Can J Diabetes 40 (2016) 242–246

Contents lists available at ScienceDirect

Canadian Journal of Diabetes

journal homepage: www.canadianjournalofdiabetes.com

Original Research

Agreement of Point-of-Care Capillary Glycated Hemoglobin Levels with Conventional Screening Tests for Diabetes Mellitus in a Canadian First Nations Population

Jessica Mackenzie-Feder MD, FRCPC [a], Andrew Jin MD, MHSc [b,*], David W. Seccombe MD, FRCPC [c], Sandra Sirrs MD, FRCPC [a], Carolyne Neufeld BSc, MA [d], Keith G. Dawson MD, FRCPC [a]

[a] *Division of Endocrinology, Department of Medicine, Faculty of Medicine, University of British Columbia, Vancouver, British Columbia, Canada*
[b] *Epidemiology consultant, Surrey, British Columbia, Canada*
[c] *Canadian External Quality Assessment Laboratory and Department of Pathology and Laboratory Medicine, Faculty of Medicine, University of British Columbia, Vancouver, British Columbia, Canada*
[d] *Seabird Island Band, Agassiz, British Columbia, Canada*

ARTICLE INFO

Article history:
Received 8 August 2015
Received in revised form
3 November 2015
Accepted 9 November 2015

Keywords:
glycated hemoglobin
glycohemoglobin
Aboriginal
Indians, North American (MeSH)
Indigenous population (MeSH)
type 2 diabetes

ABSTRACT

Objectives: 1) How closely do capillary glycated hemoglobin (A1C) levels agree with venous A1C levels? 2) How well do venous A1C levels agree with plasma glucose for diagnosis of diabetes in this population? *Methods:* The Seabird Island mobile diabetes clinic screened people not known to have diabetes by using finger-prick capillary A1C levels with point-of-care analysis according to the Siemens/Bayer DCA 2000 system. Clients then went to a clinical laboratory for confirmatory testing for venous A1C levels, fasting plasma glucose (FPG) and plasma glucose 2 hours after 75 g oral glucose load (2hPG). A reference laboratory compared the DCA 2000 and the clinical laboratory's Roche Integra 800CTS system to the National Glycohemoglobin Standardization Program Diabetes Control and Complications Trial (DCCT) reference. *Results:* 1) In the reference laboratory, DCA 2000 and Integra 800CTS both agreed very closely with the DCCT standard. In the field, capillary glycated hemoglobin percent (A1C) % was biased, underestimating venous A1C % by a mean of 0.19 ($p<0.001$). The margin of error of bias-adjusted capillary A1C % was ±0.36 for 95% of the time, compared to ±0.27 for venous A1C%. 2) By linear regression, we found FPG 7.0 mmol/L and 2hPG 11.1 mmol/L predicted mean venous A1C levels very close to 6.5%, with no significant bias. *Conclusions:* Point-of-care capillary A1C did not perform as well in the field as in the laboratory, but the bias is correctible, and the margin of error is small enough that the test is clinically useful. In this population, venous A1C levels ≥6.5% agree closely with the FPG and 2hPG thresholds to diagnose diabetes; ethnic-specific adjustment of the venous A1C threshold is not necessary.

Mots clés :
hémoglobine glyquée
glycohémoglobine
Autochtone
Indiens d'Amérique du Nord (Inserm)
population indigène (Inserm)
diabète de type 2

RÉSUMÉ

Objectifs : 1) Dans quelle mesure les taux d'hémoglobine glyquée (A1c) du sang capillaire correspondent-ils aux taux d'A1c du sang veineux? 2) Dans quelle mesure les taux d'A1c du sang veineux correspondent-ils à la glycémie veineuse pour le diagnostic du diabète de cette population? *Méthodes :* La clinique mobile de diabète de la Seabird Island faisait subir un test de dépistage aux personnes qui ignoraient si elles avaient le diabète en utilisant les taux d'A1c obtenus par prélèvement du sang capillaire au bout du doigt et analysés hors laboratoire selon le système Siemens/Bayer DCA (dichloroacétate) 2000. Les clients se rendaient ensuite dans un laboratoire clinique pour l'épreuve de confirmation des taux d'A1c du sang veineux, de la glycémie veineuse à jeun (GVJ) et de la glycémie veineuse 2 heures après l'ingestion de 75 g de glucose par voie orale (GV2h). Un laboratoire de référence comparait le DCA (dichloroacétate) 2000 et l'Integra 800CTS de Roche à la méthode de référence de l'étude DCCT (Diabetes Control and Complications Trial) du programme NGSP (National Glycohemoglobin Standardization Program).

* Address for correspondence: Andrew Jin, MD, MHSc, 2762-133 Street, Surrey, British Columbia V4P 1X9, Canada.
E-mail address: jin2007a@gmail.com

1499-2671 © 2015 Canadian Diabetes Association.
http://dx.doi.org/10.1016/j.jcjd.2015.11.003

Résultats : 1) Au laboratoire de référence, le DCA 2000 et l'Integra 800CTS correspondaient très étroitement aux normes de la DCCT. Sur le terrain, le % d'A1c du sang capillaire était biaisé, puisqu'il sous-estimait le % de l'A1c du sang veineux de 0,19 en moyenne ($p < 0,001$). La marge d'erreur du % d'A1c du sang capillaire ajusté au biais était de ± 0,36 dans 95% du temps comparativement à ± 0,27 pour le % d'A1c du sang veineux. 2) Dans la régression linéaire, nous avons observé qu'une GVJ de 7,0 mmol/l et une GV2h de 11,1 mmol/l prédisaient des taux moyens d'A1c du sang veineux se rapprochant de 6,5%, sans biais significatifs.
Conclusions : Les taux d'A1c du sang capillaire hors laboratoire n'avaient pas un aussi bon rendement qu'au laboratoire, mais le biais est corrigible et la marge d'erreur est si petite que les analyses sont utiles sur le plan clinique. Dans cette population, les taux d'A1c du sang veineux ≥6,5% correspondent étroitement aux seuils du GVJ et du GV2h pour diagnostiquer le diabète. L'ajustement sur l'ethnicité du seuil d'A1c du sang veineux n'est pas nécessaire.

Introduction

Since December 2009, the Seabird Island Band (www.seabirdisland.ca) has operated a mobile diabetes clinic serving 70 First Nations bands in the southern mainland of British Columbia, which have a population of 22 435 residing on reserves. The mobile clinic team travels to First Nations communities and provides diabetes-care services recommended by the current Clinical Practice Guidelines (1): focused interview and physical examination (height, weight, blood pressure measurement, vascular and neural foot examination), point-of-care laboratory tests (glycated hemoglobin [A1C] levels, fasting serum lipid profile, serum creatinine, urinary albumin-to-creatinine ratio, estimated glomerular filtration rate), and eye examination (retinal photography, tonometry). A certified diabetes nurse educator provides personal diabetes-management education. The examination record is entered into a web-based information system, then is reviewed by an endocrinologist and an ophthalmologist, and recommendations are sent to the clients' primary care providers. From April 2011 through May 2013, the mobile clinic implemented a pilot program of community-based screening to detect previously undiagnosed diabetes, using finger-prick capillary A1C levels with point-of-care analysis. We compare this A1C measurement method to conventional screening tests. These were the research questions:

How closely do capillary A1C levels agree with venous A1C levels?

Glycated hemoglobin (A1C) can be measured in venous blood or in capillary blood (obtained by finger-prick). Portable point-of-care systems testing A1C levels in capillary blood are very acceptable to clients and are useful in settings where clinical laboratory services are not readily available. However, to diagnose diabetes, the clinical Practice Guidelines specify that A1C levels be measured in venous blood, using a validated assay standardized to the National Glycohemoglobin Standardization Program-Diabetes Control and Complications Trial (DCCT) reference (2). Correlation of capillary A1C levels with venous A1C levels has received only limited study (3). To monitor clients with known diabetes, the Seabird Island mobile diabetes clinic measures capillary A1C levels using the Bayer (Siemens, Munich, Germany) DCA 2000 point-of-care system. We test how closely this capillary A1C level measurement method agrees with the DCCT reference standard directly and with a DCCT-validated venous A1C assay by a commercial clinical laboratory.

In this program's target population, how well do venous A1C levels agree with plasma glucose, for purposes of diagnosing diabetes?

The Canadian Diabetes Association Clinical Practice Guidelines Expert Committee accepts 3 tests to diagnose diabetes: A1C levels, fasting plasma glucose (FPG), and plasma glucose measured 2 hours after a 75 gram oral glucose load (2hPG) during an oral glucose tolerance test (OGTT) (2). A1C-level testing does not require fasting or waiting, so it is more convenient than the other 2 tests. In the general populations of Canada and the United States, any one of A1C ≥6.5%, FPG ≥7.0 mmol/L or 2hPG ≥11.1 mmol/L is considered diagnostic of diabetes (subject to confirmation by repeat of the same test) because all 3 thresholds are independently associated with similar probability of diabetic retinopathy (2,4,5). However, a study in the United States found that American Indian subjects had mean A1C levels 0.36 higher than Caucasian subjects (6.12% vs. 5.76%) after adjusting for plasma glucose measured before and during OGTT (6). This suggests that among American Indian populations, the criterion of A1C levels ≥6.5% would be biased toward overestimating the prevalence of diabetes, and the threshold should be adjusted upward by 0.36 to correct the bias. Among Canadian First Nations populations, the correlation of A1C levels with FPG and 2hPG has received only limited study (7) and, as noted in the 2013 Clinical Practice Guidelines, more research may help to determine whether an ethnicity-specific adjusted A1C threshold is needed (2). The question can be definitively answered only by a study comparing the predictive validities of A1C levels, FPG and 2hPG with respect to the presence of diabetic retinopathy among the Canadian First Nations population. As an exploratory first step, we tested the hypothesis that the 3 thresholds (A1C levels = 6.5%, FPG = 7.0 mmol/L, and 2hPG = 11.1 mmol/L) are inconsistent with each other when applied to a Canadian First Nations population.

Methods

The University of British Columbia Clinical Research Ethics Board reviewed and approved the methods (file H10-02551). All subjects gave informed consent (or assent in the case of minors).

The Seabird Island Band, collaborating with First Nations leaders, community health centres and local healthcare providers, organized diabetes-awareness events in 5 First Nations communities: 4 in the urban-influenced Fraser Valley and 1 in the rural Bella Coola Valley. Each event was a 1-day program about preventing and living well with diabetes. Everyone in the community was invited. There were talks by community leaders, healthcare providers and people with diabetes, with questions and discussions, traditional dances and songs and dinners of traditional foods. These events promoted diabetes awareness, prevention and improved management. They also helped the community to build relationships with healthcare providers and to access resources.

During these events, Seabird Island mobile diabetes clinic nurses offered screening for diabetes to people 10 years of age or older who were not known to have diabetes. The screening test included A1C levels measured in capillary blood collected by finger-prick and analyzed by a DCA 2000 point-of-care system. If A1C levels were ≥5.7%, the nurse directed the person to the nearest BC Biomedical Laboratory specimen-collection point for confirmatory testing (venous A1C levels, FPG and OGTT with 2hPG), with instructions to attend within 1 week and to arrive after fasting. To reduce the travel burden, a phlebotomist visited the Fraser Valley sites to collect venous blood specimens. The Bella Coola Valley site was 4.6 km from the nearest