Patterns of Care and Outcomes Differ for Urban Versus Rural Patients With Newly Diagnosed Heart Failure, Even in a Universal Healthcare System

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Background—Access to medical care differs between urban and rural residents, but the magnitude of these differences and whether they affect outcomes are unknown. We aimed to determine whether outcomes differ for patients with incident heart failure (HF) by urban-rural status.

Methods and Results—This cohort study used administrative data from Alberta, Canada. Patients with incident HF were identified from April 1, 1999, to December 31, 2005, and followed for 1-year. Multivariable logistic regression was used to assess differences in 1-year outcomes after initial HF diagnosis in patients living in rural versus urban settings. We identified 72,043 patients with incident HF (mean age, 72±14; male sex, 50%) of whom 12,173 (17%) died and 29,074 (39%) were hospitalized within 1 year. Although crude all-cause 1-year mortality rates were higher in urban than in rural residents (17.3% versus 15.6%, \(P<0.001\)), after adjustment for comorbidities, no significant differences were observed (adjusted odds ratio [aOR], 0.95; 95% CI, 0.90 to 1.00). However, sex-specific analyses indicated that urban men had a significantly lower risk of mortality than rural men (aOR, 0.89; 95% CI, 0.83 to 0.96). In contrast, no difference was observed between urban and rural women (aOR, 1.02; 95% CI, 0.94 to 1.10). Urban patients were more likely to have office-based physician visits in the first year after HF diagnosis (aOR, 1.09; 95% CI, 1.02 to 1.17) and exhibited lower rates of hospitalization (aOR, 0.71; 95% CI, 0.68 to 0.74) and emergency department visits (aOR, 0.62; 95% CI, 0.60 to 0.65) than rural patients.

Conclusions—Even within a universal healthcare system, there are differences in outcomes after HF diagnosis based on location of residence. Urban patients with HF are more likely to receive outpatient care and less likely to be hospitalized or present to the emergency department in the first year after diagnosis than rural patients with HF. (Circ Heart Fail. 2011;4:317-323.)

Key Words: epidemiology ■ heart failure ■ mortality

Historically, differences in health outcomes between urban and rural residents have been documented, particularly for infectious diseases. In the modern era, after exponential economic and technological growth in the 20th century, urban life has offered increased education, employment, income, and access to medical care.1 Yet, urbanization has been associated with higher crude mortality rates compared with rural living in some, but not all, studies.1–6 Furthermore, variation in mortality differences among urban and rural residents has been observed between sex and across age groups.1,3–5 Urban-rural differences in mortality, morbidity, access to care, and cost of care have been studied in several clinical conditions, including diabetes,7–9 prostate cancer,10 stroke,11 mental health,12 and acute myocardial infarction.13

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Persons with heart failure (HF) may be particularly vulnerable to urban-rural differences given that specialized care, which has been shown to optimize outcomes, often is only available (or at least more readily available) in urban settings.14,15 Indeed, access to care may differ substantially between urban and rural residents with HF,16 and it is conceivable that this may result in clinically important differences in health outcomes. Literature comparing outcomes among rural and urban hospitals has shown no difference in length of hospital stay or mortality, but readmissions to the hospital are more frequent in patients with HF discharged from rural hospitals.17 However, whether differences between urban- and rural-dwelling patients exist outside of the
acute care setting and over the longer term is unknown. The objective of the present study was to measure differences in 1-year mortality and utilization of healthcare services (hospital, emergency department, and office-based physician visits) among urban and rural residents with incident HF.

Methods

Population and Setting
A population-based cohort of patients with incident HF was identified between April 1, 1999, and December 31, 2005, using the administrative databases of Alberta Health and Wellness. The province of Alberta, Canada, is a single-payer healthcare system that provides universal access to hospital, emergency department, and physician services and serves a population of >3.5 million. Using a deidentified unique number, health and demographic information were linked for individuals using 5 databases, which have been described previously. G Briefly, the Canadian Institute for Health Information Discharge Abstract Database contains information on hospital admissions and incorporates the most diagnosis and up to 16 secondary diagnostic fields (25 diagnosis fields after 2002); the Alberta Health Care Insurance Plan Registry file contains demographic and vital statistics; the ambulatory care database captures outpatient visits, including emergency department visits; and the physician claims database captures office-based visits. The Alberta Blue Cross medication database captures dispensations claims information for individuals aged ≥65 years. Patients with heart failure were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification, claim code 428.x or International Classification of Diseases, Tenth Revision, claim code 150.x in any diagnostic field within the Discharge Abstract Database, the ambulatory care database, or physician claims between April 1, 1999, and December 31, 2005. G To include incident cases only, patients with an HF claim before April 1, 1999, were excluded. Our washout period extended to 1997 for the ambulatory care database claims, 1994 for physician claims, and 1992 for the Discharge Abstract Database. This study received ethics approval from the Health Ethics Research Board at the University of Alberta.

Outcomes
The primary outcome of interest, defined a priori, was 1-year mortality after an incident HF diagnosis. Secondary outcomes, defined a priori, were 1-year rates of all-cause hospitalizations, cardiovascular-related hospitalizations (online-only Data Supplement), emergency department visits, and office-based physician visits.

Statistical Analysis
Differences in baseline characteristics between urban and rural residents were compared using χ², Student t, and Mann–Whitney tests, where appropriate. Logistic regression was used to evaluate the effect of urban-rural residence on all outcomes. As per the methodology used by Statistics Canada and others, G urban-rural residence effect of urban-rural residence on all outcomes. As per the methodology used by Statistics Canada and others, urban-rural residence was determined using the second character of the forward sortation address for each patient’s home address as reported in the Alberta Health Care Insurance Plan Registry file. We used a multivariable logistic model to adjust for differences between groups. Covariates in the model were age, sex, government subsidy (ie, social assistance), comorbidities present before HF diagnosis (ischemic heart disease, diabetes, cerebrovascular disease, hypertension, valvular disease, arrhythmias, chronic pulmonary disease, neoplasms, dementia, peptic ulcer disease, and renal disease as defined based on all hospital, emergency department, and physician visits for each patient in the year before HF diagnosis), year of HF diagnosis, number of physician visits, and physician specialty (general practitioner, internal medicine specialist or cardiologist, and other specialist) in the year before HF diagnosis. We tested first-order interactions between urban-rural status and age and sex. We included an interaction term in our primary model if P < 0.1. We also used a Poisson regression model to compare the 1-year rates of hospitalization, emergency department, and office-based physician visits between urban and rural patients.

To evaluate the robustness of our study results, we undertook several sensitivity analyses. First, we replicated our primary analyses using Cox proportional hazards models to consider any time-to-event differences. Second, we adjusted for the potential effect of drug therapy on outcomes using drug data from the Alberta Blue Cross database in all subjects aged ≥65 years (prescription data are not available for patients aged <65 years) and focused on angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, β-blockers, spironolactone, digoxin, loop diuretics, amiodarone, warfarin, and statins. We used time-dependent covariates in a Cox proportional hazards model to adjust for those drugs used within the first year after incident HF diagnosis to evaluate the relationship between urban-rural status and all-cause mortality, all-cause hospitalizations, cardiovascular-related hospitalizations, emergency department visits, and outpatient physician visits. Third, we restricted our analyses to only those patients receiving a diagnosis of HF in the hospital. For all hypothesis testing, we used two-sided tests and considered a P < 0.05 as significant. Analyses were conducted using Stata/SE version 11.0 (StataCorp LP, College Station, TX) statistical software.

Results

We identified 72 043 patients with incident HF between April 1, 1999, and December 31, 2005. Mean ± SD age was 72 ± 14, 50% were men, 16,213 (23%) were rural residents, and 55,830 (77%) were urban residents (Table 1). On average, urban patients were older, had more comorbidities present at the time of HF diagnosis, and were more likely to receive special care from either a cardiologist or an internal medicine specialist in the year before the HF diagnosis. Of the 53,612 elderly patients in whom we had prescribing data, >30% were receiving an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker, and nearly 25% were receiving β-blockers at baseline. These proportions increased to 69% and 49%, respectively, within the first year of diagnosis, with urban patients more likely to be receiving these proven-efficacious pharmaceutical HF therapies.

All-Cause Mortality
All-cause mortality at 1-year was higher in urban than in rural residents (17% versus 16%, P < 0.001) (Table 2). Given the higher comorbidity burden in urban patients, after adjustment for demographics and baseline comorbidities, no significant differences were observed for urban compared with rural patients (adjusted odds ratio [aOR], 0.95; 95% CI, 0.90 to 1.00; P = 0.054). However, a significant interaction between sex and location of residence was observed (P = 0.01), indicating that our results were not consistent between men and women. Further evaluation of mortality in men and women separately indicated that although crude mortality in urban men did not differ from rural men, after adjustment for comorbidities, urban men showed a significantly lower risk of mortality than rural men (aOR, 0.89; 95% CI, 0.83 to 0.96; P = 0.002). In contrast, although urban women exhibited a higher crude mortality rate than rural women, similar 1-year mortality rates were observed after adjustment for urban versus rural women (aOR, 1.02; 95% CI, 0.94 to 1.10; P = 0.628) (Figure 1, Table 2). Thus, although overall 1-year mortality was not different between urban and rural patients, evaluation of sex-specific differences indicated that urban men were at lower risk of mortality than rural men.
Table 1. Baseline Characteristics of 72,043 Rural and Urban Residents With Incident Heart Failure, Stratified by Sex

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Overall</th>
<th>Female</th>
<th>Male</th>
<th>Overall</th>
<th>Female</th>
<th>Male</th>
<th>Overall</th>
<th>Female</th>
<th>Male</th>
<th>Overall</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. patients</td>
<td>16,213 (23)</td>
<td>55,830 (77)</td>
<td>&lt;0.01</td>
<td>7,785 (22)</td>
<td>28,165 (78)</td>
<td>&lt;0.01</td>
<td>8,428 (23)</td>
<td>27,665 (77)</td>
<td>&lt;0.01</td>
<td>11,915 (73)</td>
<td>41,697 (75)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Age, y</td>
<td>72.2 (13.6)</td>
<td>72.5 (14.4)</td>
<td>&lt;0.01</td>
<td>73.1 (14.1)</td>
<td>74.2 (14.7)</td>
<td>&lt;0.01</td>
<td>71.3 (13.0)</td>
<td>70.9 (13.9)</td>
<td>0.02</td>
<td>11,915 (73)</td>
<td>41,697 (75)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Age ≥65 y</td>
<td>11,915 (73)</td>
<td>41,697 (75)</td>
<td>&lt;0.01</td>
<td>5,791 (74)</td>
<td>22,042 (78)</td>
<td>&lt;0.01</td>
<td>6,124 (73)</td>
<td>19,665 (71)</td>
<td>0.00</td>
<td>11,915 (73)</td>
<td>41,697 (75)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Location of diagnosis</td>
<td>0.33</td>
<td>0.03</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>5,967 (37)</td>
<td>20,973 (38)</td>
<td>2862 (10,632 (38)</td>
<td>3,105 (37)</td>
<td>10,346 (37)</td>
<td>0.00</td>
<td>5,967 (37)</td>
<td>20,973 (38)</td>
<td>2862 (10,632 (38)</td>
<td>3,105 (37)</td>
<td>10,346 (37)</td>
<td>0.00</td>
</tr>
<tr>
<td>ED</td>
<td>2227 (14)</td>
<td>7514 (13)</td>
<td>992 (13)</td>
<td>3819 (14)</td>
<td>1,235 (15)</td>
<td>3695 (13)</td>
<td>2227 (14)</td>
<td>7514 (13)</td>
<td>992 (13)</td>
<td>3819 (14)</td>
<td>1,235 (15)</td>
<td>3695 (13)</td>
</tr>
<tr>
<td>Ambulatory setting</td>
<td>655 (4)</td>
<td>2201 (4)</td>
<td>976 (2)</td>
<td>1,229 (4)</td>
<td>0.02</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician office</td>
<td>7,364 (45)</td>
<td>25,137 (45)</td>
<td>3655 (17,742 (45)</td>
<td>3,708 (44)</td>
<td>12,395 (45)</td>
<td>0.00</td>
<td>7,364 (45)</td>
<td>25,137 (45)</td>
<td>3655 (17,742 (45)</td>
<td>3,708 (44)</td>
<td>12,395 (45)</td>
<td>0.00</td>
</tr>
<tr>
<td>Office-based physician visits in year before diagnosis, median (IQR)</td>
<td>10 (11)</td>
<td>12 (11)</td>
<td>&lt;0.01</td>
<td>11 (12)</td>
<td>13 (13)</td>
<td>&lt;0.01</td>
<td>10 (11)</td>
<td>12 (11)</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED visits in year before diagnosis, median (IQR)</td>
<td>1 (2)</td>
<td>0 (1)</td>
<td>&lt;0.01</td>
<td>1 (2)</td>
<td>0 (1)</td>
<td>&lt;0.01</td>
<td>1 (2)</td>
<td>0 (1)</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospitalizations in year before diagnosis, median (IQR)</td>
<td>1 (2)</td>
<td>1 (1)</td>
<td>&lt;0.01</td>
<td>1 (2)</td>
<td>1 (1)</td>
<td>&lt;0.01</td>
<td>1 (2)</td>
<td>0 (1)</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government subsidy*</td>
<td>13,500 (83)</td>
<td>43,174 (77)</td>
<td>0.01</td>
<td>6737 (87)</td>
<td>23,151 (82)</td>
<td>&lt;0.01</td>
<td>6763 (80)</td>
<td>20,023 (72)</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as n (%) or mean±SD, unless otherwise indicated. ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CABG, coronary artery bypass graft; ED, emergency department; IQR, interquartile range; PCI, percutaneous coronary intervention.

*Government subsidy includes Provincial Government Alberta Blue Cross Programs.

†All drug types.

‡Seventy-two percent of patients who visited a cardiologist also were seen by an internal medicine specialist.

ACEI or ARB: 4110 (34) 14,782 (35) 0.05 2150 (37) 8148 (37) 0.82 1960 (32) 6634 (34) 0.01

Digoxin: 871 (7) 2898 (7) 0.18 451 (8) 1651 (7) 0.45 420 (7) 1247 (6) 0.15

β-blocker: 2553 (21) 9945 (24) 0.01 1269 (22) 5197 (24) 0.01 1284 (21) 4748 (24) 0.01

Statin: 1652 (14) 6879 (16) 0.01 726 (13) 3218 (15) <0.01 927 (15) 3661 (19) 0.01

Spironolactone: 267 (2) 884 (2) 0.42 137 (2) 522 (2) 0.99 130 (2) 382 (2) 0.16

Loop diuretic: 2271 (19) 7751 (19) 0.25 1161 (20) 4211 (19) 0.11 1110 (18) 3540 (18) 0.84

Amiodarone: 124 (1) 502 (1) 0.14 51 (1) 225 (1) 0.34 73 (1) 277 (1) 0.20

Warfarin: 1264 (11) 4868 (12) 0.01 561 (10) 2502 (11) <0.01 703 (11) 2366 (12) 0.24

Dispensations, median (IQR)†: 8 (9) 8 (9) 0.69 8 (10) 8 (10) 0.21 7 (8) 7 (8) 0.14

Unique drugs, median (IQR)‡: 7 (8) 7 (8) 0.26 7 (8) 7 (8) 0.88 6 (6) 6 (6) 0.01

Visit in year before diagnosis by physician type:

General practitioner: 16,115 (99) 54930 (98) 0.01 7752 (100) 27,868 (99) <0.01 3836 (99) 27,044 (98) <0.01

Specialist, internal medicine: 7743 (48) 37762 (68) 0.01 3350 (43) 18,292 (65) <0.01 4393 (52) 19,470 (70) <0.01

Cardiologist: 3143 (19) 19,627 (35) 0.01 1242 (16) 8536 (30) <0.01 1901 (23) 11,091 (40) <0.01
Table 2. Crude and Adjusted Odds Ratios for 1-Year Outcomes of Urban Residents Compared to Rural Residents

<table>
<thead>
<tr>
<th>1-Year Outcomes</th>
<th>No. Events in Rural Residents (n=16 213)</th>
<th>No. Events in Urban Residents (n=55 930)</th>
<th>Crude OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
<th>Corrected RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>2529 (16)</td>
<td>9644 (17)</td>
<td>1.13 (1.08–1.19)</td>
<td>0.95 (0.90–1.00)</td>
<td>0.96 (0.91–1.00)</td>
</tr>
<tr>
<td>All-cause hospitalization</td>
<td>7352 (43)</td>
<td>21 722 (39)</td>
<td>0.77 (0.74–0.80)</td>
<td>0.71 (0.68–0.74)</td>
<td>0.81 (0.80–0.83)</td>
</tr>
<tr>
<td>CV-related hospitalization</td>
<td>4603 (28)</td>
<td>14 739 (26)</td>
<td>0.9 (0.87–0.94)</td>
<td>0.83 (0.79–0.86)</td>
<td>0.87 (0.84–0.90)</td>
</tr>
<tr>
<td>ED visits</td>
<td>6999 (43)</td>
<td>17 583 (31)</td>
<td>0.61 (0.58–0.63)</td>
<td>0.62 (0.60–0.65)</td>
<td>0.74 (0.72–0.77)</td>
</tr>
<tr>
<td>Office-based physician visits</td>
<td>14 818 (91)</td>
<td>50 794 (91)</td>
<td>0.95 (0.89–1.01)</td>
<td>1.09 (1.02–1.17)</td>
<td>1.01 (1.00–1.01)</td>
</tr>
</tbody>
</table>

Women

| All-cause mortality     | 1089 (14)                               | 4733 (17)                              | 1.24 (1.16–1.33)  | 1.02 (0.94–1.10)     | 1.02 (0.95–1.08)      |
| All-cause hospitalization| 3493 (45)                               | 10 796 (38)                            | 0.76 (0.73–0.80)  | 0.70 (0.66–0.74)     | 0.81 (0.78–0.84)      |
| CV-related hospitalization| 2068 (27)                              | 6986 (25)                              | 0.91 (0.86–0.97)  | 0.83 (0.78–0.88)     | 0.73 (0.83–0.91)      |
| ED visits               | 3341 (43)                               | 8934 (32)                              | 0.62 (0.59–0.65)  | 0.63 (0.60–0.67)     | 0.76 (0.72–0.78)      |
| Office-based physician visits | 7146 (92)                            | 25 628 (91)                            | 0.90 (0.83–0.99)  | 1.06 (0.97–1.17)     | 1.00 (1.00–1.01)      |

Men

| All-cause mortality     | 1440 (17)                               | 4911 (18)                              | 1.05 (0.98–1.12)  | 0.89 (0.83–0.96)     | 0.91 (0.85–0.97)      |
| All-cause hospitalization| 3859 (46)                               | 10 926 (39)                            | 0.77 (0.74–0.81)  | 0.72 (0.69–0.76)     | 0.83 (0.80–0.85)      |
| CV-related hospitalization| 2535 (30)                              | 7753 (28)                              | 0.91 (0.85–0.95)  | 0.83 (0.78–0.88)     | 0.87 (0.84–0.91)      |
| ED visits               | 3658 (43)                               | 8649 (32)                              | 0.59 (0.56–0.62)  | 0.61 (0.58–0.64)     | 0.73 (0.71–0.76)      |
| Office-based physician visits | 7672 (91)                            | 25 166 (91)                            | 0.99 (0.91–1.08)  | 1.12 (1.03–1.23)     | 1.01 (1.00–1.02)      |

Data are presented as n (%) unless otherwise indicated. Covariates included in the adjusted model were age, sex, government subsidy, ischemic heart disease, diabetes, cerebrovascular disease, hypertension, valvular disease, arrhythmias, chronic pulmonary disease, neoplasms, dementia, peptic ulcer disease, renal disease, year of heart failure diagnosis, number of physician visits in the year before heart failure diagnosis, and physician type seen in the year before heart failure diagnosis. Corrected RRs are provided to aid in interpretation because the event rates are relatively common, and therefore, the OR does not approximate the RR. Calculations are based on the formula: \( RR = OR/[(1 - P_0) + (P_0 \times OR)] \), where \( P_0 \) is the event rate in the reference group (rural).22 OR indicates odds ratio; RR, relative risk.

Hospitalizations, Emergency Department Visits, and Physician Visits

Compared with rural patients, urban patients had lower rates of all-cause hospitalizations, cardiovascular-related hospitalizations, and emergency department visits (Table 2). Although total physician visits were similar between urban and rural patients (aOR, 0.95; 95% CI, 0.83 to 1.08; \( P=0.422 \)), urban patients were more likely to have an office-based physician visit (aOR, 1.09; 95% CI, 1.02 to 1.17; \( P=0.001 \)). Similarly, based on Poisson regression, the 1-year rates of hospitalization (adjusted rate ratio [aRR], 0.69; 95% CI, 0.68 to 0.71; \( P<0.001 \)) and emergency department visits (aRR, 0.55; 95% CI, 0.54 to 0.56; \( P<0.001 \)) were lower for urban than for rural patients, and urban patients had higher rates of office-based physician visits (aRR, 1.11; 95% CI, 1.11 to 1.12; \( P<0.001 \)). Unlike the mortality outcomes, no notable sex differences were observed for any of these secondary end points (interaction \( P>0.1 \) for all). Of note, although 76% of urban patients visited a cardiac specialist (cardiologist or internal medicine specialist) within 1 year of HF diagnosis, only 58% of rural patients visited a specialist. However, this finding did not fully account for the observed differences between urban and rural outcomes because incorporating the number of specialist visits in the year after HF diagnosis did not appreciably change the aOR for mortality (aOR, 0.91; 95% CI, 0.85 to 0.96 for urban versus rural men; aOR, 1.02; 95% CI, 0.96 to 1.09 for urban versus rural women).

Sensitivity Analyses

Replicating our primary and secondary analyses using Cox proportional hazards models did not alter our findings. Although crude mortality was higher in urban patients than in
rural patients, after multivariable adjustment, there was no mortality differences between urban and rural patients (adjusted hazard ratio [aHR], 0.95; 95% CI, 0.91 to 1.00). Sex-specific results were consistent with our primary analysis (aHR, 1.02; 95% CI, 0.96 to 1.09 for women; aHR, 0.90; 95% CI, 0.85 to 0.96 for men; P = 0.006 for sex×residence interaction). We also observed consistent results through Cox proportional hazards models for our secondary end points, whereby urban patients had lower rates of all-cause hospitalizations (aHR, 0.76; 95% CI, 0.74 to 0.78; P < 0.001), cardiovascular-related hospitalizations (aHR, 0.85; 95% CI, 0.82 to 0.88; P < 0.001), and emergency department visits (aHR, 0.68; 95% CI, 0.66 to 0.70; P < 0.001) but higher rates of office-based physician visits (aHR, 1.04; 95% CI, 1.02 to 1.06; P < 0.001) than rural patients. In the subgroup of patients aged ≥65 years in whom we had prescribing data, we further adjusted (in addition to the main-effects model) for medication use after HF diagnosis (Figure 2). We used a Cox proportional hazards model with time-varying covariates for medication use, and the results did not alter our findings with respect to all-cause mortality for urban versus rural men (aHR, 0.92; 95% CI, 0.86 to 0.98) or women (aHR, 1.03; 95% CI, 0.96 to 1.11). Cox proportional hazards models with time-varying covariates for medication use for our secondary end points revealed similar patterns as our secondary analyses outlined earlier: Urban patients had lower rates of all-cause hospitalizations (aHR, 0.76; 95% CI, 0.73 to 0.79; P < 0.001), cardiovascular-related hospitalizations (aHR, 0.86; 95% CI, 0.81 to 0.91; P < 0.001), and emergency department visits (aHR, 0.70; 95% CI, 0.67 to 0.73; P < 0.001) but higher rates of office-based physician visits (aHR, 1.06; 95% CI 1.03 to 1.10; P < 0.001) than rural patients. We also adjusted for cardiac procedures (coronary artery bypass graft, percutaneous coronary intervention, pacemaker implantation) in an additional sensitivity analysis, which did not change our results for all-cause mortality in urban versus rural women (aOR, 1.02; 95% CI, 0.94 to 1.10) and men (aOR, 0.89; 95% CI, 0.82 to 0.96). Additionally our results were consistent when the cohort was restricted to only cases identified in the hospital, whereby we observed higher crude mortality among urban patients than among rural patients (6354 [30.3%] versus 1600 [26.8%], respectively; P = 0.05), which disappeared after multivariable risk adjustment (aOR, 1.01; 95% CI, 0.94 to 1.09).

**Discussion**

In our population-based cohort of patients given a new diagnosis of HF and followed in a single-payer healthcare system with universal access to medical services, 1-year mortality was less frequent in men who live in urban areas than in those who live in rural areas; however, this difference was not observed in women. Moreover, urban patients with HF are less likely to be hospitalized or visit emergency departments than rural patients; however, urban patients are
more likely to have office-based physician visits in the year after HF diagnosis.

Our results are consistent with others who have found a higher rate of rehospitalization in patients with HF admitted to rural area hospitals than to urban area hospitals and differences in access to outpatient care between urban and rural residents.17 Because total physician encounters were similar in urban and rural patients in the present data, this finding implies that models of care differ between urban and rural centers. In urban centers, patients are more likely to be seen in physician offices, which may have driven the reduction in emergency department and hospital visits we observed. This notion is supported by several small, randomized controlled trials of outpatient support programs in patients with HF that have previously shown reductions in emergency department visits, hospitalizations, and mortality resulting from more frequent outpatient monitoring.15 Indeed, our findings are consistent with another Canadian study that reported that rural patients with diabetes were more likely to use acute care facilities for diabetes management than urban patients with diabetes.9 Whether the more frequent interactions with office-based physicians in urban centers reflects a lack of access for patients with HF in rural communities or a systematic difference in approach to healthcare delivery cannot be determined from administrative data and requires more detailed qualitative work to explore the reasons underlying the practice pattern differences we observed.

Although we and others have found different pharmacotherapy patterns in rural patients with HF compared with urban patients with HF,16 this finding does not entirely explain the different outcomes for the 2 groups of patients because the outcome differences persisted even after we adjusted for use of HF therapies in a Cox proportional hazards model with time-varying covariates. In addition, others have found that persons living in rural settings are slower to adopt healthy behaviors, such as smoking cessation and screening for chronic disease, than urban dwellers.23,24 Finally, it is also plausible that the type of physician care received by urban and rural patients may differentially affect mortality.14 However, adjustment for the type of physician care received in the year after HF diagnosis did not negate the outcome differences we observed between urban and rural patients with HF.

Limitations
Although the present data are drawn from a single-payer healthcare system with universal access to physician and laboratory services and the results are robust across a variety of sensitivity analyses, there are some limitations to this study. First, the study is an observational cohort design, and despite careful adjustment for multiple covariates, there may still be confounding due to unmeasured factors that may be related to both urban-rural status and the outcomes of interest. However, such an unmeasured confounder or group of confounders with an RR of 5 would have to be present in 20% of rural patients and carry an OR for hospitalization of ≤0.39 to negate the differences we found. Furthermore, our results should not be interpreted as causal in nature but, rather, as an association between location of residence and 1-year outcomes in patients with incident HF. Second, we used the postal code of each patient’s registered address at the time of HF diagnosis to define rural and urban status, and although this is an accepted methodology recommended by Statistics Canada,21 there is a possibility that patients may have moved to seek medical care after diagnosis. Although Statistics Canada data suggest location of primary residence is relatively stable, any such bias introduced through migration patterns into urban settings would have acted to obscure differences between the comparison groups (urban versus rural) rather than create the differential outcome rates we observed. Third, we did not have information on cause of death and, thus, our analyses are based on all-cause mortality. Although this end point is most likely to capture systematic differences in quality of care between urban and rural settings, it should be acknowledged that rural men are more likely to die from injury than urban men, and this may have contributed to the differential mortality rates we observed in men with HF.25,26 Although inpatient International Classification of Disease, Ninth Revision and Tenth Revision, codes for HF are highly accurate,19,20,27 use of a single-physician billing claim for HF in Medicare data may result in a higher rate of false-positive HF diagnoses26; however, it is unlikely that this overestimation would be different between physicians practicing in urban and rural settings and, thus, would not differentially affect the present results. Although the location of initial treatment also may affect outcomes, we did not find any difference in the proportion of urban and rural patients initially diagnosed and treated in the hospital versus the emergency department versus the outpatient clinic.29 Finally, we do not have data on left ventricular ejection fraction and, thus, cannot analyze whether the outcome differences are present for patients with systolic versus diastolic HF; a prospective cohort is being assembled in Alberta to capture data on ejection fraction and various biomarkers and laboratory tests at baseline in all patients receiving a new diagnosis of HF, which will permit future analyses of this issue.

Conclusions
Location of residence is related to the risk of 1-year mortality in men given a new diagnosis of HF, but not in women. Urban patients with HF are more likely to receive outpatient physician care and perhaps as a result, are less likely to be hospitalized and less likely to visit the emergency department than rural patients.

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Disclosures

None.

References


CLINICAL PERSPECTIVE

Patterns of care and outcomes differ for urban versus rural patients with a new diagnosis of heart failure, even in a universal healthcare system. Access to medical care differs between urban and rural residents, but the magnitude of these differences and whether they affect outcomes are unknown. We conducted a population-based cohort study to estimate the association between location of residence (urban-rural status) and 1-year outcomes for patients with incident heart failure. We identified 72,043 patients with a new diagnosis of heart failure between April 1, 1999, and December 31, 2005, who lived in Alberta, Canada, and had universal access to hospital and physician services. The study population had a mean age of 72±14 years, 50% were men, and 55 830 (77%) lived in an urban setting. We found that urban patients had a higher crude 1-year mortality rate than rural patients (17.3% versus 15.6%). However, urban patients showed a higher comorbidity burden, and after risk adjustment, urban men showed a significantly lower risk of 1-year mortality than rural men (adjusted odds ratio [aOR], 0.89; 95% CI, 0.83–0.96), and no difference existed between urban and rural women (aOR, 1.02; 95% CI, 0.94–1.10). Furthermore, urban patients with heart failure are more likely to receive outpatient care (aOR, 1.09; 95% CI, 1.02–1.17) and less likely to be hospitalized (aOR, 0.71; 95% CI, 0.68–0.74) or present to the emergency department (aOR, 0.62; 95% CI, 0.60–0.65) in the first year after diagnosis than rural patients. These differences in outcomes exist even within the context of a universal healthcare system and should alert clinicians and policy-makers to a gap in care among rural and urban settings.
Patterns of Care and Outcomes Differ for Urban Versus Rural Patients With Newly Diagnosed Heart Failure, Even in a Universal Healthcare System

John-Michael Gamble, Dean T. Eurich, Justin A. Ezekowitz, Padma Kaul, Hude Quan and Finlay A. McAlister

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**SUPPLEMENTAL MATERIAL**

Appendix 1. ICD-9 and ICD-10 diagnostic codes (physician, ambulatory, and hospital claims) used to identify cardiovascular-related hospitalizations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Diagnostic Code</th>
</tr>
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<tbody>
<tr>
<td>Myocardial infarction</td>
<td>410.x, I21.x</td>
</tr>
<tr>
<td>Other ischemic heart disease</td>
<td>411.x-414.x, 429.2, V45.81, I20, I22.x-I25.x</td>
</tr>
<tr>
<td>Heart failure</td>
<td>428.x, I50.x</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>362.34, 430.x-438.x, G45.x, G46.x, I61.x-I69.x, H34.0</td>
</tr>
</tbody>
</table>