

available at www.sciencedirect.comjournal homepage: www.elsevier.com/locate/diabres

Brief report

Self-monitoring of blood glucose in type 2 diabetes: An inter-country comparison

The SMBG International Working Group^{1,2}

ARTICLE INFO

Article history:

Received 10 March 2008

Received in revised form

15 August 2008

Accepted 26 August 2008

Keywords:

Self-monitoring of blood glucose

Type 2 diabetes

Non-insulin treated

ABSTRACT

Self-monitoring of blood glucose (SMBG) in type 2 diabetic patients was compared across 14 countries. There was an unexpectedly high SMBG-use in non-insulin-treated patients. Reimbursement policies differed by country, region, insurance status, and patient income. More rigorous and systematic data collection is needed to ensure evidence-based SMBG-use.

© 2008 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Those involved in caring for persons with type 2 diabetes must be puzzled by the increasing number of controversial studies, analyses, comments and guidelines on SMBG-use, in particular in non-insulin-treated patients [1–3]. This lack of scientific consensus is reflected by wide variation in reimbursement policies for glucose meters and strips.

A balanced description and discussion of the available evidence is required to take the debate forward. As one step towards this aim we undertook a worldwide survey among SMBG International Working Group members to determine

the prevalence, frequency and reimbursement of SMBG in patients with type 2 diabetes.

2. Methods

We conducted a cross-sectional survey in 2007 of current Group members in 14 countries worldwide on the use of SMBG by people with type 2 diabetes, frequency of strip-use, strip reimbursement policies and the unsubsidized cost of a strip in their countries. A detailed questionnaire ([available online](#)) was used and additional comments invited. To facilitate inter-

¹ Corresponding author: W. A. Davis, University of Western Australia, School of Medicine and Pharmacology, Fremantle Hospital, PO Box 480, Fremantle, Western Australia 6959, Australia. Tel.: +61 8 9431 3641; fax: +61 8 9431 2977.

E-mail address: wdavis@cyllene.uwa.edu.au.

² S. Bot (Amsterdam, Netherlands), T.M.E. Davis (Perth, Australia), W.A. Davis (Perth, Australia), A. Farmer (Oxford, UK), J. J. Gagliardino (La Plata, Argentina), C. Giorda (Regione Piemonte, Italy), P. D. Home (Newcastle-upon-Tyne, UK), G. Jermendy (Budapest, Hungary), L. Ji (Beijing, China), J. Johnson (Edmonton, Canada), A.J. Karter (Oakland, CA, USA), H. Kolb (Dusseldorf, Germany), S. Martin (Dusseldorf, Germany), V. Mohan (Chennai, India), A. Nicolucci (S. Maria Imbaro, CH, Italy), M. Porta (Turin, Italy), A. Ramachandran (Chennai, India), K.L. Ramaiya (Dar es Salaam, Tanzania), J. H. Shah (Tucson, AZ, USA), A.S. Shera (Karachi, Pakistan), S. Skeie (Stavanger, Norway). 0168-8227/\$ – see front matter © 2008 Elsevier Ireland Ltd. All rights reserved.

doi:10.1016/j.diabres.2008.08.021

Table 1 – Use of self-monitoring of blood glucose (SMBG), frequency of testing and reimbursement policy in type 2 diabetes by treatment and country of residence.

	USA [5]	Canada [7]	Argentina [8]	Germany [9,10]	Hungary ^c	Italy [11]	Netherlands ^a
Patients reported using SMBG ^d (%)							
Lifestyle	31.0	22.4	Unknown	5–10 [9]	10	38.8	17.4
OGLM ^e	64.3	62.5	Unknown	35 [9]	30	59.9	36.6
Insulin/insulin + OGLM ^e	87.8	83.1	Unknown	90 [9]	90	88.7	94.8
Average SMBG ^d use: test strips/week)							
Lifestyle	4.4	0.96	2–3	14.0 [10]	2	1.43	2.29
OGLM ^e	5.2	3.84	14	14.0 [10]	3	2.47	2.88
Insulin/insulin + OGLM ^e	13.6	9.13	18–20	18.9 [10]	10	5.69	6.90
Reimbursement policy							
Lifestyle	Extent varies	Varies from none to full	Partial and variable	None	None	Extent varies	Partial and variable
OGLM ^e	Extent varies	Varies from none to full	Partial but uniform	Partial and variable	None	Extent varies	Partial and variable
Insulin/insulin + OGLM ^e	Extent varies	Varies from none to full	Full	Full	Partial but uniform	Full	Full
Factors determining supply of subsidized or free strips	Health insurance status and benefit structure [6]	Region of country	Health coverage system	Region and insurance status	Reimbursement for insulin-treated patients	Region of country	
Cost/strip (in local currency)	US\$0.48–1.22	C\$0.45–0.96	ARS2.40–3.00	€0.40–0.70	HUF 49	€0.65–1.00	€0.50–1.00
PPP ^f conversion factor (2006) [4]	1	1.244630	1.059523	0.901240	123.049977	0.838502	0.927817
Cost/strip (I\$)	I\$0.48–1.22	I\$0.36–0.77	I\$2.27–2.83	I\$0.44–0.78	I\$0.40	I\$0.78–1.19	I\$0.54–1.08
	Norway ^a	UK ^{a,b}	Australia [12]	India [13] ^c	Pakistan ^c	China ^a	Tanzania ^c
Patients reported using SMBG ^d (%)							
Lifestyle	44.9	54 ^a	66.4	0 [13]	0	14.3	Unknown
OGLM ^e	72.7	73 ^a	69.7	0 [13]	34.5	23.3	Unknown
Insulin/insulin + OGLM ^e	96.2	93 ^a	81.7	2.4 [13]	68.6	50.2	Unknown
Average SMBG ^d use: test strips/week)							
Lifestyle	Unknown	<2 ^b	3.1	0 ^c	0	3.0	Unknown
OGLM ^e	Unknown	2–6 ^b	3.5	0 ^c	1.2	2.0	Unknown
Insulin/insulin + OGLM ^e	Unknown	7–14 ^b	8.5	0.5 ^c	3.4	2.2	Unknown
Reimbursement policy							
Lifestyle	Full	Full but variable	Partial but uniform	None	None	None-partial and variable	None
OGLM ^e	Full	Full but variable	Partial but uniform	None	None	None-partial and variable	None
Insulin/insulin + OGLM ^e	Full	Full but variable	Partial but uniform	None	None	None-partial and variable	None
Factors determining supply of subsidized or free strips	Prescription from doctor required	Local guidance to clinician	Ability of patient to pay				
Cost/strip (in local currency)	NOK5.83	£0.30–0.32	A\$0.52	INR24–30	PKR24.29	Y4–5	299–364 shillings
PPP ^f conversion factor (2006) [4]	9.83229	0.600832	1.496358	9.654549	19.01225	2.084942	539.9578
Cost/strip (I\$)	I\$0.59	I\$0.50–0.53	I\$0.35	I\$2.49–3.11	I\$1.28	I\$1.92–2.40	I\$0.55–0.67

^a Unpublished data.^b Guidelines.^c Personal assessment.^d SMBG Self-monitoring of blood glucose.^e OGLM Oral glucose lowering medication.^f PPP = purchasing power parity.

country price comparison, we applied the United Nations 2006 purchasing power parities conversion factors from local currencies to the international dollar (I\$) [4].

3. Results

Table 1 gives an overview of reported SMBG-use in type 2 diabetes by country. There were published data for only half these countries [5–13]. No country had data available at the national level. For insulin-treated type 2 patients, the prevalence of SMBG-use was above 80% in most countries with data, except for the three Asian countries. The lowest prevalence of SMBG-use was in India (0.2%) where there is generally no reimbursement and the relative cost of a strip is the highest amongst the countries surveyed. SMBG-use is also likely to be low in Tanzania but there are no confirmatory data available. Only two countries (Norway and the UK) provided free strips to patients taking oral glucose-lowering medication (OGLM), and these reported the highest prevalence of SMBG-use. In half the countries surveyed, the majority of OGLM-treated patients used SMBG.

Monitoring frequency in patients who used SMBG varied markedly between countries (Table 1). In India, insulin-treated patients used SMBG once every 2 weeks, whilst such patients in Argentina and Germany monitored 18–20 times/week. In the remaining countries with data, SMBG frequency ranged from 2 to 14 times/week in insulin-users. Amongst OGLM-treated patients, those living in India did not monitor at all whereas those from Argentina and Germany monitored 14 times/week despite only partial reimbursement of test strips. In the other countries, OGLM-treated patients monitored 1–6 times/week. Diet-treated patients living in India and Pakistan did not monitor, whilst German patients monitored 14 times/week. In other countries, the rate for diet-treated patients ranged from 1 to 4 times/week. Norway, with full reimbursement for strips, had no SMBG frequency data.

SMBG reimbursement policies varied considerably not only by country, but by region within countries, health insurance status, health benefit structure and patient income. In Norway and the UK, SMBG is free for patients with a prescription from a doctor, but in the UK there are constraints on the prescriber limiting use in some districts to those using insulin secretagogues or insulin. In Australia, the co-payment is dependent on patient income and membership of the National Diabetes Services Scheme (membership is free). Pakistan and Tanzania have no reimbursement, whilst in China there is no reimbursement or it is partial and variable. For most diabetic patients in India there is no reimbursement but some get reimbursed by their employer. In the USA there is no consistent reimbursement policy. Reimbursement depends on health insurance status and type of coverage (pharmacy or durable medical equipment benefit). Most patients, however, are covered by managed care with 60% getting free strips, 31% subsidised strips and 9% paying in full [6]. In Canada, reimbursement policy varies by province, ranging from full coverage under a total pharmaceutical benefits programme with co-payments and deductibles to no coverage. Reimbursement depends on the health coverage system in Argentina.

In Germany reimbursement varies by region and health insurance system, but, generally, a limited number of strips (100–200 every 3 months) is reimbursed for patients on bolus and biphasic insulin and up to 600 strips for those on intensive insulin therapy. Some strips may also be reimbursed when a patient is put on OGLMs for better dosing. Reimbursement varies by region in Italy, but insulin-users are completely reimbursed. In Hungary, 85% of the cost of strips is reimbursed for insulin-treated patients only, whilst in the Netherlands strips are fully reimbursed for insulin-users, but reimbursement is partial and variable for non-insulin-users.

The unsubsidized cost of a strip varied from I\$0.35 in Australia to I\$3.11 in India, whilst the relative cost to the patient ranged from nothing to I\$3.11. Strip-cost appears to be a major barrier to use with the lowest use occurring in countries with the highest relative cost.

4. Discussion

Factors that may affect SMBG-use in people with type 2 diabetes include (i) country and region of residence, (ii) diabetes treatment type and (iii) relative cost to the patient. The paucity of national-level data on SMBG-use is surprising given its widespread use and high cost. National guidelines unanimously recommend SMBG in insulin-treated type 2 diabetes [1] and the prevalence of SMBG-use in insulin-users is generally high. In view of the lack of consensus in the value of SMBG in non-insulin-users, the unexpectedly high SMBG-use in OGLM-treated patients worldwide is remarkable, suggesting that treating physicians and/or patients support self-monitoring.

Limitations of this study include the self-reported nature of some of the data, the lack of worldwide coverage, and the lack of a more detailed breakdown on SMBG-use. Strengths of the study are that the data are contemporary and the wide range of countries surveyed across all populated continents.

This *ad hoc* survey highlights the need for more rigorous and systematic data collection across and within countries to ensure evidence-based SMBG-use, particularly in non-insulin-using diabetic patients.

Acknowledgement

Working Group members who contributed to the data presented in Table 1: S. Bot (Netherlands), T.M.E. Davis (Australia), W.A. Davis (Australia), A. Farmer (UK), J.J. Gagliardino (Argentina), C. Giorda (Italy), P.D. Home (UK), G. Jermendy (Hungary), L. Ji (China), J. Johnson (Canada), A.J. Karter (USA), H. Kolb (Germany), S. Martin (Germany), V. Mohan (India), A. Nicolucci (Italy), M. Porta (Italy), A. Ramachandran (India), K.L. Ramaiya (Tanzania), J.H. Shah (USA), A.S. Shera (Pakistan), S. Skeie (Norway).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.diabres.2008.08.021](https://doi.org/10.1016/j.diabres.2008.08.021).

REFERENCES

- [1] J.S. Burgers, J.V. Bailey, N.S. Klazinga, A.K. Van der Bij, R. Grol, G. Feder, et al., Inside guidelines. Comparative analysis of recommendations and evidence in diabetes guidelines from 13 countries, *Diabetes Care* 25 (2002) 1933–1939.
- [2] E. Ipp, R.L. Aquino, P. Christenson, Point: self-monitoring of blood glucose in type 2 diabetic patients not receiving insulin. The sanguine approach, *Diabetes Care* 28 (2005) 1528–1530.
- [3] M.B. Davidson, Counterpoint: self-monitoring of blood glucose in type 2 diabetic patients not receiving insulin. A waste of money, *Diabetes Care* 28 (2005) 1531–1533.
- [4] United Nations Statistics Division, Millenium Development Goals Indicators. Purchasing power parities (PPP) conversion factor, local currency unit to international dollar, Available from <http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=699> (accessed 17.08.07).
- [5] A.J. Karter, M.M. Parker, H.H. Moffett, M.M. Spence, J. Chan, S.L. Ettner, et al., Longitudinal study of new and prevalent use of self-monitoring of blood glucose, *Diabetes Care* 29 (2006) 1757–1763.
- [6] A.J. Karter, M.R. Stevens, W.H. Herman, S. Ettner, D.G. Marrero, M.M. Safford, et al., Out-of-pocket costs and diabetes preventive services: the Translating Research Into Action for Diabetes (TRIAD) study, *Diabetes Care* 26 (2003) 2294–2299.
- [7] J.A. Johnson, S.L. Pohar, K. Secnik, N. Yurgin, Z. Hirji, Utilization of diabetes medication and cost of testing supplies in Saskatchewan 2001, *BMC Health Services Research* 6 (2006) 159.
- [8] J.J. Gagliardino, M. de la Hera, F. Siri, Preliminary evaluation of quality of care of people with diabetes in Argentina, *Revista de la Sociedad Argentina de Diabetes* 35 (2001) 121–133.
- [9] S. Martin, B. Schneider, L. Heinemann, Self-monitoring of blood glucose in type 2 diabetes and long-term outcome: an epidemiological cohort study, *Diabetologia* 49 (2006) 271–278.
- [10] M. Schutt, W. Kern, U. Krause, P. Busch, A. Dapp, R. Grziwotz, et al., Is the frequency of self-monitoring of blood glucose related to long-term metabolic control? Multicenter analysis including 24,500 patients from 191 centers in Germany and Austria, *Experimental and Clinical Endocrinology and Diabetes* 114 (2006) 384–388.
- [11] M. Franciosi, F. Pellegrini, G. de Berardis, et al., The impact of blood glucose self-monitoring on metabolic control and quality of life in type 2 diabetic patients. An urgent need for better educational strategies, *Diabetes Care* 24 (2001) 1870–1877.
- [12] W.A. Davis, D.G. Bruce, T.M.E. Davis, Is self-monitoring of blood glucose appropriate for all type 2 diabetic patients? The Fremantle Diabetes Study, *Diabetes Care* 29 (2006) 1764–1770.
- [13] V. Mohan, R. Deepa, A.K. Shefali, et al., Evaluation of One Touch HORIZON—a highly affordable glucose monitor, *Journal of the Association of Physicians of India* 52 (2004) 779–782.