Research

Diabetes care and health status of First Nations individuals with type 2 diabetes in Alberta

Richard T. Oster MSc   Shainoor Virani MD FRCPC   David Strong MD FRCPC   Sandra Shade RN   Ellen L. Toth MD FRCPC

ABSTRACT

OBJECTIVE To describe the state of diabetes care among Alberta First Nations individuals with diabetes living on reserves.

DESIGN Survey and screening for diabetes-related complications.

SETTING Forty-three Alberta First Nations communities.

PARTICIPANTS A total of 743 self-referred First Nations individuals with known diabetes.

MAIN OUTCOME MEASURES Clinical measurements (glycated hemoglobin A_{1c} levels, body mass index, waist circumference, total cholesterol, blood pressure, and the presence of kidney complications or proteinuria, retinopathy, and foot abnormalities), self-reported health services utilization, clinical history, and knowledge of and satisfaction with diabetes services.

RESULTS Female participants tended to be more obese ($P<.05$) and to have abnormal waist circumferences more often than men ($P<.05$). Male participants, however, had a higher proportion of proteinuria ($P<.05$), hypertension ($P<.05$), limb complications ($P<.05$), and retinopathy ($P<.05$). Family physicians were the main diabetes care providers for most participants. Nearly half the participants felt they did not have care from a diabetes team. A total of 38% had never seen dietitians. Diabetes-related concerns were responsible for 24% of all hospitalizations and emergency department visits. Approximately 46% and 21% of participants had recommended hemoglobin A_{1c} testing and foot examinations, respectively. Only 24% of participants with kidney complications were receiving treatment. A considerable proportion of participants had undiagnosed complications of diabetes: kidney damage or proteinuria (23%), high cholesterol (22%), foot complications (11%), hypertension (9%), and retinopathy (7%).

CONCLUSION Diabetes care is suboptimal in Alberta First Nations communities. Rural physicians caring for First Nations individuals on reserves should be involved, along with other members of diabetes health care teams, in strategies to improve diabetes care. Our results justify the need for community-based screening for diabetes control and complications in First Nation communities.

EDITOR'S KEY POINTS

- Prevalence of diabetes is much higher in First Nations populations than in the general Canadian population, and complications of diabetes are much more common.
- Previous studies in Saskatchewan and Ontario demonstrated that overall management of diabetes is poor among First Nations individuals, but no studies had been done in Alberta. As part of the SLICK project, this study screened Alberta First Nations individuals with diabetes for complications of the disease and surveyed them about their clinical histories, their use of health services, and their satisfaction with and knowledge of diabetes care and available services.
- Although some data were self-reported and the participants were self-selected (and might therefore not represent the general First Nations population with diabetes), diabetes care was suboptimal in this group, and diabetes care guidelines were generally not being followed. Undiagnosed complications and notable treatment gaps were common. Future longitudinal SLICK results are expected to determine whether or not improvements in diabetes care among Alberta First Nations people are occurring.

Recherche

Traitement du diabète et état de santé des diabétiques de type 2 des Premières nations de l'Alberta

Richard T. Oster MSc   Shainoor Virani MD FRCPC   David Strong MD FRCPC   Sandra Shade RN   Ellen L. Toth MD FRCPC

RÉSUMÉ

OBJECTIF Décrire la situation du traitement du diabète chez les diabétiques des Premières nations de l'Alberta vivant dans des réserves.

TYPE D'ÉTUDE Enquête et dépistage des complications du diabète.

CONTEXTE Quarante-trois collectivités albertaines des Premières nations.

PARTICIPANTS Un total de 743 diabétiques connus des Premières nations acceptant de participer.

PRINCIPAUX PARAMÈTRES À L'ÉTUDE Données cliniques (hémoglobine glyquée A_{1c}, indice de masse corporelle, circonférence de taille, cholestérol total, tension artérielle et présence de complications rénales, protéinurie, rétinopathie ou problème aux pieds), déclaration des participants sur leur utilisation des services de santé, leur histoire médicale, et sur leur connaissance et satisfaction des services aux diabétiques.

RÉSULTATS Les participantes avaient tendance à être plus obèses que les hommes ($P<.05$) et à avoir un tour de taille plus souvent excessif ($P<.05$). Toutefois, les hommes avaient des taux plus élevés de protéinurie ($P<.05$), d'hypertension ($P<.05$), de complications aux membres ($P<.05$) et de rétinopathies ($P<.05$). Les médecins de famille étaient les principaux responsables du traitement du diabète pour la plupart des participants. Près de la moitié des participants estimaient n'avoir pas été suivis par une équipe du diabète. Un total de 38% n'avaient jamais rencontré de diététiste. Les inquiétudes reliées au diabète étaient responsables de 24% de toutes les hospitalisations et visites à l'urgence. Environ 46% et 21% des participants avaient eu, tel que recommandé, une mesure de l'hémoglobine A_{1c} et un examen des pieds, respectivement. Seulement 24% des participants avec complication rénale étaient traités. Bon nombre de participants présentaient des complications diabétiques non diagnostiquées: atteinte rénale ou protéinurie (23%), cholestérol élevé (22%), problèmes aux pieds (11%), hypertension (9%) et rétinopathie (7%).

CONCLUSION Le traitement du diabète est sous-optimal dans les communautés des Premières nations de l'Alberta. Les médecins ruraux qui pratiquent dans les réserves devraient, conjointement avec les autres membres de l'équipe responsables des soins du diabète, développer des stratégies pour améliorer ces soins. Nos résultats démontrent la nécessité d'un dépistage visant le contrôle du diabète et de ses complications dans les communautés de Premières nations.

POINTS DE REPÈRE DU RÉDACTEUR

- La prévalence du diabète est beaucoup plus élevée chez les membres des Premières nations que dans la population canadienne générale, et les complications de cette affection sont beaucoup plus fréquentes.

- Des études antérieures en Saskatchewan et en Ontario ont montré que le traitement général du diabète est déficient chez les personnes des Premières nations, mais aucune étude n'a été faite en Alberta. Cette étude qui faisait partie du projet SLICK a recherché chez les diabétiques des Premières nations de l'Alberta les complications de cette maladie; on les a interrogés sur leur histoire clinique, leur utilisation des services de santé, et leur connaissance et satisfaction relatives aux soins du diabète et des services disponibles.

- Même si certaines des données résultaient d'auto-déclarations et si les participants l'étaient par choix personnel (pouvant ainsi ne pas représenter la population générale des diabétiques des Premières nations), le traitement du diabète était sous-optimal dans ce groupe, et les directives sur les soins des diabétiques n'étaient généralement pas suivies. Complications non diagnostiquées et traitement incomplet étaient fréquents. Les résultats futurs de l'étude longitudinale SLICK devraient permettre de déterminer si les soins aux diabétiques des Premières nations de l'Alberta s'améliorent.

Diabetes is an epidemic among First Nations populations, with prevalence rates markedly higher than in the general Canadian population.[1,2] In 2005, the estimated diabetes prevalence rate among First Nations residents in Alberta was 12%.[3] This could be an underestimate, however, owing to high rates of undiagnosed diabetes.[4,5] First Nations individuals with diabetes experience complications more frequently than those in other groups do,[6-10] and the rate of complications is expected to increase dramatically over the next decade.[11]

Despite available research on diabetes prevalence and complications in First Nations communities, very little is known about the state of diabetes care. A clinical audit conducted in Saskatchewan and the Sandy Lake Diabetes study in Ontario suggested that overall diabetes management is poor among First Nations individuals.[12,13] However, no studies have been done in Alberta. The SLICK (Screening for Limb, I-eye, Cardiovascular, and Kidney complications of diabetes) project aims to reduce the burden of diabetes in the Alberta First Nations population living on reserves. An initial goal of SLICK, and the objective of this study, was to evaluate diabetes care and health status among the population on reserves. First Nations individuals with diabetes were screened for diabetes complications and completed a survey targeting self-reported health services utilization, clinical history, and satisfaction with and knowledge of diabetes care and services before SLICK was implemented.

METHODS

Mobile clinics staffed by health professionals and equipped with portable laboratory equipment traveled to each of the 43 First Nations communities in Alberta, starting in 2001. The communities are situated within 3 treaty areas. In general, Treaty 6, Treaty 7, and Treaty 8 cover central, southern, and northern Alberta, respectively. The SLICK project is ongoing. This report deals with baseline results to July 2003. First Nations individuals with known diabetes were enrolled through referral by community care workers or through self-referral in response to advertising. Participants completed a survey[14] and were screened for diabetes complications. A diabetes knowledge questionnaire was included with the survey. Complete methodology has been reported elsewhere.[15] Original and previously developed questions[16-18] were included in the survey.

Glycated hemoglobin A_{1c} (HbA_{1c}) levels, body mass index (BMI), waist circumference, blood pressure, total cholesterol levels, and the presence of foot abnormalities, kidney damage (dipstick proteinuria or microalbuminuria), and retinopathy were assessed. Concentrations of HbA_{1c} and microalbumin were

determined using the Bayer DCA2000+ analyzer. Total cholesterol levels were measured using the Cholestech LDX portable analyzer. The presence of foot abnormalities (peripheral neuropathy) was determined using a microfilament wire. Three-dimensional retinal images were sent to specialists at the Tele-Ophthalmology Unit at the Royal Alexandra Hospital in Edmonton, Alta, for assessment. Because SLICK began in 2001, inadequate glucose control was assessed according to the 1998 Canadian Clinical Practice Guidelines (CPGs) cutoff of HbA_{1c} levels greater than 8.4%.[19] Optimal glucose control was further defined by the 2003 Canadian CPGs as HbA_{1c} levels below 7%.[20]

The SLICK project was approved by the University of Alberta Health Research Ethics Board, and informed consent was sought from all participants for collective analysis and dissemination. Significant differences ($P<.05$) between participants by sex were detected using χ^2 tests. Parameters were analyzed using SPSS, version 11.5.

RESULTS

Of the 1151 initial participants, 743 (254 male, 489 female) completed both the survey and screening, representing a 65% response rate. An estimate from administrative databases of Alberta Health and Wellness, using a validated algorithm, suggests 5727 First Nations individuals with diabetes reside in Alberta,[3] approximately 60% of whom live on reserves. Therefore, the population reported on here represents about one-third of the target population. (As of July 2007 SLICK had seen a total of 2102 unique individuals with diabetes, representing two-thirds of the target population.) The mean age of participants was 53, and ages ranged from 14 to 92. The presented parameters fall into 3 categories: 1) objective clinical parameters, 2) self-reported survey parameters, and 3) a survey-based assessment of diabetes knowledge and satisfaction with care.

Clinical parameters
Participants' clinical characteristics are outlined in **Table 1.** Only 30% of participants had optimal HbA_{1c} levels, and glucose control was inadequate in 43%. Twenty-five percent of participants were overweight, 64% were obese, and 88% had abnormal waist circumferences. Obesity and abnormal waist circumferences were more prevalent among women than men ($P<.05$). Sixty-one percent of participants had hypertension; the proportion was significantly higher among men than among women ($P<.05$). Fifty-eight percent of participants had high cholesterol. Approximately 6% of participants had high-risk foot abnormalities, with another 31% at lower risk; significantly more men were at high risk of foot complications ($P<.05$). Overt proteinuria was detected in 13% of participants, and 39% had

Table 1. Clinical characteristics of participants by sex: *A) Mean measurements. B) Percentage of participants with various characteristics.*

CHARACTERISTICS	MALE, MEAN (SD) N = 254	FEMALE, MEAN (SD) N = 489	TOTAL, MEAN (SD) N = 743
A)			
BMI, kg/m^2	33.8 (11.2)	34.1 (8.4)	34.0 (9.4)
Waist circumference, cm	110.8 (13.1)	111.4 (13.7)	111.2 (10.3)
Systolic blood pressure, mm Hg	133.6 (17.4)	130.8 (18.4)	131.7 (18.0)
Diastolic blood pressure, mm Hg	79.3 (10.5)	76.0 (10.1)	77.1 (10.3)
MAP, mm Hg	97.4 (11.5)	94.2 (11.1)	95.3 (11.3)
HbA$_{1c}$, %	8.3 (2.1)	8.2 (2.0)	8.2 (2.0)
Cholesterol, mmol/L	5.52 (1.4)	5.40 (1.1)	5.44 (1.2)
B) CHARACTERISTICS	MALE, % (95% CI) N = 254	FEMALE, % (95% CI) N = 489	TOTAL, % (95% CI) N = 743
BMI, kg/m^2			
• % normal BMI (18.5-24.9)	12 (2.6-22.2)	11 (3.4-18.2)	11 (4.5-18.1)
• % overweight (25-29.9)	29 (20.7-37.5)	22 (15.4-29.0)	25 (18.3-30.9)
• % obese (>30)	59* (52.6-64.4)	67* (62.9-71.1)	64 (59.8-68.4)
Waist circumference, cm			
• % with abnormal waist circumference (>102 for men; >88 for women)	76* (69.4-81.6)	95* (93.0-97.0)	88 (86.0-90.9)
MAP, mm Hg			
• % with hypertension (>130/80)	68* (62.0-73.0)	57* (52.9-61.9)	61 (56.3-65.3)
Foot risk category			
• % with no abnormality (0)	55* (50.2-60.6)	67* (60.7-68.9)	63 (59.5-66.3)
• % at low risk (1)	18 (10.1-26.5)	14 (8.4-18.6)	15 (9.5-20.7)
• % at moderate risk (2)	16 (8.0-24.6)	16 (11.0-21.4)	16 (10.6-21.8)
• % at high risk (3)	10* (2.2-17.8)	4* (0-7.0)	6 (0.5-10.9)
HbA$_{1c}$, %			
• % with optimal HbA$_{1c}$ (<7)	30 (21.1-39.7)	30 (23.8-36.6)	30 (25.2-35.2)
• % with inadequate HbA$_{1c}$ (>8.4)	44 (35.8-52.2)	42 (36.4-48.0)	43 (38.3-47.1)
Cholesterol, mmol/L			
• % with high cholesterol (>5.2)	58 (50.7-64.8)	58 (52.9-62.4)	58 (53.9-61.3)
• % with abnormal ratio (>2 for men; >2.8 for women)	49* (41.1-56.6)	33* (26.9-39.5)	39 (34.3-43.5)
Other			
• % with proteinuria	20* (9.6-29.4)	10* (2.7-17.7)	13 (7.6-19.2)
• % with retinopathy	40* (19.3-32.5)	26* (19.3-32.5)	31 (25.8-35.8)

BMI—body mass index, CI—confidence interval, HbA$_{1c}$—glycated hemoglobin A$_{1c}$, MAP—mean arterial pressure.
*Significant sex difference (*P*<.05).

abnormal microalbumin-creatinine ratios; rates were significantly higher among male participants (*P*<.05). Retinopathy was detected in 31% of participants, and the proportion was higher among men (*P*<.05).

Self-reported clinical services use

The main diabetes care providers were family doctors for 65% of participants, nurses for 16%, and diabetes specialists for 2% (**Table 2**). Roughly 10% of participants had no regular health care providers, 46% had never

seen diabetes nurses, and 18% had not visited diabetes care providers in the previous year. Only 28% of participants had visited dietitians in the previous year. Visits to physicians were frequent among participants; 95% had visited doctors at least once in the previous year, and 54% had made more than 5 visits. Approximately 40% of participants had been hospitalized overnight; half of these patients had multiple stays and more than half reported that the primary cause of these hospitalizations was diabetes. Forty-seven percent of participants had at

Table 2. Reported use of health services by participants: *N = 743.*

HEALTH SERVICES USE	%	95% CI
Main diabetes health care provider		
• Doctor	65	60.8–69.3
• Nurse	16	11.4–20.6
• Diabetes specialist	2	0.1–4.1
• Other	6	1.9–10.9
• None	11	6.2–15.8
No. of visits to main diabetes health care provider in past y		
• 0	18	12.5–23.5
• 1–2	23	17.7–28.3
• 3–6	28	20.9–33.1
• 7–11	12	6.3–17.8
• ≥ 12	19	13.3–24.5
No. of visits to any doctor in past y		
• None	5	0.0–10.0
• 1	7	1.1–12.9
• 2–5	34	28.2–39.8
• ≥ 5	54	49.1–58.9
No. of times seen by a diabetes nurse in past y		
• 0	46	40.7–51.3
• 1–2	27	21.9–32.1
• 3–6	13	7.3–18.7
• 7–11	5	0.0–10.0
• ≥ 12	9	3.1–14.9
Last visit with a dietitian		
• Never	38	32.3–43.7
• < 1 y	28	22.9–33.1
• ≥ 1 y	34	28.2–39.8
No. of overnight hospitalizations in past y		
• None	61	56.5–65.5
• 1	19	13.5–24.5
• 2–5	16	10.4–21.6
• ≥ 5	4	0.1–8.1
No. of overnight hospitalizations owing to diabetes in past y		
• None	76	72.5–79.5
• 1	13	7.3–18.7
• 2–5	8	2.1–13.9
• ≥ 5	3	0.0–6.0
No. of emergency room visits in past y		
• None	53	48.1–57.9
• 1	21	15.6–26.4
• 2–5	21	15.6–26.4
• ≥ 5	5	0.0–10.0
No. of emergency room visits owing to diabetes in past y		
• None	76	72.5–79.5
• 1	12	6.3–17.8
• 2–5	10	4.2–15.8
• ≥ 5	2	0.1–4.1
Last HbA$_{1c}$ blood test		
• Never	20	14.6–25.4
• ≥ 1 y	14	8.3–19.7
• 6–12 mo	20	14.6–25.4
• < 6 mo	46	40.7–51.3
Last cholesterol blood test		
• Never	21	15.6–26.4
• ≥ 1 y	5	0.0–10.0
• 6–12 mo	14	8.3–19.7
• < 6 mo	60	55.5–65.6
Last urine protein test		
• Never	12	6.3–17.8
• > 2 y	7	1.1–12.9
• 1–2 y	13	7.3–18.7
• < 1 y	68	63.9–72.1
Last visit with a podiatrist		
• Never	66	61.8–70.2
• > 2 y	8	2.1–13.9
• 1–2 y	5	0.0–10.0
• < 1 y	21	15.6–26.4
Last retinopathy eye test		
• Never	24	18.7–29.3
• > 2 y	15	9.4–20.6
• 1–2 y	25	19.8–30.2
• < 1 y	36	30.3–41.8

CI—confidence interval, HbA$_{1c}$—glycated hemoglobin A$_{1c}$.

least 1 emergency department visit, and diabetes-related concerns were the cause of 24% of such visits.

Recommended HbA$_{1c}$ and blood cholesterol testing frequencies were met in 46% and 74% of cases, respectively. When asked about urine protein tests, 68% of participants reported that they had been tested within the past year. Only 21% of participants reported seeing podiatrists in the previous year, and 61% had had eye examinations within the previous 2 years.

Clinical history

Overall and diabetes-related health was reported as good or excellent by 75% of participants. One-third of the participants recalled having had heart or circulation problems, 16% had had heart attacks (30% of males and 13% of females), and 6% had had heart operations. A total of 36% of participants recalled being diagnosed with high cholesterol, 52% with hypertension, and 16% with kidney damage (described as protein or kidney leakage). Among these patients, 52%, 76%, and 24%, respectively, were on medication for their conditions. Moreover, 47% of those with kidney damage were receiving antihypertensive medication. About 26% of participants reported having foot complications, of whom 39% had ulcers or sores on their feet or legs that would not heal for longer than 1 month. Approximately 24% of participants recalled having eye complications; of those, 38% had had laser surgery and 27% had had cataract operations. Finally, when comparing self-reported and clinical measurements (**Table 3**), we found additional undiagnosed complications of diabetes: kidney damage (23%), high cholesterol (22%), foot complications (11%), hypertension (9%), and retinopathy (7%).

Table 3. Comparison of clinical measurements with self–reported clinical health: *N = 743.*

CONDITION	CLINICAL MEASURE, % WITH CONDITION (95% CI)	SELF-REPORTED, % WITH CONDITION (95% CI)	UNDIAGNOSED COMPLICATION, % (95% CI)
Kidney damage	39 (33.4–44.6)	16 (10.4–22.6)	23 (17.7–28.3)
High cholesterol	58 (53.3–62.7)	36 (30.3–41.8)	22 (16.7–27.4)
Foot complications	37 (31.3–42.7)	26 (20.8–31.2)	11 (5.2–16.8)
Hypertension	61 (56.5–65.5)	52 (47.0–57.0)	9 (3.1–14.9)
Retinopathy	31 (26.0–36.0)	24 (18.7–29.3)	7 (1.1–12.9)

CI—confidence interval.

Knowledge of diabetes and satisfaction with care

Thirty-six percent of participants rated their overall understanding of diabetes as fair or poor, and 47% had not attended a formal diabetes education program (**Table 4**). Knowledge indicators, additive indexes

Table 4. Participants' knowledge of diabetes and satisfaction with care, N = 743: *Mean (SD) understanding of complications = 4.15 (1.1) on a scale of 0 (low) to 5 (high); mean (SD) understanding of screening tests = 2.04 (0.7) on a scale of 0 (low) to 5 (high).*

KNOWLEDGE AND SATISFACTION	%	CI 95%
Understanding of diabetes		
• Poor	14	8.3–19.7
• Fair	22	16.7–27.4
• Good	39	33.4–44.6
• Very good	20	14.6–25.4
• Excellent	5	0.0–10.0
No. of formal diabetes education sessions		
• None	46	40.7–51.3
• 1	31	26.0–36.0
• 2–5	19	13.5–24.5
• ≥ 5	3	0.0–6.0
Believed they had diabetes care "team"		
• Yes	55	50.2–59.8
• No	45	39.7–50.3

CI—confidence interval.

ranging from 0 (low) to 5 (high), revealed that participants knew significantly more about complications of diabetes (mean score = 4.15) than they knew about screening for complications (mean score = 2.04) ($P < .05$). Finally, only 55% of participants felt they were being cared for by a diabetes health "team."

DISCUSSION

Our results demonstrate that diabetes health status of Alberta First Nations individuals living on reserves is poor, and sex differences in diabetes complications exist. Diabetes care guidelines were generally not being well followed before SLICK implementation, and diabetes care was suboptimal. A large proportion of First Nations people with diabetes reported that their care was not provided using a team approach. Participants also generally had poor knowledge about diabetes screening and prevention. Additionally, undiagnosed complications and notable treatment gaps were common.

A higher proportion of First Nation individuals with diabetes were overweight or obese (89%) compared with the general Canadian population with diabetes (74%).[21] This supports data from the Canadian Community Health Survey, which show higher rates of overweight and obese individuals among aboriginals.[22] Considerably more participants in our study had inadequate HbA$_{1c}$ levels (43%) compared with Saskatchewan First Nations individuals in a previous study (31%).[12]

Only 30% of participants had optimal levels of HbA$_{1c}$, which is less than among Ontario First Nation individuals (37%) and nonaboriginal rural Albertans (50%).[13,23]

The underlying causes and implications of the reported sex differences cannot be determined from this study and require further research. Sex differences in diabetes complications reported in other populations have been contradictory. Studies have shown higher rates of microvascular complications among men,[24] higher rates among women,[25] and no significant difference between sexes.[26] Whether or not diabetes confers a higher risk of cardiovascular disease in women compared with men is also debatable.[27-29] In our study, female participants appeared to be at higher risk of cardiovascular complications, as more were obese and had abnormal waist circumferences. On the other hand, male participants had higher proportions of kidney problems, hypertension, limb complications, and retinopathy.

According to the 2003 Canadian CPGs for the prevention and management of diabetes, a multidisciplinary diabetes health care team is needed in the long-term care of those with diabetes.[20] Our results, however, show that almost half (45%) of First Nations people with diabetes believed they did not receive diabetes care from teams. A considerable proportion of participants did not have main diabetes care providers (11%), and many never visited diabetes nurses (46%) or dietitians (38%), which could have resulted in the higher rate of diabetes-related hospitalization (24%) compared with the general population (9%).[30] This is consistent with evidence from other provinces, where hospitalization rates for diabetes among First Nation patients are at least double those of the general population.[31,32] This is likely because of the remote rural location of most reserves, as rural individuals with diabetes are far more likely to see physicians or visit emergency departments and are less likely to see specialists.[3,23] Moreover, physician retention and shortage problems are generally worse in rural Alberta than in urban centres,[33,34] which also limits First Nations access to appropriate diabetes care.

Screening for diabetes-related complications was not well understood by participants, and screening practices for glucose control and foot complications were poor. Approximately 46% of participants had had HbA$_{1c}$ tests in the past 6 months and 21% had had their feet examined within the previous year, considerably lower than the general Canadian population (60% and 36%, respectively)[35] and than Australian aboriginals (56% to 80% and 35% to 51%, respectively) with diabetes.[36] Although most participants had been screened according to guidelines for high cholesterol and retinopathy, a large proportion had never been tested (21% and 24%, respectively).

We observed treatment gaps in the management of high cholesterol, high blood pressure, kidney damage, foot complications, and retinopathy. This is consistent with data from rural individuals with diabetes in Alberta,

where treatment gaps for hyperglycemia, hypertension, and dyslipidemia were detected.[23] Moreover, our observations of undiagnosed diabetes complications support other reports showing high rates of complications among aboriginals in both Canada and the United States.[6-10,37] The prevalence of complications is expected to increase with the rise in diabetes prevalence in First Nations communities.[38] However, clinical trials have shown that modest improvements in HbA_{1c} levels, blood pressure, and blood lipid levels can reduce risk of complications.[39-42] These findings, in conjunction with our demonstration of suboptimal diabetes care, indicate that enhancement in quality of care and interventions to improve diabetes control are critical in First Nations communities. Community-based programs like SLICK, updated Canadian CPGs,[43] improved diabetes treatments and care, and federally funded health promotion and prevention activities have been introduced to help close treatment gaps. Future longitudinal SLICK results are expected to determine whether or not improvements in diabetes care among Alberta First Nations people are occurring.

Limitations

Because health records were not accessed, the accuracy of our subjective assessments derived from the survey are likely less robust than our objective measures, and thus must be regarded with caution. Moreover, participants were not from a purposefully representative sample and might have been those most concerned about their health. Population-based sampling would have been desirable, but it would have been ethically challenging.[44] Despite these limitations, this work provides valuable community-based information and represents a successful partnership between Alberta First Nations people, Health Canada, the Implementation Committee of the Aboriginal Diabetes Initiative, and the University of Alberta.

Conclusion

Diabetes care was suboptimal and diabetes care guidelines were generally not being met in Alberta First Nations individuals living on reserves. Given the lack of literature on diabetes care in this population, our results help narrow a gap in knowledge. Strategies aimed at improving metabolic control, treatment gaps, and screening for diabetes complications will be critical for rural physicians caring for First Nations individuals. The lack of a multidisciplinary team approach to diabetes care and little knowledge among patients about diabetes screening and prevention are likely important factors that resulted in the observed suboptimal health status and care. Additionally, high rates of undiagnosed diabetes complications as well as sex differences in the risk of diabetes complications were observed and should be considered by those providing diabetes care in this population.

Our findings justify the need for community-based screening for diabetes complications and improvement

in diabetes care in First Nations communities. The SLICK project continues to provide a multidisciplinary team of health care providers (nurses, dietitians, retinal photographers) and aims to integrate care with rural family doctors and rural (on-reserve) health centre staff. Forthcoming results from SLICK are expected to shed some light on whether or not diabetes care improvements are occurring in First Nations communities. ❧

Mr Oster is a research assistant in the Department of Medicine at the University of Alberta in Edmonton. **Dr Virani** is Senior Medical Specialist at the Centre for Immunization and Respiratory Infectious Diseases, Clinical Assistant Professor in the Faculty of Medicine and Dentistry at the University of Alberta, and Adjunct Clinical Professor in the Faculty of Medicine at the University of Calgary. **Dr Strong** is Deputy Medical Officer of Health for the Calgary Health Region, and formerly worked for the First Nations and Inuit Health Branch of Health Canada. **Ms Shade** is Director of Home Care for the Blood Tribe Department of Health. **Dr Toth** is a Professor in the Division of Endocrinology of the Department of Medicine at the University of Alberta.

Contributors
Mr Oster contributed to analysis and interpretation of data, drafted the manuscript, and handled revisions. **Dr Virani** conceived the analytical plan and contributed to manuscript revisions. **Dr Strong** conceived the study design and contributed to manuscript revisions. **Ms Shade** implemented the study, aided in the acquisition of data, contributed to manuscript revisions, and represented the Aboriginal Diabetes Initiative. **Dr Toth** contributed to study design and to the analytical plan, and revised and provided final approval for the manuscript.

Competing interests
None declared

Correspondence
Mr Richard T. Oster, University of Alberta, Medicine, 362C Heritage Medical Research Centre, Edmonton, AB T6G 2S2; telephone 780 407-8456; e-mail **roster@ualberta.ca**

References
1. Young TK, Reading J, Elias B, O'Neil JD. Type 2 diabetes mellitus in Canada's First Nations: status of an epidemic in progress. *CMAJ* 2000;163(5):561-6.
2. First Nations Centre, National Aboriginal Health Organization. First Nations regional longitudinal health survey (RHS) 2002/03—results for adults, youth and children living in First Nations communities. Ottawa, ON: First Nations Centre, National Aboriginal Health Organization; 2005.
3. Alberta Diabetes Surveillance System. *Alberta diabetes atlas 2007.* Edmonton, AB: Institute of Health Economics; 2007.
4. Harris SB, Gittelsohn J, Hanley A, Barnie A, Wolever TM, Gao J, et al. The prevalence of NIDDM and associated risk factors in Native Canadians. *Diabetes Care* 1997;20(2):185-7.
5. Kaler SN. The BRAID study: believing we can reduce the Aboriginal incidence of diabetes [dissertation]. Edmonton, AB: University of Alberta; 2005.
6. Berinstein DM, Stahn RM, Welty TK, Leonardson GR, Herlihy JJ. The prevalence of diabetic retinopathy and associated risk factors among Sioux Indians. *Diabetes Care* 1997;20(5):757-9.
7. Dyck RF, Tan L. Rates and outcomes of diabetic end-stage renal disease among registered Native people in Saskatchewan. *CMAJ* 1994;150(2):203-8.
8. Molitch ME, DeFronzo RA, Franz MJ, Keane WF, Mogensen CE, Parving HH, et al. Nephropathy in diabetes. *Diabetes Care* 2004;27(Suppl 1):S79-83.
9. Zhang Y, Lee ET, Devereux RB, Yeh J, Best LG, Fabsitz RR, et al. Prehypertension, diabetes, and cardiovascular disease risk in a population-based sample: the Strong Heart Study. *Hypertension* 2006;47(3):410-4.
10. Macaulay AC, Montour LT, Adelson N, Macaulay AC, Montour LT, Adelson N. Prevalence of diabetic and atherosclerotic complications among Mohawk Indians of Kahnawake, PQ. *CMAJ* 1988;139(3):221-4.
11. Green C, Blanchard J, Wajda A, Depew N, Cooke C, Brazeau L, et al. Projecting future diabetes prevalence in Manitoba First Nations. In: *Proceedings of the 4th International Conference on Diabetes and Aboriginal People, San Diego, 1997.* Tucson, AZ: Native American Research and Training Center, University of Arizona; 1999.
12. Mak DB, Whitehead S, Plant AJ. So far and yet so close: quality of management of diabetes in Australian and Canadian Indigenous communities. *Aust J Rural Health* 2004;12(5):206-9.
13. Hanley AJ, Harris SB, Mamakeesick M, Goodwin K, Fiddler E, Hegele RA, et al. Complications of type 2 diabetes among Aboriginal Canadians: prevalence and associated risk factors. *Diabetes Care* 2005;28(8):2054-7.

14. Virani S, Datta NK. The SLICK project: Screening for Limb, Eye, Cardiovascular, and Kidney complications of diabetes using mobile diabetes clinics. An Alberta First Nations project. Edmonton, AB: Canadian Health Infostructure Partnership Program, Health Canada; 2004.

15. Virani S, Strong D, Tennant M, Greve M, Young H, Shade S, et al. Rationale and implementation of the SLICK project: Screening for Limb, I-eye, Cardiovascular and Kidney (SLICK) complications in individuals with type 2 diabetes in Alberta's First Nations communities. *Can J Public Health* 2006;97(3):241-7.

16. Michigan Diabetes Research and Training Centre. *Diabetes history form.* Ann Arbor, MI: Michigan Diabetes Research and Training Center; 1998. Available from: **www.med.umich.edu/mdrtc/profs/documents/svi/dh20.pdf**. Accessed 2008 Mar 10.

17. Michigan Diabetes Research and Training Center. *Michigan Diabetes Research and Training Center's brief diabetes knowledge test.* Ann Arbor, MI: Michigan Diabetes Research and Training Center; 1998. Available from: **www. med.umich.edu/mdrtc/profs/documents/svi/dkt5answers.pdf**. Accessed 2008 Mar 10.

18. Ware J Jr, Kosinski M, Keller SD. A 12-item short form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996;34(3):220-33.

19. Meltzer S, Leiter L, Daneman D, Gerstein HC, Lau D, Ludwig S, et al. 1998 clinical practice guidelines for the management of diabetes in Canada. Canadian Diabetes Association. *CMAJ* 1998;159(Suppl 8):S1-29.

20. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2003 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes* 2003;27(Suppl 2):S1-152.

21. Statistics Canada. *Health care services: recent trends.* Ottawa, ON: Statistics Canada; 2000. Available from: **www.statcan.ca/bsolc/english/bsolc?catno=82-003-X19990034938**. Accessed 2008 Mar 10.

22. Statistics Canada. *Obesity and the eating habits of the Aboriginal population.* Ottawa, ON: Statistics Canada; 2008. Available from: **www.statcan.gc.ca/daily-quotidien/080123/dq080123a-eng.htm**. Accessed 2008 Mar 10.

23. Toth EL, Majumdar SM, Lewanczuk RZ, Lee TK, Johnson JA. Compliance with clinical practice guidelines for type 2 diabetes in rural patients: treatment gaps and opportunities for improvement. *Pharmacotherapy* 2003;23(5):659-65.

24. Wandell PE, Gafvels C. Patients with type 2 diabetes aged 35-64 years at four primary health care centres in Stockholm County, Sweden. Prevalence and complications in relation to gender and socio-economic status. *Diabetes Res Clin Pract* 2004;63(3):195-203.

25. Hayward LM, Burden ML, Burden AC, Blackledge H, Raymond NT, Botha JL, et al. What is the prevalence of visual impairment in the general and diabetic populations: are there ethnic and gender differences? *Diabet Med* 2002;19(1):27-34.

26. Lundman B, Engstrom L. Diabetes and its complications in a Swedish county. *Diabetes Res Clin Pract* 1998;39(2):157-64.

27. Lee WL, Cheung AM, Cape D, Zinman B. Impact of diabetes on coronary artery disease in women and men: a meta-analysis of prospective studies. *Diabetes Care* 2000;23(7):962-8.

28. Huxley R, Barzi F, Woodward M. Excess risk of fatal coronary heart disease associated with diabetes in men and women: meta-analysis of 37 prospective cohort studies. *BMJ* 2006;332(7533):73-8.

29. Kanaya AM, Grady D, Barrett-Connor E. Explaining the sex difference in coronary heart disease mortality among patients with type 2 diabetes mellitus: a meta-analysis. *Arch Intern Med* 2002;162(15):1737-45.

30. Public Health Agency of Canada. Chapter 5: Use of health services and costs. In: *Diabetes in Canada.* 2nd ed. Ottawa, ON: Health Canada; 2003. Available from: **www.phac-aspc.gc.ca/publicat/dic-dac2/english/41chap5-eng.php**. Accessed 2008 Sep 15

31. Jin A, Martin JD, Sarin C. Diabetes mellitus in the First Nations population of British Columbia, Canada. Part 2. Hospital morbidity. *Int J Circumpolar Health* 2002;61(3):254-9.

32. Epidemiology Unit and Diabetes Unit, Manitoba Health. *Epidemiology of diabetes in First Nations.* Winnipeg, MB: Manitoba Health; 1997.

33. C.A. MacDonald and Associates. *Physician retention in rural Alberta: an update of pockets of good news (1994).* Edmonton, AB: Rural Physician Action Plan; 2002.

34. Hakes J, Bai M, Tolhurst H, Dickinson JA. Rural intentions: factors affecting the career choices of family medicine graduates. *Can Fam Physician* 2008;54:1016-7.

35. Harris SB, Stewart M, Brown JB, Wetmore S, Faulds C, Webster-Bogaert S, et al. Type 2 diabetes in family practice. Room for improvement. *Can Fam Physician* 2003;49:778-85.

36. McDermott RA, Tulip F, Schmidt B. Diabetes care in remote northern Australian Indigenous communities. *Med J Aust* 2004;180(10):512-6.

37. Johnson S, Martin D, Sarin C. Diabetes mellitus in the First Nations population of British Columbia, Canada. Part 3. Prevalence of diagnosed cases. *Int J Circumpolar Health* 2002;61(3):260-4.

38. Green C, Blanchard JF, Young TK, Griffith J. The epidemiology of diabetes in the Manitoba-registered First Nation population: current patterns and comparative trends. *Diabetes Care* 2003;26(7):1993-8.

39. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 1998;352(9131):837-53. Erratum in: *Lancet* 1999;354(9178):602.

40. Goldberg RB, Mellies MJ, Sacks FM, Moye LA, Howard BV, Howard WJ, et al. Cardiovascular events and their reduction with pravastatin in diabetic and glucose-intolerant myocardial infarction survivors with average cholesterol levels: subgroup analyses in the Cholesterol And Recurrent Events (CARE) trial. The Care Investigators. *Circulation* 1998;98(23):2513-9.

41. UK Prospective Diabetes Study (UKPDS) Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ* 1998;317(7160):703-13. Erratum in: *BMJ* 1999;318(7175):29.

42. Gaede P, Lund-Andersen H, Parving HH, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. *N Engl J Med* 2008;358(6):580-91.

43. Canadian Diabetes Association. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes* 2008;32(Suppl 1):S1-201.

44. Canadian Institutes of Health Research. *CIHR guidelines for health research involving Aboriginal people.* Ottawa, ON: Canadian Institutes of Health Research; 2007.

———✳✳———