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Original Research

Geographic Clustering of Acute Complications and Sociodemographic Factors in Adults with Type 1 Diabetes

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ABSTRACT

Objectives: To assess the geographic distribution of acute complications in patients with type 1 diabetes in a large urban centre; and to assess the association between acute complications and community-level sociodemographic factors.

Methods: Adults (aged ≥ 18 years old) with type 1 diabetes and acute complications were identified between 2004 and 2008 by using a diabetes centre clinical database or discharge abstracts for acute complications (diabetic ketoacidosis or hypoglycemia). Using a geographic information system, hot-spot analysis was used to identify spatial clusters of acute complications in a large urban centre. The association between acute complications and community-level sociodemographic factors were assessed by Spearman rank correlation.

Results: We identified 1779 patients with type 1 diabetes, of whom 456 had been hospitalized for acute complications. The mean age of patients was 40.9 ± 16.0 years, and men were more likely to have acute complications (59.2% vs. 52.3%; $p < 0.01$). Spatial clusters of high values and low values were identified. Higher median family income ($r = -0.36$; $p < 0.0001$) and higher education levels ($r = -0.30$; $p < 0.0001$) were associated with lower rates of acute complications.

Conclusions: This study demonstrated geographic clusters of hospitalizations for acute complications and important community sociodemographic factors. Prevention strategies and interventions targeting these geographic and sociodemographic disparities need to be explored as a means of minimizing hospitalizations for acute complications.

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R É S U M É

Mots clés :

complications à court terme

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acidocétose diabétique

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Objectifs : Évaluer la répartition géographique des complications à court terme chez les patients atteints du diabète de type 1 d'une grande agglomération urbaine et évaluer l'association entre les complications à court terme et les facteurs sociodémographiques à l'échelle communautaire.

Méthodes : Des adultes (≥ 18 ans) atteints du diabète de type 1 qui ont eu des complications à court terme ont été identifiés entre 2004 et 2008 à partir d'une banque de données cliniques d'un centre du diabète ou de résumés de sorties d'hôpital à la suite de complications à court terme (acidocétose diabétique ou hypoglycémie). À l'aide d'un système d'information géographique, une analyse de points chauds a été utilisée pour déterminer les agrégats spatiaux des complications à court terme d'une grande agglomération urbaine. L'association entre les complications à court terme et les facteurs sociodémographiques à l'échelle communautaire a été évaluée par le coefficient de corrélation de rangs, appelé le coefficient de Spearman.

Résultats : Nous avons relevé 1779 patients atteints du diabète de type 1, dont 456 ont été hospitalisés à la suite de complications à court terme. L'âge moyen des patients était de $40,9 \pm 16,0$ ans, et les hommes étaient plus susceptibles de souffrir de complications à court terme (59,2 % vs 52,3 %; $p < 0,01$). Les agrégats spatiaux de valeurs élevées et de valeurs faibles ont été déterminés. Le revenu familial médian le plus élevé ($r = -0,36$; $p < 0,0001$) et les niveaux de scolarité les plus élevés ($r = -0,30$; $p < 0,0001$) ont été associés à des taux plus faibles de complications à court terme.

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Conclusions : Cette étude a démontré les agrégats géographiques d'hospitalisations à la suite de complications à court terme et les facteurs sociodémographiques importants à l'échelle communautaire. Les stratégies de prévention et les interventions qui visent ces disparités géographiques et sociodémographiques doivent être explorées comme moyen de minimiser les hospitalisations liées aux complications à court terme.

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Introduction

Acute metabolic complications of type 1 diabetes, such as diabetic ketoacidosis (DKA) and hypoglycemia, are associated with significant morbidity and account for one-third of all deaths in patients younger than 40 years of age (1–4). Furthermore, DKA and hypoglycemia are associated with high healthcare utilization and costs; DKA hospitalizations are estimated to account for approximately 25% of direct medical charges in adults with type 1 diabetes (5–9).

There are a number of clinical factors that are associated with the development of acute complications. They include glycemic control, duration of diabetes, knowledge of insulin adjustment and precipitating factors, such as inappropriate insulin doses, infection, acute illness, trauma and alcohol use (4,10–13). However, we lack information about the geographic and sociodemographic factors associated with acute complications in patients with type 1 diabetes (14–16). Geographic and sociodemographic determinants of complications have been identified in patients with type 2 diabetes (14,17), although research to date concerning the geographic determinants in diabetes outcomes has focused on rural and urban comparisons. Geographic and sociodemographic disparities in health outcomes are always concerning and can signal communities that are not adequately resourced to provide preventive healthcare services (such as diabetes education) or that these services are not appropriately accessed by community members. We sought to explore 1) the geographic distribution of patients with hospitalizations for acute complications and 2) the association of acute complications with community-level sociodemographic factors in adult patients with type 1 diabetes.

Methods

Study population

The study population consisted of adults (≥ 18 years old) with type 1 diabetes who were residents of Calgary, Alberta (population ~1.1 million) and had valid Personal Health Numbers (PHNs) (18). Those with valid PHNs are a part of Alberta's universal healthcare system, which provides full coverage for physician care, allied diabetes health professionals and emergency and hospital care. Patients with type 1 diabetes were identified by using an established diabetes centre clinical database or discharge abstracts with codes indicating the occurrence of acute complications. The diabetes centres' clinical database has been used since 2003, both clinically and for diabetes research studies (13,19). The study period took place between January 1, 2004, and September 30, 2008. This period was chosen because there were 2 centrally located comprehensive diabetes centres in Calgary during that time. Thereafter, there were a number of changes in outpatient diabetes care; the main diabetes centre moved to a different location, additional outpatient diabetes centres opened and more individual physicians' offices (family physicians and specialists) included diabetes healthcare professionals in their respective offices.

Data sources and linkage

We merged 3 data sources to identify our study population and exposures. These data sources included the following.

Alberta inpatient discharge abstract database

All inpatient separation abstracts in Alberta (by discharge or death) are filed with the Canadian Institute for Health Information. Coders review inpatient charts and extract data, including PHNs, patient demographics, diagnoses and interventions. All permanent residents are covered by their provincial health insurance plan except for Registered First Nations people, members of the military and the Royal Mounted Police and prison inmates, who are the responsibility of the federal government. All eligible Alberta residents are assigned a unique lifetime PHN, which is an ideal variable to use in performing record linkage. Hospitalizations for acute complications were identified using the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada (ICD-10-CA v. 2003 and v. 2006). The ICD-10-CA codes for DKA hospitalization include E10.100, E10.101, E10.120, E10.121, E10.10 and E10.12, and for hypoglycemia hospitalization, they include E10.63, E10.630, E10.631, E10.632, E10.633, E10.634 and E10.639. For patients with repeated hospitalizations, only the first hospitalization was used.

Diabetes, hypertension and cholesterol centre (DHCC) database

During the study period, there were 2 publicly funded interdisciplinary diabetes centres for adults in this urban health region (catchment 1.1 million) (20). All patients who received diabetes care or education at these centres have been recorded in a clinical database since 2003. Data collected include patient demographics (date of birth, PHN, address with postal code) and type of diabetes.

Statistics Canada 2006 census data

Statistics Canada 2006 Census data were used for median household income, education level (proportion of subjects with a university degree, diploma or certificate) and proportion of residents who are visible minorities per census area. Statistics Canada uses the *Employment Equity Act* to define visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour" (21). Census data at the community area level were used for this study (22). These community areas were defined by the city of Calgary and were used as proxies for individual-level sociodemographic data.

Data linkage

Linkages were based on PHNs (for clinical data) and postal codes (for census data). Each patient record was geocoded to residential location, using the Postal Code Conversion File within Esri ArcGIS 10.0 (Redlands, California, United States) (23). Patient residential postal code data from the administrative databases was linked to the census data based on a spatial join within ArcGIS.

Statistical analysis

Descriptive characteristics of patients with and without hospitalizations were compared by using t tests for continuous variables and chi-square tests for categorical variables after ensuring that the assumptions of each test were met. The association between hospitalization for acute complications and sociodemographic factors by community area were assessed by Spearman rank correlation because data were not normally distributed. Statistical analyses were performed using STATA software v.11.1 (StataCorp, College Station, Texas, United States).

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