Trends in prevalence, incidence and pharmacologic management of diabetes among seniors newly admitted to long-term care facilities in Saskatchewan between 2003 and 2011

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Abstract

Objective: We aimed to describe trends in the prevalence and incidence of diabetes and also report the overall use of diabetes medications among patients newly admitted to long term facilities (LTCFs). **Methods:** A retrospective cohort study using health-administrative databases in Saskatchewan. Eligible patients were newly admitted to LTCF in Saskatchewan between 2003 and 2011 and maintained LTCF residency for at least six months. Prevalence of diabetes was defined with physician or hospital claims in the two years preceding admission. Antihyperglycemic medication use was estimated from prescription claims data during the first six months following LTCF admission. All data were descriptively analyzed. **Results:** The validated case-definition for diabetes (≥ 2 diagnostic claims) in the two-years before or six-months after admission was met in 16.9% (2,471/14,624) of patients. An additional 965 patients (6.6%) had a single diabetes diagnostic claim or antihyperglycemic prescriptions only. Among patients receiving antihyperglycemic therapies, 64.9% (1,518/2,338) were exclusively managed with oral medications and metformin was the most commonly used medication. Glyburide was commonly withdrawn after LTCF admission. Insulin use was observed in 23.9% of diabetes patients for a mean daily average consumption of 54.7 units/day. **Conclusion:** use of diabetes medications appear to generally align with Canadian practice recommendations as evidenced by declining use of glyburide and frequent use of metformin. Future studies should examine clinical benefits and safety of hypoglycemic agent use in LTCFs.

Keywords: Long term care, elderly, longitudinal trend, antihyperglycemic agents.

Introduction

The prevalence of diabetes mellitus has increased substantially over the past two decades, and elderly patients are most commonly affected. Almost 1 in every 3 Canadians (23-29%) aged 75 to 79 have been diagnosed with diabetes and many more may have impaired glucose tolerance or undiagnosed disease.[1] The 2013 Canadian Diabetes Association (CDA) guidelines advocate for an individualized approach to diabetes management among elderly patients.[2] Diabetes medications can cause hypoglycemia, especially among frail elderly patients residing in long term care facilities (LTCF); thus, management of many elderly patients requires lower treatment intensity to ensure patient safety. Also, medications such as glyburide[3,4,5] and insulin have been associated with a substantially increased risk for hypoglycemia.[6,7] Both of these medications should be used cautiously among elderly patients residing in LTCF because the level of frailty observed in these institutions is typically high.

Despite the rising prevalence and high risks for adverse events among frail elderly, the literature describing diabetes epidemiology and management among residents of Canadian LTCFs is limited. In the province of Saskatchewan, diabetes prevalence was found to range from 21% to 25%, depending on data source.[8] A lower prevalence of 17% was reported in a survey of five LTCFs in the province of British Columbia (BC).[9] While it is expected that the prevalence of diabetes in LTCFs is increasing corresponding to community-based estimates, time-trends of diabetes in Canadian LTCFs have not been examined previously.

A systematic review of 20 studies with a total sample of 779,707 LTCF residents outside of Canada reported a mean prevalence of diabetes to be 18.5%.[10] In this systematic review, only 16% of residents with diabetes were managed with oral medications alone (i.e., without insulin), while 39% received insulin (alone or in combination with oral antihyperglycemics), and almost

half received no antihyperglycemic therapy at all.[10] These findings may have been confounded by the use of survey methods rather than electronic databases in the majority of studies examined; certainly, the low rate of oral antihyperglycemic use would not be expected in a Canadian LTCF. In contrast, a small Canadian survey of a LTCF reported the use of oral agents without insulin in 30% of residents, whereas insulin use was estimated as 45%.[9] However, the data were not confirmed by electronic prescription records and no information was available to characterize the intensity of insulin therapy used in this small sample.

The aim of our study was to describe trends in the prevalence and incidence of diabetes among patients newly admitted to LTCFs in the province of Saskatchewan between 2003 and 2011, and to also describe the overall use of diabetes medications following LTCF admission.

Methods

Data source

This study was based on information derived from health-administrative databases from the province of Saskatchewan, Canada. Provincial government health care benefits cover approximately 99% of all residents in Saskatchewan. Excluded individuals are those covered by the federal government such as the Royal Canadian Mounted Police, Canadian Armed Forces, and inmates in federal penitentiaries.[11] Data from the Institutional Care Home (ISCH) database, prescription drug database, as well as person registry were electronically linked at the individual level to perform this study. The ISCH database includes dates of LTCF admission and discharge along with LTCF characteristics. The prescription drug database includes all provincial formulary prescription medications dispensed to beneficiaries who are outpatients or residents of most LTCFs in the province. Prescription medications dispensed for registered First Nation

residents, who represent almost 9% of the population, are not included because their prescriptions are paid through federal government benefits. Each prescription medication record includes the date of dispensation and national drug identification number (DIN) as well as quantity dispensed. The person registry database includes dates of health insurance coverage, and demographic information such as date of birth, date of death, gender, marital status and location of residence. Numerous studies have demonstrated the accurateness and comprehensiveness of Saskatchewan's administrative health data for research.[12-14]

Ethics approval for database access was obtained from the University of Saskatchewan Biomedical Research Ethics Board (Bio-REB # 12-354).

Study cohort

We identified a cohort of individuals ≥ 60 years of age who were newly admitted to a LTCF in Saskatchewan between Jan 1st, 2003 and Dec 31st, 2011. A new admission was defined as no LTCF admission in the two years preceding the index LTCF admission; thus, individuals must have been receiving provincial health benefits during this period. Also, individuals must have remained in a LTCF continuously for at least six months following the initial admission. Transferring from one facility to another during this follow-up period was allowed if the difference between a LTCF discharge date and a subsequent admission was < 2 days.

Identification of patients with diabetes

Prevalent diabetes was identified using the Canadian Chronic Disease Surveillance System definition (i.e., ≥ 2 claims in the physician services file or ≥ 1 hospital discharge with a diagnosis of diabetes) within two years preceding LTCF admission.[15] An alternate case definition that required only 1 physician claim or ≥ 1 claim for a diabetes medication,[16] was also

adopted, because elderly patients with longstanding diabetes may be less likely to receive a diagnostic claim for diabetes within a two-year period preceding LTCF admission. Incident cases of diabetes were identified during 180 days (6 months) following LTCF admission among those who were free of diabetes upon admission to LTCF. Diabetes diagnostic codes included ICD9=250.X from physician-claims data or ICD10/ICD10-CA= E10 - E14.X from hospital discharge data in any diagnostic field.

Antihyperglycemic medication use

Dispensations for diabetes medications were recorded during the first six months of LTCF admission among all prevalent or incident cases of diabetes. The following types of medications were identified: (a) oral medications only, (b) insulin only, and (c) combination of oral medication and insulin. Insulin was further stratified into rapid-acting insulin (lispro, aspart, and glulisine), short-acting insulin (regular insulin), intermediate-acting insulin (isophane or NPH), and long–acting insulin (glargine, and detemir). Oral diabetes medications were further stratified into the following categories: (a) metformin, (b) acarbose, (c) sulfonylureas (including gliclazide and glyburide), (d) thiazolidediones (TZDs) including rosiglitazone (either alone or in combination with metformin), and pioglitazone, and (e) meglitinides (including repaglinide and nateglinide). Other sulfonylureas including tolbutamide or chlorpropamide were excluded from analysis because fewer than five claims were made during the study period. Other medications such as the glucagon-like peptide-1 (GLP-1) agonists and dipeptidyl peptidase-4 (DPP-4) inhibitors were not benefit formulary medications during the defined study period so no claims for these agents were recorded.

In a subgroup analysis, prevalent glyburide users (defined with at least one dispensation of glyburide in the six months prior to LTCF admission) were examined to determine if this

medication was frequently discontinued in the LTCF setting. Discontinuation was assumed if no glyburide dispensations were recorded in the six months following LTCF admission among prevalent users. In a sensitivity analysis, we expanded the definition of discontinuation to include individuals with only one glyburide dispensation occurring within 30 days of LTCF admission but not thereafter.

For individuals receiving at least one dispensation for insulin following LTCF admission, doses for each individual were estimated using the daily average consumption (DACON) approach.[16,17] Specifically, DACON was calculated by summing all insulin units dispensed from the first to the second-last insulin dispensation during the first six months of LTCF residence, divided by the number of days between the first and last dispensation. For individuals with only one insulin claim, the total insulin units dispensed in this dispensation was divided by the time elapsing from first insulin prescription to the end of follow up (180 days after LTCF admission). In a sensitivity analysis, individuals with only one insulin prescription were excluded from the calculation.

Statistical analysis

Data were descriptively analyzed using means, medians, standard deviations, frequencies and percentages. We used student's t-test to compare means in continuous variables. All analyses were stratified by calendar year of LTCF admission.

Results

A total of 44,846 individuals were admitted to a LTCF between January 1, 2003 and December 31, 2011. Among these, 14,624 (32.6%) were at least 60 years of age on admission,

remained in a LTCF for at least six months, were covered under the provincial health plan for at least 2 years prior to admission without any LTCF admissions during this period (Figure 1). The mean age of individuals on their index admission date was 84.1 years (median=85, SD=7.9) and 64.4% were female.

Prevalence and incidence of diabetes

A total of 2,340 new LTCF residents (16.0%) satisfied the CCDSS criteria for diabetes (i.e., at least 2 outpatient claims or 1 inpatient claim) in the preceding two years. An additional 527 patients (3.6%) had received a single outpatient diabetes claim and 217 (1.5%) received a diabetes medication without an associated diabetes diagnosis in the previous two years. Among those without diabetes in the previous two years, only 131 (0.9% of total cohort) were considered to have diabetes using two recorded claims within the 6 month follow-up period. An additional 221 (1.5%) received a diabetes medication or a single diagnostic claim. In total, the validated CCDS definition of diabetes (both incident and prevalent cases) was satisfied by 16.9% (n=2,471) of patients. A total of 3,436 patients (23.5%) were classified as having diagnosed diabetes using the alternate case definition. The mean age of this sub-cohort was 82.1 (median=83, SD=7.8) and 57.5% were female (Table 1). Between 2003 and 2011, an increase in crude prevalence (but not in incidence) of diabetes among subjects newly admitted to LTCF was observed (Figure 2). Prevalence and incidence estimates did not change when we expanded inclusion to include also individual who remained in a LTCF for at least two months in a sensitivity analysis (total n=19,583). For example, in this case (3,332, 16.8%) satisfied CCDSS criteria for diabetes prevalence, while (170, 0.9%) satisfied this definition among individuals who were free from diabetes upon LTCF admission.

Diabetes medication use

Two thirds (68.0%; 2,338/3,463) of patients meeting the expanded diabetes case-definition received an antihyperglycemic medication within six months of admission. The percentage of patients who received diabetes medications remained stable over time and the vast majority (88.0%) had also received diabetes medications before admission.

The majority of patients receiving diabetes treatments were managed on oral medications exclusively (64.9%; 1,518/2,338), while 20.4% received insulin alone, and 14.7% received both oral agents and insulin. Metformin was the most commonly dispensed diabetes medication during the first six months following LTCF admission, accounting for 43.3% of the 17,226 diabetes medications dispensed and 66.9% of the patients using diabetes medications. Insulin was the second-most common medication with 28.8% of all dispensations and was used in over one-third of patients (35.1%; 820/2,338). Sulfonylureas accounted for 18.8% of all dispensations while TZD medications (6.1%), meglitinides (2.5%), and acarbose (0.5%) were used less frequently. Although the use of TZDs doubled between 2003 and 2006, it declined thereafter to approximately 3.0% of all diabetic medications in 2011(Figure 3).

Use of glyburide

Glyburide was the most frequently dispensed sulfonylurea (80.6%) followed by gliclazide (19.4%). However, gliclazide was not a formulary benefit in the provincial drug plan until January 1, 2009. Gliclazide has overtaken glyburide as the most commonly dispensed sulfonylurea among newly admitted residents of LTCF beginning late 2008. (Figure 4). In 2011, gliclazide dispensations represented 59.3% of all sulfonylurea dispensations.

Of the 749 participants with at least one dispensation for glyburide within six months prior to LTCF admission, one third (33.8%) received no glyburide in the six-month follow-up. Further, nearly half (49.5%) of glyburide users received only a single dispensation of glyburide within 30 days of admission but none thereafter. Combining these groups, it appears that glyburide is commonly withdrawn soon after admission to a Saskatchewan LTCF (Figure 5). Overall, only 16.8% (125/749) of individuals continued to receive glyburide beyond the first month of LTCF residence. Among individuals who discontinued glyburide, 148 (23.7%) received at least one dispensation of insulin within the six months post LTCF admission, whereas 23 (3.7%) received at least one dispensation of gliclazide.

Insulin use

The vast majority of insulin dispensed within six months after LTCFs admission was for intermediate-acting insulin (isophane) (38.7%), for short-acting (regular) insulin (23.6%) or for the combination of both (30%). Other types of insulin were rarely used and accounted for only 7.7% of insulin dispensations. The mean DACON among all 820 individuals (23.9% of all diabetes patients) who had at least one dispensation of insulin in the follow-up period was 52.1 units/day (median=43.9, SD=56.2, and inter-quartile range (IQR) 28.6 to 62.5). This estimate was unchanged when excluding the 88 individuals (10.7%) who had one insulin dispensation only. Over the study period the mean DACON of insulin fluctuated, and no clear trends were observed from 2003 to 2011. The mean DACON among individuals who were using insulin alone was (54.8 units/day), and it was not statistically different (student's t-test =0.45) from individuals using insulin in combination with oral medications (48.4 units/day).

Discussion

We conducted a descriptive analysis of diabetes prevalence and incidence along with diabetic medication use among a cohort of residents newly admitted to LTCFs in Saskatchewan between 2003 and 2011. Using the CCDSS definition of diabetes, the total number of cases (i.e., incident and prevalent cases) equaled 16.9% of all new admissions to LTCF. However, using a more sensitive definition (i.e., accepting a single diagnostic claim or an antihyperglycemic dispensation), the estimated diabetes burden increases to 23.5%. Favourable trends in oral medications that corresponds to CDA guidelines were generally observed.[2] Metformin was the most frequently used antihyperglycemic medication while glyburide was frequently discontinued and TZDs use declined. Insulin was the second most commonly dispensed agent for individuals newly admitted to a LTCF. One out of four insulin users received less than 29 units per day while three-quarters received less than 63 units per day. The estimated total daily consumption did not differ between those using oral agents concurrently versus those receiving insulin alone.

The growing prevalence of diabetes among LTCF populations will undoubtedly impact resource-allocation for the care of this vulnerable population.[18] However, the medication-use trends observed in Saskatchewan are encouraging. The most widely used agent, metformin, is the drug of choice for most patients with type 2 diabetes due to its evidence for reducing major consequences of diabetes along with its low risk for hypoglycemia and weight gain.[3,4,5] Also, the declining use of glyburide should translate into lower risks for hypoglycemia; and the declining use of TZD is expected to reduce the risk of fractures among LTCF residents.[19] Also, the decline of TZD is in alliance with the Health Canada warning regarding the association between rosiglitazone use and adverse cardiovascular outcomes such as heart failure.[20] Insulin use was difficult to evaluate due to the complex factors underlying its use. Although insulin dosing

appeared low to moderate on average, information on glycated hemoglobin and blood glucose were unavailable to assess appropriateness of dosing. Regardless, estimates of insulin consumption have not been previously carried out in LTCF settings at the population level.

The data used in our study encompass all residents newly admitted to LTCFs over an extended period of time in the province of Saskatchewan. Additionally, the validity of diabetes diagnosis in our data was shown to be high.[15] However, several limitations can be noted in our study. First, in spite of using extended definition of diabetes cases, our results may in fact underestimate the prevalence and incidence of diabetes. This may be due to the scarcity of universal protocols for diabetes identification in LTCFs in Canada.[9] Also, antihyperglycemic medication use was estimated by adjudicated claims in the prescription drug file during the first six months following LTCF admission. Thus, we may have overestimated antihyperglycemic medication use if medications were dispensed but not consumed by patients. Another possible source of inaccuracy might be from individuals who receive diabetes medications that are not a benefit in the provincial drug plan or receiving insulin without a prescription and thus, not captured by adjudicated claims file. In addition, some diabetes medications included in this study, such as rapid-acting insulin and meglitinides are only available for restricted provincial drug benefits under the Exception Drug Status (EDS) program. Prescriptions for these drugs are included in the database when EDS has been requested and approved for a particular patient. Although access to non-adjudicated claims will reduce the potential for misclassification, it is not expected to change these estimates substantially. Second, all trends have been reported without adjustment for differences in age and sex that may occur from year to year. However, considering the advanced age of all individuals in the cohort, it is expected that adjustment has little impact on the overall comparison over time. Third, the insulin DACON was calculated by

summing all insulin units using reported quantities in the prescription files. Because insulin pen fill is supplied as packages of 5 cartridges of 300 I.U. each, a source of inaccuracy may arise from quantities of partial packages refills. However, it is expected that partial insulin refills are uncommon. Finally, all observations were purely descriptive and do not take into account clinical factors that may have influenced medication use in this population.

Conclusions

The prevalence of diabetes in Saskatchewan LTCF is consistent with previous estimates among elderly populations. Overall medication use appears favourable in the majority of cases as evidenced by substantial use of metformin and declining use of glyburide. Continued following of LTCF should be employed to ensure this growing population receives safe and effective diabetes care. Future research should examine associations between changes in diabetes medication use and clinical outcomes such as hypoglycemia, falls, and hospital admissions.

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Authors Contributions

MWA wrote the manuscript; and KM contributed to the writing of the manuscript. MWA and XL researched data. KM, LML, GT, YS, AC and DFB contributed to the discussion and reviewed/edited the manuscript.

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Table 1: Baseline characteristics of the total study cohort and diabetic patients sub-cohort

Variable	Total cohort (N = 14,624) **n (%)[a]**	Diabetic patients sub-cohort (N = 3,436) **n (%)[a]**
Age at index LTCF admission mean, median (SD)	84.1, 85.0 (7.9)	82.1, 83.0 (7.8)
Female sex	9,412 (64.4)	1,980 (57.5)
Urban residence before admission	7,766 (53.1)	1,801 (53.0)
Index year of admission to LTCF		
2003	1720(21.2)	364(10.6)
2004	1598(21.8)	348(10.1)
2005	1620(21.7)	351(10.2)
2006	1605(23.6)	379(11.0)
2007	1658(24.7)	409(13.6)
2008	1734(22.6)	392(11.4)
2009	1785(26.3)	469(13.6)
2010	1644(23.8)	391(11.4)
2011	1260(26.4)	333(9.7)

[a]Mean, median (SD) reported for age

Figure 1: Flow chart for development of the study cohort

Figure 2: Prevalence and incidence of diabetes* among individuals newly admitted to a LTCF between 2003 and 2011, stratified by index year of admission

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* Diabetes cases were identified using the Canadian Chronic Disease Surveillance System (CCDSS) definition (i.e., ≥ 2 diabetes claims in the physician services file or ≥ 1 hospital discharge) and by the expanded case-definition (1 diabetes physician claim or ≥ 1 claim for a diabetes medication) within two years preceding LTCF admission (prevalence) and within six months following admission (incidence).

Figure 3: Use of diabetes medications in the first 6 months of LTCF admission reported as a percentage of total dispensations and stratified by index year of admission

Figure 4: Use of glyburide and gliclazide in the first 6 months of LTCF admission reported as a percentage of total sulfonylurea dispensations, stratified by index year of admission

Figure 5: Percentage of residents continuing and discontinuing glyburide following admission to a LTCF, stratified by index year of admission