Relationship Between Avoidable Hospitalizations for Diabetes Mellitus and Income Level

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**Background:** Acute diabetic emergencies are potentially avoidable or amenable to timely and effective outpatient therapy.

**Objective:** To evaluate the relationship between socioeconomic status (SES) and acute complications of diabetes mellitus in Ontario.

**Methods:** We used a population-based cohort of persons with diabetes mellitus (N=605825) derived from hospital and physician service claims between April 1, 1992, and March 31, 1999. Socioeconomic status was estimated using neighborhood-level data from the 1996 Canadian Census. Outcome events were defined as 1 or more hospitalizations or emergency department visits for hyperglycemia or hypoglycemia.

**Results:** There was a clear inverse gradient between income level and event rates. Individuals in the lowest income quintile were 44% more likely to have an event than those in the highest quintile (16.4% vs 11.4%; \( P < .001 \)) and had a greater propensity toward recurrent emergency department admissions (1.9 vs 1.6 episodes per patient; \( P < .001 \)). The gradient was most marked in 45- to 64-year-olds (odds ratio [OR], 1.76; 95% confidence interval [CI], 1.69-1.82) and less apparent in children (OR, 1.06; 95% CI, 0.99-1.13). The relationship between SES and events persisted after adjusting for age, sex, urban vs rural residence, comorbidity, frequency of physician visits, continuity of care, physician specialty, and geographic region (adjusted OR, 1.09 [95% CI, 1.08-1.10] per quintile level). In contrast, admission rates for non-ambulatory care–sensitive conditions (appendicitis and hip fracture) were unaffected by SES.

**Conclusion:** Even when some economic barriers to accessing care are removed, patients from low-SES neighborhoods still experience an excess number of hospitalizations for conditions that should be prevented by optimal care in the ambulatory setting.

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**HERE HAS BEEN increasing attention devoted to understanding social inequalities in access to health care. In the United States, individuals living in low-income areas have considerably higher rates of avoidable hospitalizations (AHs) for diabetes mellitus (DM), asthma, hypertension, and several other chronic diseases.1-3 Diabetes mellitus is the prototype of an ambulatory care–sensitive condition because its management relies heavily on outpatient services, and hospital admissions for hyperglycemia or hypoglycemia are generally preventable in patients receiving good ambulatory care.**

Differences in income can explain up to 50% of the variation in AH rates across neighborhoods in the United States,1 but other factors are clearly important. For example, insurance status is a major confounder because inadequate health care coverage predisposes to poor access to ambulatory care and higher AH rates, independent of socioeconomic indicators.1,5

The Canadian health care system provides insurance coverage for all medically necessary physician, laboratory, and hospital services. However, social disparities in health persist despite universal access to care. As in other countries, there is a strong inverse gradient between income level and mortality from various causes,6,7 in part owing to a higher prevalence of cardiovascular disease, DM, and other conditions in low-income populations. Commensurate with greater health needs, Canadians of lower socioeconomic status (SES) have more frequent primary care visits and hospitalizations, but also reduced access to specialists and specialized services compared with wealthier individuals.6,10 A comparative study2 reported that poor neighborhoods in Canadian cities have hospital admission rates...
for ambulatory care–sensitive conditions that are 1.4 times greater than more affluent areas; however, this gradient is less pronounced than in the United States, where rates may vary by more than 6-fold.

In Canada, the relationship between SES and acute hospital admissions for DM is unknown. Previous studies combined admissions for DM and other conditions as an aggregate outcome and may have been confounded by an excess of disease in lower SES quintiles and other factors known to affect AHS. The purpose of this study is to evaluate the effect of SES on hospital admissions for acute diabetic complications (hyperglycemia and hypoglycemia) using a large database of patients with DM derived from hospital and physician claims data in Ontario. This setting controls for access to care by eliminating the role of health insurance status in the development of these events.

METHODS

We used the Ontario Diabetes Database (ODD), which contains electronic records from administrative data sources, to identify all patients with DM in the province. Creation of the database is described in full elsewhere. Briefly, hospital discharge abstracts prepared by the Canadian Institute for Health Information were used to identify patients admitted to the hospital with a diagnosis of DM based on the presence of an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), code of 250.x on any 1 of 16 diagnostic fields. The Ontario Health Insurance Plan database was used to identify physician service claims for visits coded with a diagnosis of “250,” a modified version of the ICD-9-CM code for DM. Individuals having at least 1 hospitalization or 2 physician service claims for DM within 2 years were included in the ODD. All records for individuals were linked using a reproducibly scrambled unique health care identifier, retaining patient anonymity. The ODD has been demonstrated to have a sensitivity of 86% and a specificity of more than 93% for detecting patients in whom DM was reported in primary care charts.

This study included prevalent cases of DM in the ODD between April 1, 1992, and March 31, 1999. We included individuals who had a valid Ontario postal code and who lived in regions for which census data on household income were available.

The main outcome in this study was the occurrence of at least 1 hospitalization or emergency department (ED) visit for an acute complication of DM. Admissions for hyperglycemic emergencies were identified from hospitalization records that listed diabetic ketoacidosis, hyperosmolar nonketotic coma, or mixed ketoacidosis and hyperglycemic coma (ICD-9-CM codes 250.1-250.3) as the most responsible or primary diagnosis. Admissions for hypoglycemic or insulin coma (ICD-9-CM code 251.0) were identified from hospitalization records using the same criteria. Emergency department visits were derived from physician service claims in which the diagnostic code was 250 or 251 and the visit occurred in an ED. Unlike hospital discharge abstracts, these claims only allow the reporting of a single diagnostic code.

The principal predictor variable was SES. In Ontario, personal income is not available in administrative data sources. Therefore, income level for individuals in the ODD was estimated from neighborhood-level data collected in the 1996 Canadian Census, using a validated algorithm. Each neighborhood in Ontario, representing a census enumeration area (average population ~700), was divided into 5 categories based on median household income, which ranged from Can $7680 to Can $39852 in the lowest quintile (Q1) up to Can $70512 to Can $304454 in the highest quintile (Q5). Income quintiles were then assigned to individual patients in the ODD by linking the 2 databases using the patient’s postal code as a common identifier. Income data for 17% of the 13401 enumeration areas in Ontario were suppressed by Statistics Canada because of small sample size. As a conservative measure, individuals living in enumeration areas that lacked income data (n=3101 or 0.5% of the sample) were assigned to the middle quintile (Q3). This approach would trend to minimize income-related differences, particularly since individuals with DM are overrepresented in the lower SES categories. In contrast, income data were missing for only 2% of forward sortation areas, larger regions corresponding to the first 3 digits of the postal code. Therefore, the analysis was repeated using quintiles based on median household income for each forward sortation area.

The main analysis was a comparison of the proportion of individuals who had an acute event (≥1 hospitalization or ED visit for hyperglycemia or hypoglycemia) across income quintiles using a χ² analysis. Logistic regression was used to adjust for the following factors: age, sex, comorbidity, type of residential area (urban vs rural, based on definitions used by Canada Post), geographic region of the province, and ambulatory care use. Ambulatory measures were derived from physician service claims for visits occurring during the year before the index date, regardless of the date of entry into the ODD. The following variables were included: number of primary care office visits, presence of a usual care provider (≥50% of ambulatory visits to a single primary care physician), and provision of DM care by a specialist, defined as at least 1 physician service claim submitted by an endocrinologist, general internist, or pediatrician in the preceding year for which the diagnostic code was 250. To derive ambulatory measures for individuals who were event free, the index date was defined as the midpoint of their duration in the DM database. A sensitivity analysis revealed that choosing an earlier index date (such as in the first year of entry into the database) did not alter the results of this analysis. Case-mix adjustment was performed using the Johns Hopkins Ambulatory Care Groups assignment software (Sparc/Solaris version 4.52; Sun Microsystems Inc, Santa Clara, Calif), Clinical details, such as case severity and type of therapy, are not available in administrative data sources and therefore were not included in the model.

As a control, we evaluated the effect of SES on nonavoidable hospitalizations in people with DM by comparing the proportion of individuals in the ODD 65 years and older who were admitted for hip fracture (ICD-9-CM codes 820.0-820.9) with the proportion of those younger than 65 years who were admitted for appendicitis (ICD-9-CM codes 540.0-541.0) in each quintile during the same period.

RESULTS

There were 611404 prevalent cases of DM identified in the ODD between April 1, 1992, and March 30, 1999. Of these, 605825 individuals had an Ontario postal code for which census data were available. Characteristics of individuals in the highest and lowest SES groups are compared in Table 1. There were considerably more people with DM in the lowest than in the highest income category. Patients in the highest quintile were somewhat younger and less likely to live in rural or remote areas of the province than those in the lowest quintile. However, measures of comorbidity and ambulatory care use were comparable across all economic strata. Annual out-
Patient visit rates were high across all groups, yet more than one tenth of the people with DM in the province did not see a primary care physician in the preceding year.

Overall, 14% of individuals (n=87,425) had at least 1 hospitalization (total number of admissions=43,440) or ED visit (total number of episodes=184,646 [157,550 ED visits only and 27,096 that led to hospitalization]) for hyperglycemia or hypoglycemia during the 7 study years. In most cases, the reason for hospital admission was hyperglycemia (94%), with most of these due to diabetic ketoacidosis (36%) or mixed cases of hyperglycemic coma with acidosis (56%). Emergency department visits followed a similar pattern. From the main analysis, there was a clear inverse gradient between income level and event rates (Table 2). Individuals in the lowest income quintile were 44% more likely to have an event than individuals in the highest quintile (16.4% vs 11.4%; P<.001). Fewer events occurred in patients with more primary care visits (2.7% [95% CI, 2.6%-2.8%] lower for each additional visit per year), a usual primary care provider (22% vs 13%; P<.001), and provision of DM care by a specialist in the preceding year (15% vs 11%; P<.001).

The gradient in event rates was most marked in the 45- to 64-year age group and was less apparent in children (Table 3). Low income was also associated with a relatively greater risk in rural than in urban settings (odds ratio, 1.60 [95% CI, 1.50-1.70] vs 1.37 [95% CI, 1.34-1.40]). Interactions between income and age and between income and rural vs urban residence were significant (P<.001 for each analysis); however, SES continued to exert an independent effect on event rates after adjusting for both.

On multivariate analysis, all of these factors remained strongly associated with the likelihood of requiring either admission to the hospital or an ED visit for an acute complication of DM. Similarly, the relationship between SES and event rates persisted after adjusting for age, sex, urban vs rural residence, comorbidity, frequency of physician visits, continuity of care, physician specialty, and geographic region (adjusted odds ratio, 1.09 [95% CI, 1.08-1.10] per decline in income quintile) (Table 4). Individuals in the lowest income quintile also had a greater propensity toward recurrent ED visits than those in the highest quintile (1.9 vs 1.6 episodes per patient; 0.00)

### Table 1. Baseline Characteristics of Patients in the Ontario Diabetes Database

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Patients (N = 605,825)</th>
<th>Lowest (Q1) (n = 155,475)</th>
<th>Highest (Q5) (n = 86,264)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of patients, %</td>
<td>100</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>Age, mean, y</td>
<td>58.8</td>
<td>59.1</td>
<td>56.0</td>
</tr>
<tr>
<td>Male, %</td>
<td>52</td>
<td>50</td>
<td>54</td>
</tr>
<tr>
<td>Rural, %</td>
<td>18</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>Remote region, %</td>
<td>9</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Usual care provider, %</td>
<td>86</td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td>No visits in the past year, %</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Seen by a specialist in the previous year, %</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Primary care visits per year, median, No.</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 2. Socioeconomic Gradient in Acute Events

<table>
<thead>
<tr>
<th>Income Quintile (Median Income, Can $)</th>
<th>ED Visit or Hospitalization (n = 184,646)</th>
<th>ED Visit Only (n = 157,550)</th>
<th>Hospitalization (n = 43,440)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (7,680-39,852)</td>
<td>1.43 (1.40-1.46)</td>
<td>1.31 (1.27-1.34)</td>
<td>1.20 (1.14-1.26)</td>
</tr>
<tr>
<td>2 (39,852-49,734)</td>
<td>1.32 (1.29-1.35)</td>
<td>1.26 (1.23-1.30)</td>
<td>1.13 (1.07-1.19)</td>
</tr>
<tr>
<td>3 (49,736-57,852)</td>
<td>1.29 (1.26-1.32)</td>
<td>1.14 (1.11-1.17)</td>
<td>1.11 (1.05-1.17)</td>
</tr>
<tr>
<td>4 (57,862-70,494)</td>
<td>1.13 (1.11-1.16)</td>
<td>1.04 (1.02-1.08)</td>
<td>1.11 (1.05-1.17)</td>
</tr>
<tr>
<td>5 (70,512-304,454)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; ED, emergency department; OR, odds ratio.
null
In summary, despite universal access to health care in Ontario, we found that patients with DM from low-SES neighborhoods experience an excess of complications that should be prevented by optimal ambulatory care. Several measures could reduce the gradient in AH rates based on income. Although out-of-pocket expenses are not the only contributing factor, development of programs to subsidize the cost of expensive medications and monitoring supplies would likely diminish the variation in rates across socioeconomic strata. Furthermore, widened exposure to DM education programs that are accessible to people from a variety of cultural and educational backgrounds may also reduce admissions by improving motivation and adherence.

Even if access to care was equivalent across SES groups, income-related disparities in health might persist. Careful study is needed to elicit the underlying causes of this gradient, with attention devoted to individual and regional factors. Physicians should be aware that vulnerable groups carry a greater risk of AH and should obtain additional support from DM educators, social workers, and other health professionals and consider early referral to a DM specialist for such patients. If event rates in the entire diabetic population in Ontario were equivalent to those in the highest SES group, then as many as 40,000 episodes might have been avoided during the 7-year observation period. Thus, strategies to prevent acute complications may not only reduce the burden of illness among vulnerable groups but may lead to an appreciable cost savings to the health care system.

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REFERENCES

6. Roos NP, Mustard CA. Variation in health and health care use by socioeconomic...
status in Winnipeg, Canada: does the system work well? yes and no. Milbank Q. 1997;75:89-111.