

**The Association of Enrolment in Primary Care Networks on
Diabetes Care and Outcomes in First Nations and Low Income Albertans**

David JT Campbell, Paul E Ronksley, Brenda R Hemmelgarn,
Jianguo Zhang, Cheryl Barnabe, Marcello Tonelli, Braden Manns

David JT Campbell MSc - is a MD candidate and MSc candidate in the Department of Community Health Sciences at the University of Calgary, Calgary, AB. (email: dcampbel@ucalgary.ca)

Paul E Ronksley MSc - is a PhD candidate in the Department of Community Health Sciences at the University of Calgary, Calgary, AB. (email: peronksl@ucalgary.ca)

Dr. Brenda R Hemmelgarn MD, PhD - is an associate professor in the Departments of Medicine and Community Health Sciences at the University of Calgary, Calgary, AB. (email: Brenda.hemmelgarn@albertahealthservices.ca)

Jianguo Zhang MSc - is a research assistant with the Alberta Kidney Disease Network, at the University of Calgary, Calgary, AB. (email: jzhang@ucalgary.ca)

Dr. Cheryl Barnabe MD, MSc - is an assistant professor in the Departments of Medicine and Community Health Sciences at the University of Calgary, Calgary, AB. (email: ccbarbab@ucalgary.ca)

Dr. Marcello Tonelli MD, SM - is a professor in the Department of Medicine at the University of Alberta, Edmonton, AB. (email: mtonelli@ualberta.ca)

Dr. Braden Manns MD, MSc - is an associate professor in the Departments of Medicine and Community Health Sciences at the University of Calgary, Calgary, AB.
(email: braden.manns@albertahealthservices.ca)

Corresponding Author:

Dr Braden Manns
Associate Professor, Departments of Medicine and Community Health Sciences
Foothills Medical Center
1403 29th St NW
Calgary, AB T2N 2T9
Phone: 403-944-2595, Fax: 403-944-2876
E-mail: braden.manns@albertahealthservices.ca

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ABSTRACT

Background: The prevalence of diabetes and its complications is higher among First Nations people and those with low socioeconomic status (SES). While studies have shown that Primary Care Networks (PCNs) are associated with better care and outcomes for people with diabetes, possibly due to higher use of chronic disease management programs, it is unknown whether First Nations or those in lower SES groups experience similar benefit from PCNs.

Methods: We did a population-based cohort study of Albertans with diabetes under age 65 using administrative and laboratory data. The primary outcome, assessed over a one year time period, was hospitalization or emergency room visit for diabetes specific ambulatory care sensitive conditions (ACSC); secondary outcomes included quality of care indicators (likelihood of HbA1c measurement and retinal screening) and measures of healthcare utilization (visits to specialist and primary care physicians). Negative binomial regression was used to determine the association between care within a PCN and hospitalization or emergency room visit for diabetes-specific ACSCs. We also assessed outcomes in three population types of interest (individuals receiving health-care subsidy [household income less than \$39,000 and not eligible for income support], those receiving income support, and First Nations individuals) compared with the remainder of the population, controlling for whether care was provided in a PCN, and adjusting for several baseline characteristics.

Results: 106,653 patients with diabetes were identified, of whom 41% were managed in a PCN. Receiving care in PCNs was associated with lower rates of ACSC hospitalizations or emergency room visits for all groups of interest, suggesting that PCNs had similar effects across each group. Care in a PCN was also associated with a higher odds of obtaining an HbA1c measurement and retinal screening across all population types. However, regardless of where

care was provided, First Nations and low SES patients had more than twice the adjusted rates of hospitalization or emergency room visits for diabetes-specific ACSCs than the general population, and were less likely to receive guideline recommended care, including HbA1c measurements and retinal screening.

Interpretation: Care in a PCN is associated with a lower risk of hospitalization or emergency room visit for diabetes-specific ACSCs even in vulnerable groups such as First Nations people and those of low SES. However, differences in outcomes and quality of care indicators persist for First Nations people and those of low SES compared with the general population, irrespective of where care is provided.

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COMPETING INTERESTS

The authors of this study have no competing interests to declare.

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AUTHORSHIP

DC, PR, BH and BM designed the study protocol. DC, PR and JZ conducted the analyses. DC wrote the first draft of the manuscript. All authors contributed to drafting and providing critical revisions of the manuscript. BM is the guarantor for the manuscript and takes responsibility for the contents and appropriateness of the reference list.

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Background

One in ten Canadian adults has diabetes (1), which is associated with high health care costs and is frequently complicated by blindness, premature cardiovascular disease, and kidney failure (2-4). The prevalence of diabetes is higher in certain subsets of the Canadian population, including First Nations People and those experiencing poverty. Up to 15% of the on-reserve Canadian First Nations population may have diabetes (5), and people with low income have a 20-26% higher risk of diabetes mellitus (6-8). Further, both low income individuals and First Nations persons are less likely to access care, including specialist care for problems such as diabetes (9-10), which may contribute to their observed worse health outcomes (4, 10-11).

Care of patients with diabetes is complex, often requiring multidisciplinary care and extensive patient education (12). Providing such care is challenging since primary care practices do not typically have additional resources to provide these services. Many Canadian jurisdictions are undergoing ‘primary care reform’ which includes establishing models of care for chronic diseases in primary care (13-14). In part, these reforms are meant to address access and equity concerns, both **important tenants of the Canadian healthcare system. Unfortunately, healthcare resources in Canada are delivered inequitably, especially in secondary and tertiary care (15). Improved primary care has been proposed as a means to improve equity in the healthcare system (16-17).**

Primary care reform in Alberta has taken the form of Primary Care Networks (PCNs). A PCN consists of primary care physicians and an allied health team working together to provide care to patients with and without chronic diseases. Funding is provided on a capitated basis to PCNs to support activities that fall outside the fee-for-service model, and may be used to hire allied health care professionals, or for other initiatives, such as the development of quality improvement programs for people with chronic disease, including diabetes. While PCNs take different approaches to chronic disease management strategies, multidisciplinary teams and enhanced patient education are used in the majority of PCNs, which have been established in rural and urban parts of the province.

PCNs are postulated to be an effective means of implementing chronic disease management (CDM) models (18). A recent study by our group, evaluating the care and outcomes of patients with diabetes managed in PCNs, documented that care in a PCN was associated with a small reduction in the rate of admissions to hospital or visits to emergency departments for diabetes-specific ambulatory care sensitive conditions (ACSC) and a slightly lower mean hemoglobin HbA1c level (19), possibly due to their implementation of quality improvement programs in primary care (20).

While this previous study suggested that PCNs were associated with small improvements in diabetes care in the overall Alberta population, it is not known if PCNs help to achieve equity of care and outcomes across patient groups, especially those who might traditionally experience difficulties with accessing health care and for whom adverse outcomes are more common (4, 10-11). Our objective in this study was to determine whether the apparent benefit of PCNs was

similar among First Nations people and those in lower SES group, compared to the general population. We hypothesized that PCNs' team-based approach might have a more significant impact on the care and outcomes for these vulnerable groups than on the general population.

Methods

Data Sources and Study Population

The data sources have been previously described (19). Data on hospitalizations, physician visits and emergency department visits was extracted from Alberta Health and Wellness administrative data files, while laboratory data was obtained from a province-wide repository that captures data for all Albertans who have inpatient or outpatient laboratory measurements (21).

Within these data sources, a validated algorithm was used to define a cohort of adult patients with a diagnosis of diabetes as of April 1, 2008 (22). Patients were considered to have prevalent diabetes based on two or more physician claims for diabetes (ICD-9-CM code 250) in 2 years, or 1 or more hospitalizations with an ICD-9-CM code of 250, selected from all available diagnostic codes on the Hospital Discharge Abstract between April 1, 1994 and March 31, 2002, or equivalent ICD-10 codes (E10-E14) from March 31, 2002 to April 1, 2008. The date of the first claim or hospitalization for diabetes (whichever came earlier) was used to define the diagnosis date.

As we were interested in assessing the impact of population type on care and outcomes of patients with diabetes, we excluded patients with diabetes aged 65 and older as they are classified into a single “seniors” population category in the Alberta Health and Wellness (AHW) Registry file and no further information on their population type is available.

Study Variables

PCN Status

Patients were assigned to a primary care network based on AHW administrative data using a defined protocol based on physician claims data (23).

Population Type

Population type was categorized as general population, First Nations, healthcare subsidy, and income support, as identified from the AHW registry file. First Nations status was defined as any individual with a First Nations status indicator at any time between April 1, 1994 and March 31, 2009, signalling they were registered under the Federal Indian Act. All others were categorized into one of three categories: general population (annual adjusted taxable family income >\$39,250); those receiving the Alberta Health Care Insurance Plan (AHCIP) subsidy (family income <\$39,250 but not receiving income support) (24); and those receiving Alberta Income Support (a heterogeneous group of individuals including those not expected to work [those with chronic mental or physical ailments] and those expected to work [those looking for or unable to find work] (25)).

Covariates and other variables of interest

Demographic data including age and sex was determined from the AHW registry file. Data from the AHW physician claims and hospitalization databases were used to define hypertension using validated algorithms (26). Other comorbid conditions and the Charlson comorbidity index were defined using validated ICD-9-CM and ICD-10 coding algorithms (27). Baseline estimated glomerular filtration rate (eGFR) and glycosylated hemoglobin (HbA1c) were obtained from a

provincial laboratory repository using the most recent outpatient eGFR or HbA1C assessment in the year prior to April 1, 2008 (21).

Outcome Variables

Our primary outcome was hospitalization or emergency department visit for a diabetes-specific ambulatory care sensitive condition (ACSC) from April 1, 2008 to April 1, 2009. In general, the primary outcome corresponded to hospitalization or emergency room visits for hypoglycemic events, diabetic ketoacidosis or hyperosmolar non-ketotic states, as determined by ICD codes in the AHW dataset (28). These conditions have been identified as a reasonable proxy for the quality of primary diabetes care since appropriate out-patient management can help to reduce the burden of complications and need for hospitalization (29-30). These outcomes have been adopted in a Canadian Consensus for Standardized Evaluation of Quality Improvement Interventions in Type 2 Diabetes (31).

The secondary outcomes of interest were quality of care indicators including the proportion of people having at least one glycosylated hemoglobin (HbA1c) measurement, and the proportion having retinal screening performed by a visit to an ophthalmologist or optometrist during the one year observation period. Canadian Diabetes Association (CDA) guidelines (32) state that all patients with diabetes should have glycosylated hemoglobin levels checked every 3-6 months. While CDA guidelines recommend that patients with type 2 diabetes and a history of previously normal funduscopy examinations require only biannual retinal screening, we assessed screening in our one year assessment period. Although not all patients require screening in this shorter period, differences in screening rates across groups would still be relevant.

Finally, since access to health care is the first step in quality outpatient care, we assessed measures of healthcare utilization, including outpatient visits to internal medicine or endocrinology specialists, and outpatient visits to primary care physicians.

Statistical Analysis

Initially, we used a Poisson log-linear regression model to determine the rate of hospitalization or ED visit for diabetes-specific ACSC, by PCN status and population type. To test for over-dispersion, we performed the deviance goodness-of-fit test. Given the presence of over-dispersion, we used negative binomial regression models to calculate rate ratios (RR) and determine the association between care within a PCN and hospitalization or emergency room visits for a diabetes-specific ACSC. Relevant covariates were identified using backwards selection techniques. Final models were adjusted for age, sex, duration of diabetes, presence of hypertension, baseline HbA1c, baseline kidney function (estimated glomerular filtration rate) and Charlson Comorbidity Score. Age, baseline HbA1c, baseline kidney function, and Charlson score were modeled as categorical variables as shown in Table 1. We used an interaction term (PCN by population type) to determine if this association varied by population type.

As our objective was to also explore the association between population type and outcomes, we subsequently developed multivariate adjusted models with population type as the primary exposure, using the general population as the reference group and adjusting for care within a PCN. We used logistic regression to determine the association between population type and dichotomous secondary outcomes (likelihood of HbA1C measurement, retinal screening and

specialist visit), adjusting as described in our primary analysis. Negative binomial regression and RRs were used for the outcome of primary care physician visit rate. All analyses were performed using STATA 11.0 (Statacorp, College Station, Texas). This study was approved by the Ethics Review Board of the University of Calgary.

Results

As of April 1, 2008, we identified 183,654 persons with diabetes. We excluded patients 65 years of age and older ($n=77,001$), leaving 106,653 subjects for analysis. Baseline subject characteristics, by population type and PCN status, are presented in Table 1. Within each population type, those cared for within PCNs were noted to be older than those cared for outside of PCNs. Baseline glycemic control (HbA1c) and renal function (eGFR) was generally observed to be slightly poorer in the non-PCN group across population types. In most population types the burden of comorbidities was similar between PCN and Non-PCN groups, the one exception being the healthcare subsidy group in whom the PCN group was noted to be more likely to have hypertension and higher Charlson comorbidity scores. Notably, only 33% of First Nations patients and 38% of Income Support patients were managed in a PCN, compared to 42% of the general population ($p<0.001$).

Primary Outcome: Association between PCN status and admissions to hospital or visits to emergency departments for diabetes-specific ACSC

Receiving care in PCNs was associated with lower rates of hospitalization or emergency room visits for diabetes-specific ACSCs across all groups (Table 2). These results did not vary by

population type (interaction term was non-significant ($p>0.10$)), suggesting that PCNs had similar effects across each of the groups.

Although our primary analysis suggested that the association between PCNs and outcomes did not vary by population type, we noted important differences in care and outcomes across population types, which are highlighted below.

Association between population type and admission to hospital or visits to emergency departments for diabetes-specific ACSC

There were significant differences in crude rates of hospitalization or emergency room visits for a diabetes-specific ACSC across groups, with significantly higher rates in the income support group and the First Nations group (Table 3). While these differences were attenuated after adjustment for the confounders, including PCN status, there remained a marked difference in the adjusted rates of the primary outcome for people in the income support group and the First Nations group. Compared to the general population, both First Nations and Income Support experienced an increased risk of admissions to hospital or visits to emergency departments for diabetes-specific ACSC (adjusted rate ratio 3.75, 95% CI: 3.30-4.26 and 2.96, 95% CI: 2.63-3.33 respectively) .

Secondary Outcomes: Quality care indicators

The likelihood of having at least one hemoglobin A1c measurement over the one year follow-up varied by population type (Table 4), with the income support patients (adjusted odds ratio 0.95,

95% CI: 0.90-1.00) and the First Nations (adjusted odds ratio 0.71, 95% CI: 0.67-0.76) being significantly less likely to have a HbA1c measurement compared with the general population.

The odds of having retinal screening performed by an ophthalmologist or optometrist over the course of the one year follow-up were lower for people in the income support and First Nations groups compared with the general population (Table 4). Those receiving the healthcare subsidy were slightly more likely to have retinal screening performed than those in the general population (adjusted odds ratio 1.17, 95% CI: 1.12-1.22). The association between population type and these outcomes did not vary by PCN status with the interaction term being non-significant ($p > 0.10$).

Healthcare resource utilization

Outpatient visits to primary care physicians were higher for the three groups of interest: subsidy (adjusted rate ratio 1.10, 95% CI: 1.09-1.12), income support (adjusted rate ratio 1.48, 95% CI: 1.45-1.50), and First Nations (adjusted rate ratio 1.41, 95% CI: 1.38-1.44), compared to the general population (Table 5). The First Nations group was significantly less likely to access specialist care over the course of the observation period (OR=0.60, 95% CI: 0.56-0.64). As for the above comparisons, we again noted a non-significant interaction term in this analysis.

Discussion

In this study we assessed the association of Alberta PCNs on the care and outcomes for patients with diabetes, and explored whether there were differences in outcomes by population type. In general, we found that care in PCNs was associated with improved outcomes and quality care

measures for people with diabetes across all population types – with lower rates of admissions to hospital or visits to emergency departments for diabetes-specific ACSCs and adherence with guideline-recommended care. This is consistent with previous work showing that receiving care in an Alberta PCN was associated with better quality of diabetes care and diabetes-related outcomes (33).

Despite our hypothesis that PCNs would prove beneficial in improving care for high risk groups (i.e., First Nations and those in lower SES groups) we found that PCNs were associated with similar improvements in care and outcomes for all groups. However the well-described disparities in care and outcomes persisted for both the income support and First Nations cohorts compared with the general population, even when cared for in PCNs.

While primary care networks have been Alberta's version of primary care reform, primary care reform has occurred in other Canadian jurisdictions. Ontario has developed several new primary care models to enhance quality and access to care. These changes have focused on changing physician payment from fee-for-service to capitation and providing incentives for provision of multidisciplinary care. Alberta's PCNs are most closely aligned with Ontario's Family Health Groups (FHG), both of which maintain a fee-for-service model with additional payments per patient enrolled. Both PCNs and FHGs provide for a representative sample of the population and are associated with decreased need for hospital care (14).

We are unaware of other studies that have compared the effect of primary care reform on care and outcomes in people who have diabetes and are First Nations or in a lower SES group. Given

that First Nations and low-income patients are at higher risk of diabetes-related complications (34-35), the impact of PCNs in these higher risk groups is of significant interest. Despite better baseline health in many measures, First Nations persons had worse glycemic control, and significantly higher crude rates of hospitalization or emergency room visits for diabetes-specific ACSCs than any of the other groups in the study -- which is consistent with literature on healthcare utilization among First Nations populations (36-38). **There are likely many issues contributing to higher ACSC in this population, including genetic, social, cultural, environmental and health-system related factors (39).**

Our study included two low-SES groups: income support (unable to work or have not found work), and those receiving healthcare subsidy (employed with family income <\$39,250 and not eligible for income support). These groups generally had worse baseline health status than the general population; this pattern followed a gradient, with subsidy being worse than general population, and income support being worse than subsidy. Consistent with other studies, we noted that individuals in the income support group have worse glycemic control and higher rates of diabetes-related hospitalizations (40-42).

Both the low SES group and the First Nations group were found to have lower enrollment in PCNs (Table 1), possibly because they face greater barriers to regular primary care and are more likely to access care in a walk-in clinic setting. For First Nations people, this may be related to many First Nations persons living on reserve, where, as noted below, some health care services might be provided by federal programs and not provincial programs such as PCNs.

Our study should be interpreted in light of its limitations. First, SES was not available for persons over age 65, as they are all classified as pensioners in the AHW registry file. Another limitation with this classification system is that we have no income data for the First Nations cohort, therefore we are unable to know how their socioeconomic status compares to the non-First Nations group. Furthermore, analyses using administrative data have well known limitations including the information available in hospitalization discharge abstracts or physician claims data used to estimate the prevalence of comorbid conditions. However, it is unlikely that systematic differences exist in completeness of coding for patients cared for in or outside of a PCN, or for patients with varying levels of SES. Finally, we were unable to identify whether First Nations people were living on reserve or off-reserve, which could potentially mask some differences in the First Nations group. This is also an important distinction to make because on many reserves diabetes care is supplemented by the First Nations and Inuit Health Branch's Aboriginal Diabetes Initiative (ADI) (43). Care provided by this federal program is not recorded in the Alberta Health and Wellness database. However, while the ADI administers the retinal screening program, all images are read through tele-ophthalmology consultations in which the ophthalmologist is paid on a fee-for-service basis through AHW – which would therefore be captured in our data. This is in contrast to point of care HbA1c measures administered by the ADI which were not captured in our administrative databases – and therefore our results may represent an underreporting of HbA1c measures performed for on-reserve First Nations individuals.

The use of population-based administrative data is a major strength of this study, allowing us to undertake a population-based study of persons with diabetes who were receiving care in Alberta.

Previous studies evaluating the impact of SES or First Nations status on diabetes control and outcomes have utilized data from a small sample of the population, limiting their generalizability. Furthermore, the ability to combine province-wide laboratory data with information on health care utilization has enabled us to assess process-based markers of care as well as clinically relevant outcomes.

While PCNs were associated with improved outcomes for First Nations individuals and those requiring social assistance, the current model of care does not appear to fully address the disparities that exist for certain groups. It is possible that this is because chronic disease management programs designed for the general populations may be less-effective at reaching people with lower SES (44-45). Patients in the lowest SES may have other priorities which take precedence over improving the way they manage their diabetes (46). Previous studies have suggested that CDM programs for people with low SES may be more effective when specifically tailored to the needs of these populations (47), and certain features of CDM programs are recommended including high-intensity, long-duration programs which include community outreach, and diligent follow-up (45, 48).

Consistent with prior work, we noted that care in PCNs was associated with improved care (HbA1c measurement and retinal checks) and outcomes (hospitalization or emergency room visit for diabetes-specific ACSCs) for persons with diabetes. While we noted this improvement across all population groups, important disparities in care and outcomes persisted in the highest risk groups (those on income support and First Nations, compared with the general population) suggesting that additional programming and models of care are required for these groups. Future

research should focus on implementing and evaluating strategies aimed at improving processes of care and outcomes in these high-risk groups.

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