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SPECIAL ARTICLE

What do professionals recommend regarding the frequency of self-monitoring of blood glucose?

J. Hortensius[1]*, N. Kleefstra[1,2], S.T. Houweling[2,3], J.J. van der Bijl[4], R.O.B. Gans[5], H.J.G. Bilo[1,2,5]

[1]Diabetes Centre, Isala Clinics, Zwolle, the Netherlands, [2]Langerhans Medical Research Group, the Netherlands, [3]Sleeuwijk General Practice, Sleeuwijk, the Netherlands, [4]Faculty of Health, Welfare and Sports, Inholland University of Applied Sciences, Amsterdam, the Netherlands, [5]Department of Internal Medicine, University Medical Centre, Groningen, the Netherlands, *corresponding author: tel:+31 (0)38-4242518, fax +31 (0)38-4247694, e-mail: h.hortensius@isala.nl

ABSTRACT

Background: Patients' adherence to guidelines regarding self-monitoring of blood glucose (SMBG) is limited. However, there are no previous reports about the recommendations that are given in clinical practice concerning SMBG. The aim of this study was to investigate what healthcare providers recommend to insulin-treated patients with diabetes regarding frequency and timing of SMBG.

Methods: In this cross-sectional descriptive study, primary care assistants, diabetes specialised nurses and doctors in the Netherlands were invited via e-mail to complete an internet survey.

Results: A total of 980 (14%) professionals returned the questionnaire. Insulin pump users and patients with type 1 diabetes (T1DM) on 4 injections a day were advised to perform SMBG daily by 96% and 63% of the professionals, respectively. The majority of the professionals advised these patients to perform 3-4 measurements per day. There was less agreement on the timing (pre- and/or postprandial). Patients with type 2 diabetes (T2DM) on four injections were advised to perform SMBG less frequently. There was a wide variation in recommendations that were given to patients with T2DM on less intensive insulin regimens.

Conclusion: This study investigated SMBG from a professional's perspective. A considerable and relevant variation in the recommendations about the number and timing of SMBG was observed. The most striking differences were found in patients with T2DM on less intensive insulin regimes, also with respect to the frequency of SMBG. Well-designed studies are necessary in order to give a more evidence-based advice on the basic frequency and timing of SMBG.

KEYWORDS

Diabetes, frequency, insulin-treated, self-monitoring of blood glucose

INTRODUCTION

A broad consensus exists on the importance of self-monitoring of blood glucose (SMBG) in subjects with diabetes who are treated with insulin. The aim of SMBG is to achieve optimal glycaemic control in order to decrease the risk of long-term complications of diabetes.[1-3] The results of SMBG are used to assess the efficacy of therapy, and to guide adjustments in medication, food intake and physical activity. However, the optimal frequency and timing of SMBG are not known.[3-7] In absence of clear evidence-based recommendations, Diabetes United Kingdom (UK) has undertaken further consultation with professionals and people with diabetes, leading to a wider consensus on the recommendations. An overview of the recommendations of Diabetes UK and the recommendations of the Netherlands, the USA and Canada is presented in *table 1*.[4-7] The recommendations of Diabetes UK, the American Diabetes Association (ADA) and the Canadian Diabetes Association do not differ much. However, the Dutch recommendations generally advise a lower frequency of SMBG.[5]

Several studies investigated the adherence to the SMBG guidelines among patients with diabetes by using questionnaires or databases on the dispensing of blood glucose strips.[8-11] The results of these studies show that patients do not perform SMBG on a regular basis, and patients' adherence regarding SMBG is limited. However,

Table 1. *Guidelines regarding the frequency and timing of self-monitoring of blood glucose in insulin-treated patients with diabetes*

	The Netherlands	UK	ADA	Canada
T1DM and T2DM: 1 or 2 insulin injection(s)	1 day a week or every 2 weeks: 4 times preprandial or 8 times a day	T1DM: ≥2 times a day T2DM: 1-2 times a day, varying the time	T2DM: unclear: SMBG may be useful as a guide to the success of therapy	2 injections: ≥3 times a day, pre- and postprandial 1 injection: ≥once a day at variable times
T1DM and T2DM: MDI	3 days a week: 4 times preprandial or 2 days a week: 8 times	2-4 times a day	≥3 times a day	≥3 times a day, pre- and postprandial
T1DM and T2DM: CSII	3 days a week: 4 times preprandial or 2 days a week: 8 times	4-6 times a day	≥3 times a day	≥3 times a day, pre- and postprandial

CSII = continuous subcutaneous insulin infusion; MDI = multiple daily injections; T1DM = type 1 diabetes mellitus; T2DM = type 2 diabetes mellitus.

there are no previous reports about the recommendations that are given in clinical practice concerning blood glucose testing.

The aim of this study was to investigate what healthcare providers in the Netherlands recommend to insulin-treated patients with diabetes, who are in stable good glycaemic control, regarding the frequency and timing of SMBG.

MATERIALS AND METHODS

Design

In this cross-sectional descriptive study, an internet survey was used to collect data. The study was part of a larger survey. The other part of the internet survey was a questionnaire with ten questions about the interpretation of haemoglobin A1C (HbA1C). The study was carried out from March to June 2010.

Participants

A total of 6965 primary care assistants, diabetes specialised nurses and doctors from the database of the Langerhans Medical Research Group were invited by e-mail to participate in this survey. Furthermore, a message containing a link to the survey was placed on the website of the Dutch Association of Diabetes Care Professionals (EADV).

Data collection

Participants anonymously completed a self-report questionnaire containing a maximum of 33 questions. The questionnaire included three questions about the profession, the province and the number of patients with T1DM and patients with T2DM in their practice. The items of the questionnaire were derived from the SMBG guidelines. The surveys were then checked for clarity, length and inappropriate use of jargon by four diabetes specialised nurses, who did this independently from one another.

Ten subcategories of patients were created, based on the type of diabetes and the kind of insulin therapy. Patients with T1DM were categorised into three groups: (1) patients on 4 insulin injections a day (multiple daily injections, MDI), including short-acting human insulin, (2) MDI, including rapid-acting insulin analogue, and (3) patients with a continuous subcutaneous insulin infusion (CSII). Insulin-treated patients with T2DM were divided into 7 groups: (1) 1 injection with long-acting insulin a day, (2) 2 injections with long-acting insulin a day, (3) 2 injections with premixed insulin a day, including short-acting human insulin, (4) 2 injections with premixed insulin a day, including rapid-acting insulin analogue, (5) MDI, including short-acting human insulin, (6) MDI, including rapid-acting insulin analogue, and (7) CSII.

In the Netherlands, patients with T1DM are almost always treated with MDI or with CSII. Therefore, the recommendations given to patients with T1DM who are using a non-intensive insulin regimen are not included in this study. The same three questions were asked for each category: in general, what advice do you give to insulin-treated patients with diabetes, who are in stable good glycaemic control, regarding:

1. The frequency of SMBG
2. The number of measurements per day
3. The timing of SMBG

In the Netherlands, stable good glycaemic control generally corresponds with an HbA1C < 53 mmol/mol (7.0%).[12]

Data analysis

The questionnaires were analysed using frequency distributions. SPSS software (version 15.0) was used for the analyses.

RESULTS

A total of 980 professionals (14%) returned the questionnaire, including 531 (54%) primary care assistants,

Table 2. *Recommendations regarding frequency of self-monitoring of blood glucose*

Insulin therapy	Every day	1 day a week	2-3 days a week	1 day in 2 weeks	Every month	Before visiting healthcare provider
T1DM						
4 injections with RA/LA; n=171	108 (63)	22 (13)	23 (14)	9 (5)	9 (5)	-
CSII; n=98	94 (96)	2 (2)	1 (1)	1 (1)	-	-
T2DM						
1 injection with LA; n=546	20 (4)	113 (21)	39 (7)	204 (37)	140 (26)	30 (5)
2 injections with LA; n=194	9 (5)	52 (27)	13 (7)	73 (37)	41 (21)	6 (3)
2 injections with PM; n=427	20 (5)	116 (27)	51 (12)	139 (32)	94 (22)	7 (2)
4 injections with RA/LA; n=298	73 (25)	86 (29)	68 (23)	48 (16)	20 (6)	3 (1)
CSII; n= 67	64 (96)	-	3 (4)	-	-	-

Data in n (%): n is the number of professionals. LA = long-acting insulin; PM = premixed insulin with rapid-acting insulin analogue and long-acting insulin; RA/LA = rapid-acting insulin analogue (3 times a day), long-acting insulin (once every day).

168 (17%) diabetes specialised nurses working in a general practice, 166 (17%) diabetes specialised nurses working in an outpatient clinic, 81 (8%) general practitioners, and 34 (4%) other professionals.

An overview of the different recommendations regarding the frequency, number of measurements per day and timing of SMBG given by professionals is presented in *tables 2 to 4*. There were no relevant differences between recommendations that were given to patients who used short-acting human insulin as part of an MDI regimen, and the patients who used rapid-acting insulin analogue. Therefore, the recommendations to patients using short-acting human insulin were not presented in this paper.

In general, there is agreement among professionals with respect to recommendations to patients with either T1DM or T2DM who use CSII to measure their glucose concentration daily. However, about two thirds of the professionals advised these patients to do 3-4 measurements per day, and most of the other professionals advised 5-6 measurements per day. There was less agreement on the timing of SMBG. Alternating pre- or postprandial and pre- and postprandial measurements (about 37%) and preprandial measurements (about 30%) were most frequently advised.

We observed more variation in the recommendations with less intensive insulin regimens. The majority (63%) of the healthcare providers advised patients with T1DM on an MDI regimen to perform SMBG daily, compared with 25% of the patients with T2DM on such a regimen. In both MDI groups, the recommendations on the number of measurements a day were (almost) similar to those in the CSII group. However, the variation in the timing of measurements was greater.

Concerning the frequency of SMBG in patients with T2DM on 1 or 2 insulin injections a day, once every two weeks was most frequently reported (32-37%), followed by one day a week (21-27%) and one day a month (21-26%). Just over 50% of the professionals advised these patients to perform SMBG 3-4 times on the specified days. Preprandial measurements were most frequently advised (29-37%).

Table 3. *Recommendations regarding the number of measurements per day*

Insulin therapy	1-2 a day	3-4 a day	5-7 a day
T1DM			
4 injections with RA/LA; n=171	14 (8)	119 (70)	38 (22)
CSII; n=99	4 (4)	69 (70)	26 (26)
T2DM			
1 injection with LA; n=546	157 (29)	281 (51)	108 (20)
2 injections with LA; n=194	29 (15)	116 (60)	49 (25)
2 injections with PM; n=427	38 (9)	248 (58)	141 (33)
4 injections with RA/LA; n=298	17 (6)	162 (54)	119 (40)
CSII; n=67	7 (10)	43 (64)	17 (26)

Data in n (%): n is the number of professionals. CSII = continuous subcutaneous insulin infusion; LA = long-acting insulin; PM = premixed insulin with rapid-acting insulin analogue and long-acting insulin; RA/LA = rapid-acting insulin analogue (3 times a day), long-acting insulin (once every day); T1DM – type 1 diabetes mellitus; T2DM = type 2 diabetes mellitus.

DISCUSSION

The majority of the professionals in the Netherlands advised patients using CSII (both T1DM and T2DM) and patients with T1DM on an MDI regimen to measure the blood glucose concentration 3-4 times a day. However, there is less agreement on the timing (pre- and/or postprandial with or without alternation) of SMBG. Patients with T2DM were advised to test their blood glucose less frequently, even when they used a similar insulin regimen. Furthermore, our study shows there is a wide variation in

Table 4. *Recommendations regarding the timing of self-monitoring of blood glucose*

Insulin therapy	1[1]	2	3	4	5	6	7	8	9
T1DM									
4 injections with RA/LA; n=171	3 (2)	-	-	64 (37)	10 (6)	19 (11)	28 (16)	28 (16)	19 (12)
CSII; n=99	2 (2)	-	-	29 (29)	1 (1)	12 (12)	12 (12)	39 (40)	4 (4)
T2DM									
1 injection with LA; n=546	55 (10)	32 (6)	45 (8)	168 (31)	80 (14)	33 (6)	53 (10)	10 (2)	70 (13)
2 injections with LA; n=194	2 (1)	11 (6)	15 (8)	72 (37)	33 (17)	13 (7)	22 (11)	7 (3)	21 (10)
2 injections with PM; n=427	2 (1)	19 (5)	31 (7)	124 (29)	89 (21)	39 (9)	65 (15)	19 (4)	39 (9)
4 injections with RA/LA; n=298	0	3 (1)	22 (7)	88 (30)	41 (14)	59 (20)	45 (15)	25 (8)	15 (5)
CSII; n=67	0	0	0	20 (30)	2 (3)	3 (5)	12 (18)	23 (34)	7 (10)

Data in n (%): n is the number of professionals. LA = long-acting insulin; PM = premixed insulin with rapid-acting insulin analogue and long-acting insulin; RA/LA = rapid-acting insulin analogue (3 times a day); long-acting insulin (once every day); [1]) fasting; 2) fasting and before evening meal or bed time; 3) alternating fasting and pre- and/or postprandial; 4) preprandial; 5) postprandial; 6) pre- and postprandial (7 measurements); 7) alternating pre- and postprandial; 8) alternating pre- or postprandial and pre- and postprandial; 9) other.

the recommendations that are given to patients with T2DM on 1 or 2 injections a day with respect to the frequency, the number of measurements per day and the timing of blood glucose testing.

Only a minority of the professionals advised patients with T1DM to perform SMBG 2–3 days a week, as recommended in the Dutch guideline (1-14%).[5] Most of the professionals advised to perform SMBG daily, which is in accordance with the recommendations of the Diabetes UK, the ADA and the Canadian Diabetes Association.[4,6,7] In the guidelines, no distinction is made between the recommendations to patients with T1DM using an intensive insulin regime or CSII, and patients with T2DM with the same insulin regimen. In daily practice, however, patients with T1DM using an intensive insulin regimen were advised to measure more frequently than patients with T2DM with the same insulin regimen. A higher number of professionals (but still only 23%) advised these patients with T2DM to perform SMBG 2-3 days a week, as recommended in the Dutch guideline. Just a quarter of the professionals advised them to test daily.

As for patients with T2DM on 1 or 2 insulin injections per day, 58 to 64% of the professionals reported that they recommend to measure the blood glucose concentration 1 day each week or 1 day every two weeks, as recommended in the Dutch guidelines. However, nearly a quarter of the professionals advised to perform SMBG on a monthly basis. In the Netherlands, there are other guidelines (clinical practice guidelines for general practitioners) for the treatment of diabetes in which patients with T2DM are advised to perform SMBG less frequently. For example, it is stated that patients on 1 injection a day, who are in stable good glycaemic control, do not have to measure their glucose concentration several times a day. Measuring a fasting glucose concentration and an HbA1C once every 3 or 6 months is sufficient.[12]

Perceptions of the healthcare providers, based on their experiences regarding the basic frequency and timing of SMBG sufficient to maintain the glycaemic goals, could be the explanation for the differences between daily practice and the guideline recommendations. Another possibility may be that the healthcare providers just do not know what the guidelines recommend.

Yet, advice on SMBG can have great consequences for patients. Studies among patients with diabetes on oral medication and insulin-treated patients with diabetes show that performing SMBG can lead to a decreased quality of life.[13-17] Complexity of the treatment is one of the factors leading to inconvenience for patients, which in turn leads to non-adherence to SMBG (e.g. alternating the timing of measurements and postprandial measurements).[17] Furthermore, there is a debate over the need to test the postprandial blood glucose. Although there are arguments that postprandial levels need to be considered important for the long-term complication risk, the verdict on this assumption is still out.[18,19] Therefore, routinely advising postprandial controls might be superfluous. This advice could be given to patients who show good preprandial glucose levels, but still have an unsatisfactorily high HbA1C, or to patients with special conditions, for example in case of pregnancy. Unnecessary measurements will also lead to unnecessary costs.

We conclude that it is important for studies that investigate the adherence to SMBG guidelines to take into account the variation in recommendations that are given to patients by healthcare professionals. When non-adherence to a specific guideline is observed, it may well be that this is due to the advice they received from their healthcare provider. Therefore, the results of studies that investigated SMBG from a patient's perspective or by using databases on the dispensing of blood glucose strips, should be interpreted with caution.

The aim of SMBG should be to reach the glycaemic goals with the least amount of inconvenience and complexity. However, more research is necessary in order to give a more evidence-based advice on the basic frequency and timing of SMBG, taking into account the glycaemic goals, quality of life and costs.

A limitation of our study is the limited response to the internet survey. One reason might be that the number of inactive e-mail addresses was unknown. The limited response may have led to a non-response bias. Unfortunately, we do not have data on the characteristics of the non-respondents. However, because we were able to use large databases, the total number of respondents is still considerable.

Finally, we have initiated a new study to investigate the effect of a specific frequency of SMBG on glycaemic control and quality of life in patients with T2DM who are on 1 injection a day (www.register.clinicaltrials.gov, NCT01460459).

CONCLUSION

This study investigated SMBG from a professional's perspective, providing a different view of blood glucose testing. It is an important and neglected aspect of SMBG in clinical practice. We observed a considerable and relevant variation in the recommendations about the number and timing of SMBG. The most striking differences were found for patients with T2DM on less intensive insulin regimens, also with respect to the frequency of SMBG. Hopefully, the results of this study will lead to an increased awareness among professionals about the recommendations they give. Well-designed studies are necessary in order to obtain more knowledge on the basic frequency and timing of SMBG, taking into account the glycaemic goals, quality of life and costs.

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