2.8)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of Significant Epicardial Coronary Artery Stenosis</th>
<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>TOTAL</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Main Coronary Artery Stenosis</td>
<td>4 571 (13.1)</td>
<td>421 (13.6)</td>
<td>64 (8.4)</td>
<td>5 056 (13.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Left Anterior Descending (LAD) Artery Stenosis</td>
<td>11 614 (33.2)</td>
<td>1 081 (35.0)</td>
<td>201 (26.3)</td>
<td>12 896 (33.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Midle/Distal LAD Stenosis</td>
<td>17 511 (50.1)</td>
<td>1 417 (45.9)</td>
<td>344 (45.0)</td>
<td>19 272 (49.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Circumflex LAD Stenosis</td>
<td>17 970 (51.4)</td>
<td>1 622 (52.5)</td>
<td>393 (51.4)</td>
<td>19 985 (51.5)</td>
<td>0.52</td>
</tr>
<tr>
<td>Right Coronary Artery Stenosis</td>
<td>Not Tested (31.2)</td>
<td>Tested (68.8)</td>
<td>&lt;34% (5.5)</td>
<td>35-49% (13.3)</td>
<td>≥50% (50.0)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>------------</td>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>10 890 (31.2)</td>
<td>24 059 (68.8)</td>
<td>1 930 (5.5)</td>
<td>4 641 (13.3)</td>
<td>17 488 (50.0)</td>
</tr>
<tr>
<td></td>
<td>1 470 (47.6)</td>
<td>1 620 (52.4)</td>
<td>134 (4.3)</td>
<td>321 (10.4)</td>
<td>1 165 (37.7)</td>
</tr>
<tr>
<td></td>
<td>402 (52.5)</td>
<td>363 (47.5)</td>
<td>34 (4.4)</td>
<td>64 (8.4)</td>
<td>265 (34.6)</td>
</tr>
<tr>
<td></td>
<td>12 762 (32.9)</td>
<td>26 042 (67.1)</td>
<td>2 098 (5.4)</td>
<td>5 026 (13.0)</td>
<td>18 918 (48.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Ventricle function, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Tested</td>
<td>10 890 (31.2)</td>
<td>24 059 (68.8)</td>
<td>1 930 (5.5)</td>
<td>4 641 (13.3)</td>
<td>17 488 (50.0)</td>
</tr>
<tr>
<td>Tested</td>
<td>1 470 (47.6)</td>
<td>1 620 (52.4)</td>
<td>134 (4.3)</td>
<td>321 (10.4)</td>
<td>1 165 (37.7)</td>
</tr>
<tr>
<td>&lt;34%</td>
<td>402 (52.5)</td>
<td>363 (47.5)</td>
<td>34 (4.4)</td>
<td>64 (8.4)</td>
<td>265 (34.6)</td>
</tr>
<tr>
<td>35-49%</td>
<td>12 762 (32.9)</td>
<td>26 042 (67.1)</td>
<td>2 098 (5.4)</td>
<td>5 026 (13.0)</td>
<td>18 918 (48.8)</td>
</tr>
<tr>
<td>≥50%</td>
<td></td>
<td></td>
<td></td>
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<td>15 658 (44.8)</td>
<td>19 291 (55.2)</td>
<td>1 663 (4.8)</td>
<td>9 858 (28.2)</td>
<td>7 770 (22.2)</td>
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<td>1 440 (46.6)</td>
<td>1 650 (53.4)</td>
<td>183 (5.9)</td>
<td>698 (22.6)</td>
<td>769 (24.9)</td>
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<td>361 (47.2)</td>
<td>404 (52.8)</td>
<td>36 (4.7)</td>
<td>195 (25.5)</td>
<td>173 (22.6)</td>
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<td>17 459 (45.0)</td>
<td>21 345 (55.0)</td>
<td>1 882 (4.9)</td>
<td>10 751 (27.7)</td>
<td>8 712 (22.5)</td>
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<td>Exercise Electrocardiogram prior to cardiac catheterization, n (%)</td>
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<td>173 (22.6)</td>
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<td>17 459 (45.0)</td>
<td>21 345 (55.0)</td>
<td>1 882 (4.9)</td>
<td>10 751 (27.7)</td>
<td>8 712 (22.5)</td>
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<tr>
<td>Low risk</td>
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<td>15 132 (43.3)</td>
<td>19 817 (56.7)</td>
<td>1 437 (46.5)</td>
<td>11 595 (33.2)</td>
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<tr>
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<td>1 653 (53.5)</td>
<td>1 437 (46.5)</td>
<td>782 (25.3)</td>
<td>782 (25.3)</td>
<td>655 (21.2)</td>
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<td>561 (73.3)</td>
<td>204 (26.7)</td>
<td>103 (13.5)</td>
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<td>101 (13.2)</td>
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<tr>
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<td>17 346 (44.7)</td>
<td>21 458 (55.3)</td>
<td>12 480 (32.2)</td>
<td>12 480 (32.2)</td>
<td>8 978 (23.1)</td>
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### Supplementary Table 2. Summary of 1-year diagnostic testing and procedures utilized

<table>
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<tr>
<th></th>
<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>Total</th>
<th>p-value</th>
<th>Odds Ratio (RIO: 40-70)</th>
<th>95% CI</th>
<th>P Value</th>
<th>Odds Ratio (RIO: ≥70)</th>
<th>95% CI</th>
<th>P Value</th>
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<tr>
<td><strong>Diagnostic Testing and Procedures, n (%)</strong></td>
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<tr>
<td>Revascularization &lt;90 days after index</td>
<td>21 473 (61.4)</td>
<td>1 844 (59.7)</td>
<td>478 (62.5)</td>
<td>23 795</td>
<td>0.12</td>
<td>0.93</td>
<td>0.85</td>
<td>1.01</td>
<td>0.07</td>
<td>1.11</td>
<td>0.94</td>
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<td>LVEF assessment</td>
<td>14 798 (42.3)</td>
<td>1 524 (49.3)</td>
<td>305 (39.9)</td>
<td>18 937</td>
<td>&lt;0.001</td>
<td>1.04</td>
<td>0.96</td>
<td>1.12</td>
<td>0.32</td>
<td>0.74</td>
<td>0.63</td>
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<tr>
<td>Stress testing, exercise or nuclear stress</td>
<td>5 896 (16.9)</td>
<td>531 (17.2)</td>
<td>130 (17.0)</td>
<td>6 557 (16.9)</td>
<td>0.90</td>
<td>1.01</td>
<td>0.92</td>
<td>1.12</td>
<td>0.83</td>
<td>0.95</td>
<td>0.78</td>
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<tr>
<td>Cardiac catheterization</td>
<td>27 417 (78.4)</td>
<td>1 877 (60.7)</td>
<td>383 (50.1)</td>
<td>29 677</td>
<td>&lt;0.001</td>
<td>0.44</td>
<td>0.41</td>
<td>0.48</td>
<td>&lt;0.001</td>
<td>0.29</td>
<td>0.25</td>
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<tr>
<td>HbA1c measurement</td>
<td>26 520 (75.9)</td>
<td>1 774 (57.4)</td>
<td>338 (44.2)</td>
<td>28 632</td>
<td>&lt;0.001</td>
<td>0.45</td>
<td>0.42</td>
<td>0.49</td>
<td>&lt;0.001</td>
<td>0.27</td>
<td>0.23</td>
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<td>Cholesterol assessment</td>
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### Supplementary Table 3. Multivariate analysis of the association between rurality and healthcare system utilization

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<tr>
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<th>RIO: &lt;40</th>
<th>RIO: 40-70</th>
<th>RIO: ≥70</th>
<th>Total</th>
<th>p-value</th>
<th>True Rate Ratio (RIO: 40-70)</th>
<th>95% CI</th>
<th>P Value</th>
<th>True Rate Ratio (RIO≥70)</th>
<th>95% CI</th>
<th>P Value</th>
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<tbody>
<tr>
<td><strong>Physician Visits, mean (SD)</strong></td>
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<tr>
<td>All physician visits</td>
<td>10.60 ± 6.98</td>
<td>8.10 ± 5.40</td>
<td>4.83 ± 4.83</td>
<td>10.33 ± 6.88</td>
<td>&lt;0.001</td>
<td>0.78</td>
<td>0.76</td>
<td>0.80</td>
<td>&lt;0.001</td>
<td>0.70</td>
<td>0.67</td>
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<tr>
<td>Cardiology visits</td>
<td>1.98 ± 2.08</td>
<td>1.59 ± 1.39</td>
<td>1.24 ± 1.80</td>
<td>1.92 ± 2.04</td>
<td>&lt;0.001</td>
<td>0.73</td>
<td>0.70</td>
<td>0.76</td>
<td>&lt;0.001</td>
<td>0.62</td>
<td>0.57</td>
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<tr>
<td>Primary physician visits</td>
<td>7.11 ± 5.77</td>
<td>4.57 ± 5.38</td>
<td>4.21 ± 5.05</td>
<td>6.93 ± 5.68</td>
<td>&lt;0.001</td>
<td>0.77</td>
<td>0.75</td>
<td>0.79</td>
<td>&lt;0.001</td>
<td>0.74</td>
<td>0.70</td>
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<tr>
<td>Internal Medicine physician visits</td>
<td>1.51 ± 2.34</td>
<td>2.04 ± 4.57</td>
<td>1.61 ± 4.21</td>
<td>1.48 ± 2.31</td>
<td>&lt;0.001</td>
<td>0.89</td>
<td>0.85</td>
<td>0.95</td>
<td>&lt;0.001</td>
<td>0.63</td>
<td>0.55</td>
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Supplemental Figures

Supplemental Figure 1.

**TIME\textsubscript{a}** = Measure of travel time to nearest advanced referral centre

\[
TIME\textsubscript{a} = \frac{\left( T_{a} - T_{sm} \right)}{T_{sm}} \times 10
\]

If \( TIME\textsubscript{a} > 15 \) then \( TIME\textsubscript{a} = 15 \).

where,
\( T_{a} \) = Minutes of travel time to nearest advanced referral centre.
\( T_{sm} \) = Median travel time = 101.4 minutes.
Max. possible score = 15; Minimum possible score = -10.

**TIME\textsubscript{b}** = Measure of travel time to nearest basic referral centre

\[
TIME\textsubscript{b} = \frac{\left( T_{b} - T_{sm} \right)}{T_{sm}} \times 10
\]

If \( TIME\textsubscript{b} > 40 \) then \( TIME\textsubscript{b} = 40 \).

where,
\( T_{b} \) = Minutes of travel time to nearest basic referral centre.
\( T_{sm} \) = Median travel time = 49.4 minutes.
Max. possible score = 40; Min. possible score = -10.

**POP** = Measure of community population

\[
POP = \left[ 25 - 3.79 \frac{(P_{06}/P_{00})}{[5 - (P_{06}/22.6)]} \right]
\]

If \( 25 - 3.79 \frac{(P_{06}/P_{00})}{[5 - (P_{06}/22.6)]} < 0 \) then set \( 25 - 3.79 \frac{(P_{06}/P_{00})}{[5 - (P_{06}/22.6)]} = 0 \).

If \( [5 - (P_{D}/22.6)] < 0 \) then set \( [5 - (P_{D}/22.6)] = 0 \).

where,
\( P_{06} \) = Total population of CSD in 2006.
\( P_{M} \) = Median population of CSDs in 2006 = 6,825 persons.
\( P_{D} \) = Median population density of CSDs = 22.6 persons/sq.km
Max. possible score = 30; Min. possible score = 0.

**Supplemental Figure Legend** 1. Equations for the calculation of the RIO score components POP, \( TIME\textsubscript{a} \), and \( TIME\textsubscript{b} \) (1)
Supplemental References