

Screening for Type 2 Diabetes in a High-risk Pediatric Population: Capillary vs. Venous Fasting Plasma Glucose

Elizabeth A.C. Sellers MSc MD FRCPC, Heather J. Dean MD FRCPC

Department of Pediatrics and Child Health, University of Manitoba, Winnipeg, Manitoba, Canada

ABSTRACT

OBJECTIVE

Annual screening by fasting plasma glucose (FPG) is recommended in Manitoba in children and youth at high risk for youth-onset type 2 diabetes. Access to venous blood is difficult in some remote jurisdictions. The objective of this project was to examine the utility of a capillary blood sample for FPG as the initial screening test for diabetes in a pediatric population at risk.

METHODS

We conducted a school-based diabetes screening project in 250 youth (ages 6 to 18 years) in a high-risk First Nations community. Fasting finger stick capillary plasma glucose and venous plasma glucose were performed consecutively.

RESULTS

Capillary FPG differed from venous FPG by >1.0 mmol/L in 31/250 (12.4%), and in 28/31 (90.3%) capillary FPG values exceeded the value obtained for venous FPG. No new cases of diabetes or impaired fasting glucose were identified.

Address for correspondence:

Elizabeth A.C. Sellers
 Department of Pediatrics and Child Health
 University of Manitoba
 FE 307-685 William Avenue
 Winnipeg, Manitoba
 R3E 0Z2 Canada
 Telephone: (204) 787-4351
 Fax: (204) 787-1655
 E-mail: esellers@exchange.hsc.mb.ca

Keywords: capillary plasma glucose, children, fasting plasma glucose, First Nations, screening for type 2 diabetes

RÉSUMÉ

OBJECTIF

Au Manitoba, chez les enfants et les adolescents qui présentent un risque élevé de diabète de type 2, on recommande un dépistage annuel au moyen du dosage de la glycémie à jeun. Il est difficile d'obtenir du sang veineux dans certaines régions éloignées. L'objectif de ce projet était d'évaluer si un échantillon de sang capillaire pouvait être utilisé pour mesurer la glycémie à jeun comme moyen de dépistage initial du diabète chez les enfants à risque.

MÉTHODE

Nous avons mené un programme de dépistage du diabète dans une école auprès de 250 jeunes (de 6 à 18 ans) d'une collectivité de Premières nations à risque. Nous avons mesuré simultanément la glycémie à jeun à partir de sang capillaire prélevé au bout du doigt et à partir de sang veineux.

RÉSULTATS

Il y a eu une différence $> 1,0$ mmol/L entre la glycémie capillaire à jeun et la glycémie veineuse à jeun chez 31 des 250 jeunes (12,4 %) et chez 28 de ces 31 jeunes (90,3 %), la glycémie capillaire à jeun était supérieure à la glycémie veineuse à jeun. Nous n'avons pas dépisté de nouveaux cas de diabète ni d'anomalies de la glycémie à jeun.

CONCLUSION

La glycémie capillaire à jeun est un moyen de dépistage acceptable dans ce contexte et peut se révéler utile dans les régions où l'accès aux ponctions veineuses est difficile.

CONCLUSION

Capillary FPG is an acceptable tool for screening in this setting and may provide a more practical tool for use in jurisdictions where access to venipuncture is difficult.

INTRODUCTION

Type 2 diabetes is increasing in children and youth (1). Children and youth of First Nations origin in Manitoba are at particular risk (2). The prevalence of type 2 diabetes in children and youth approaches 1% in some First Nations communities (3). The College of Physicians and Surgeons of Manitoba recommends that First Nations children >6 years of age with any additional risk factor (obesity, acanthosis nigricans, positive family history) be screened for diabetes on an annual basis with a venous fasting plasma glucose (vFPG) (4). The Canadian Diabetes Association (CDA) 2003 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada recommend biannual screening using a vFPG test in children ≥ 10 years of age with any 2 of the following risk factors: high-risk ethnicity, family history, especially exposure in utero, acanthosis nigricans, hypertension, dyslipidemia or polycystic ovarian syndrome (5). The more aggressive screening recommendations in Manitoba reflect the higher prevalence of youth-onset type 2 diabetes in Manitoba.

More than 50% of the First Nations population in Manitoba lives outside urban centres, many in remote fly-in communities (6). Access to venipuncture is difficult in children and may not be practical in many communities served by a nursing station and itinerant physicians.

Capillary PG, using modern point-of-care meters, has been shown to produce similar results as the reference laboratory methods in individuals with diabetes across a wide range of glycemia (7). Recently, a large epidemiologic study validated the use of capillary PG measurements in the general adult population (8). This, however, has not yet been shown in a high-risk pediatric population.

The objective of this study was to examine the utility of capillary FPG (cFPG) as the initial screening test for diabetes in a pediatric population at risk for youth-onset type 2 diabetes. This method was compared with a vFPG using the CDA criteria for the diagnosis of diabetes and/or dysglycemia (5).

METHODS

This study was conducted as part of a larger project designed to gather baseline data on the prevalence of diabetes and modifiable risk factors for the development of type 2 diabetes in youth from a First Nations community. The project was initiated at the request of the community diabetes working group.

The study took place within the single school in the study community (kindergarten to grade 12). All children in grades 2 to 12 were offered the opportunity to participate. The project was advertised throughout the community using several media. Community meetings were held in the months

that preceded the screening project, information articles were placed in the community health newsletter and public service announcements were made on the local radio channel.

Screening took place over a 4-month period during the first school term. An information sheet and consent forms were sent home with the children. Participants were instructed to have nothing to eat or drink after 10 PM the evening prior to participation. Breakfast was provided on the day of testing to encourage the participants to arrive fasting. Proper hand washing prior to cFPG was observed. A finger stick cFPG and a vFPG were performed consecutively. Abnormalities in glycemic control were classified according to the 2003 CDA clinical practice guidelines (5).

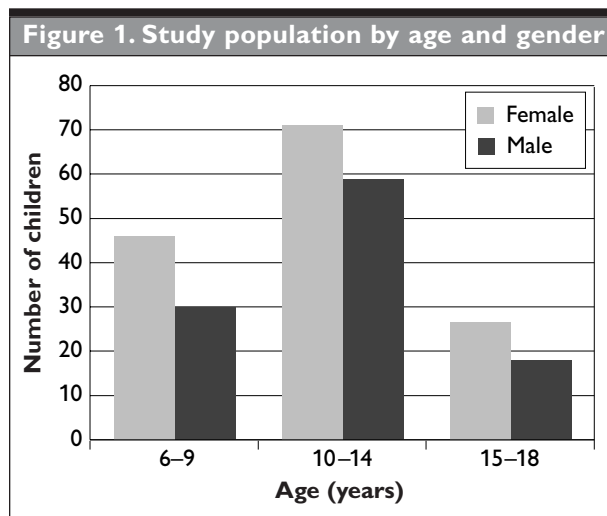
Finger stick cFPG testing was performed using the Ascencia Elite[®] home blood glucose meter (Bayer Healthcare, Toronto, Ontario, Canada). In accordance with standards, single-use lancing devices were used for cFPG. vFPG samples were analyzed using the Roche Modular (Roche Diagnostics, Laval, Quebec, Canada) at the Winnipeg Health Sciences Centre clinical chemistry laboratory.

Much of the data collected were analyzed using descriptive statistics. Capillary and venous PG were compared using the method of Bland and Altman. Using this technique, the difference between the 2 measurements against their mean are plotted (9).

The study was approved by the Institutional Review Board at the University of Manitoba.

RESULTS

Seven hundred seventeen (717) children in grades 2 to 12 were registered in school at the start of the school year. Of



these, 250 (35%) of eligible the children aged 6 to 18 years participated; 143 were female (57.4%), 76 were 6 to 9 years of age (46 females and 30 males), 129 were 10 to 14 years of age (71 females and 58 males) and 44 were 15 to 18 years of age (26 females and 18 males) (Figure 1).

One participant had type 2 diabetes diagnosed prior to the study. There were no new cases of diabetes or impaired fasting glucose (IFG) identified. Nineteen of the 250 participants had a cFPG 6.1 to 6.9 mmol/L and would have been misclassified as having impaired glucose tolerance based on their cFPG (92% specificity).

The mean difference between cFPG and vFPG was 0.16 mmol/L. cFPG differed from vFPG by >0.5 mmol/L in 73/250 (29.2%) children. Of these, cFPG underestimated vFPG in 17/73 (23%) and overestimated vFPG in 56/73 children (77%). cFPG differed from vFPG by >1.0 mmol/L in 31/250 (12.4%). Of the 31 samples where cFPG differed from vFPG by >1.0 mmol/L; 28/31 (90.3%) were overestimated by cFPG. cFPG underestimated vFPG in 3 participants whose cFPG differed from vFPG by >1.0 mmol/L (all of whom were normoglycemic based on vFPG).

Using Bland and Altman's method of comparison, cFPG ranged from 1.25 mmol/L below to 1.57 mmol/L above the vFPG (the limits of agreement) (Figure 2).

DISCUSSION

Capillary PG testing is rapid, inexpensive, safe and can be performed by a layperson with minimal training. Careful attention to hand washing prior to testing is important. The

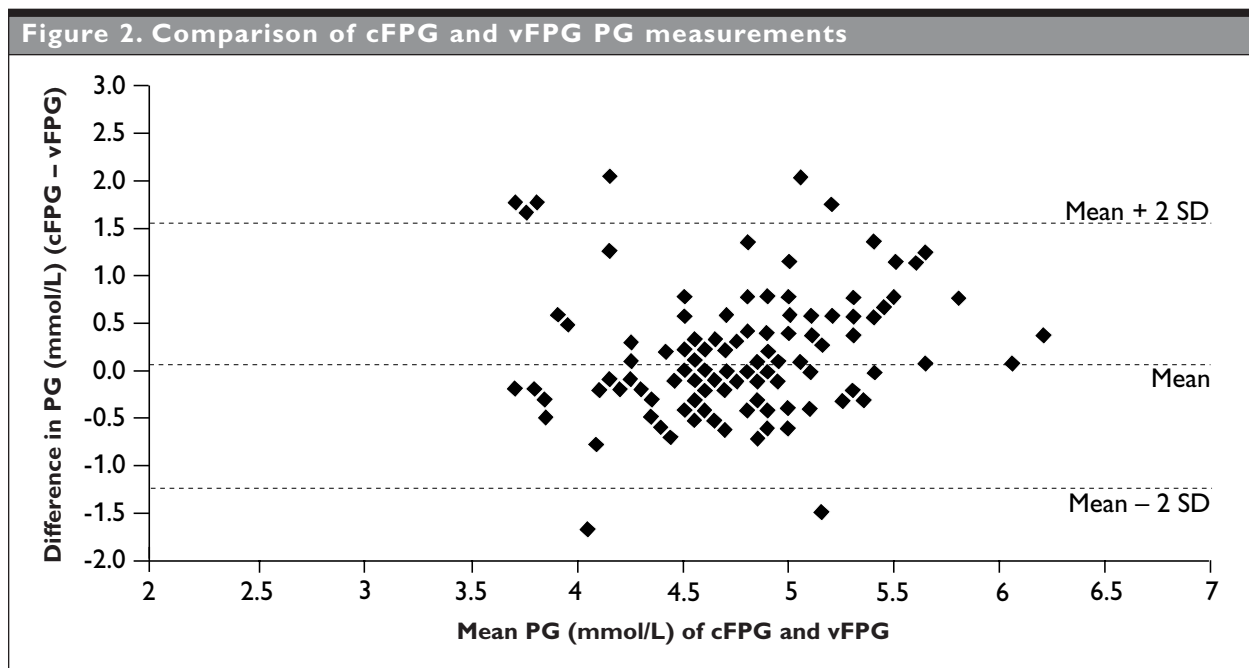
use of single-use, disposable lancing devices is paramount, as transmission of blood-borne infections has been reported with the improper reuse of single-user lancing devices in institutions (10).

Our findings are consistent with a recent report of a population-based screening study of a large number of adults (8). This study found that capillary PG overestimated venous PG in both the fasting state and 2 h after a glucose load. This finding was consistent across individuals with normoglycemia, prediabetes and diabetes. The authors concluded that capillary samples for PG were suitable for use in large epidemiologic studies. In our study, there were no new cases of diabetes or IFG confirmed. Thus, the performance of cFPG across all degrees of glycemia in this high-risk pediatric population cannot be assessed.

The specificity of cFPG was 92%, with 19/250 participants potentially "misclassified" as having IFG based on cFPG. cFPG underestimated vFPG by >0.5 mmol/L in $<7\%$ of this sample and by >1.0 mmol/L in 1.2%. A follow-up confirmatory vFPG for those with a cFPG ≥ 5.5 mmol/L would be a reasonable approach to a 2-step screening process. Using this cut-off value, both the number of false positive tests requiring venous confirmation and the potential for missing the diagnosis of diabetes would be minimized.

CONCLUSION

In summary, in a pediatric population at risk for the development of type 2 diabetes, cFPG is more likely to overestimate than underestimate vFPG. The agreement between



cFPG = capillary fasting plasma glucose
 PG = plasma glucose
 SD = standard deviation
 vFPG = venous fasting plasma glucose

cFPG and vFPG was acceptable. We found cFPG to be a suitable tool for screening of type 2 diabetes in children in this setting, and one that may be a more practical for use in jurisdictions where access to venipuncture is difficult.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contribution of Shirley Gunther RN (study nurse) and Evelyn Roulette (study assistant). They would also like to acknowledge the input and support provided by the community diabetes working group. This work was supported by a grant from the Manitoba Institute of Child Health. Capillary blood glucose strips were provided by Bayer Inc.

AUTHOR DISCLOSURES

No duality of interest declared.

REFERENCES

1. Fagot-Campagna A. Emergence of type 2 diabetes mellitus in children: epidemiological evidence. *J Pediatr Endocrinol Metab.* 2000;13(suppl 6):1395-1402.
2. Dean H. NIDDM-Y in First Nation children in Canada. *Clin Pediatr.* 1998;37:89-95.
3. Dean H, Young T, Flett B, et al. Screening for type-2 diabetes in Aboriginal children in northern Canada. *Lancet.* 1998; 352:1523-1524.
4. College of Physicians and Surgeons of Manitoba. *Screening for Type II Diabetes in Aboriginal Children.* Winnipeg, MB: College of Physicians and Surgeons of Manitoba; 2000. Publication 923.
5. 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-S152.
6. Indian and Northern Affairs Canada. Registered Indian population by sex and residence 1999. Available at: http://www.ainc-inac.gc.ca/pr/sts/rip/ripsr99_e.html. Accessed October 31, 2005.
7. Solnica B, Naskalski JW, Sieradzki J. Analytical performance of glucometers used for routine glucose self-monitoring of diabetic patients. *Clin Chim Acta.* 2003;331:29-35.
8. Kruijshoop M, Feskens EJ, Blaak EE, et al. Validation of capillary glucose measurements to detect glucose intolerance or type 2 diabetes mellitus in the general population. *Clin Chim Acta.* 2004;341:33-40.
9. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet.* 1986;1:307-310.
10. Polish LB, Shapiro CN, Bauer F, et al. Nosocomial transmission of hepatitis B virus associated with the use of a spring-loaded finger-stick device. *N Engl J Med.* 1992;326:721-725.