Original Article

Practice Of Self-Monitoring Blood Glucose Among Insulin-treated Diabetic Patients In Hospital Serdang

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ABSTRACT

Background: Diabetes Mellitus (DM), characterised by chronic hyperglycaemia, exposes patients to acute and chronic complications, such as hypoglycaemia and vascular complications, respectively. The latter is associated with the degree of glycaemic control. Glycated haemoglobin (HbA1c) indicates long-term glycaemic control of the preceding 2-3 months. The practice of self-monitoring blood glucose (SMBG) is essential for insulin-treated diabetic patients to achieve optimum glycaemic control and prevent hypoglycaemia. **Aim:** The study aimed to determine the SMBG practice and frequency and its association with HbA1c and factors in insulin-treated diabetic patients. **Methods:** This was a cross-sectional study of insulin-treated diabetic patients attending follow-up at the diabetic clinic of Hospital Serdang from April 2015 to August 2015. Consented eligible patients completed validated self-administered questionnaires. Patients' HbA1c results were obtained from the hospital information system. **Results:** Ninety-one of 137 (66%) patients practiced SMBG and 46 (34%) did not. Although 82% had seen diabetic nurses, 54% of patients did not alter their treatment accordingly. Neither the practice nor the frequency of SMBG was significantly associated with differences in HbA1c levels ($p=0.334$ and $p=0.116$ respectively). Ethnicity and household income significantly affected SMBG practice. The presence and frequency of hypoglycaemia significantly increased the likelihood of SMBG practice ($p<0.001$) and frequency ($p<0.001$). **Conclusions:** The prevalence of SMBG practice in diabetic patients on insulin was 66%. However, SMBG was not followed by proper treatment alteration in 54% of patients. There was no association between SMBG practice and frequency with good glycaemic control. Hypoglycaemia significantly affected the practice and frequency of SMBG.

Keywords: Self-monitoring blood glucose, insulin, HbA1c, hypoglycaemia

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INTRODUCTION

Malaysia is facing an increasing prevalence of diabetes mellitus (DM) from 8.3% in 1996 to 14.9% in 2006, among individuals aged 30 and above (1). In 2015, the overall prevalence of DM among adults aged 18 and above was 17.5% (2). DM is a major public health concern as it carries high mortality and morbidity, due to its acute and chronic complications. The former include hypoglycaemia, diabetic ketoacidosis and hyperosmolar hyperglycaemic state. Macrovascular complication, characterized by accelerated atherosclerosis, gives rise to cardiovascular diseases (CVD) which is the leading cause of death in Malaysia, accounting for up to 25% of all deaths in government hospitals (3). Microvascular complications, namely retinopathy, nephropathy and peripheral neuropathy with risk of blindness, renal failure and amputation, respectively, account for most of its morbidity (3). Long-term prospective studies have shown that improved glycaemic control significantly reduces the risk of microvascular complications in both types of DM whilst there is a trend towards benefit for macrovascular disease (4,5).

Glycated haemoglobin (HbA1c) is a type of haemoglobin A with a glucose group attached to the terminal amino group of the beta chain (6). HbA1c undergoes glycation at a rate proportional to the blood glucose concentration (6). Its value reflects average plasma glucose over the preceding 2-3 months and has been the gold standard for monitoring glycaemic control in diabetic patients (7).

Self-monitoring blood glucose (SMBG) includes both an assessment of the capillary glucose concentration (self-measurement) as well as the interpretation of and responding to the readings (self-regulation) (8). SMBG is an essential component in the treatment of diabetes mellitus, as an aid to achieve optimal glycaemic control and to prevent hypoglycaemia (9). In Diabetes Control and Complications Trial (DCCT) and the Stockholm Diabetes Intervention Study, SMBG

was a key protocol for the intensive insulin treatment, which was associated with better clinical outcome (9). SMBG serves as an important mechanism for assessing and improving the quality of diabetes control. It provides "real-time" feedback and will reveal derangement such as post-prandial hyperglycaemia and acute complication such as hypoglycaemia (9). Remedial actions such as treatment adjustment can then be taken immediately. Daily good glycaemic control contributes to long-term glycaemic control which is reflected by HbA1c level of less than 6.5% (7).

Several studies evaluating the effectiveness of SMBG in the glycaemic control of Type 1 DM patients showed a relationship between frequency of SMBG and the effectiveness of glycaemic control evidenced by HbA1c level (10-12). However, SMBG frequency above 5 daily did not improve metabolic control (10,12). Meanwhile, previous studies (13-15) indicated that there was no association between the frequency of SMBG and the HbA1c levels.

As SMBG plays an important role in monitoring good glycaemic control, reflected in the long-term by HbA1c levels, this study aimed to evaluate the practice of SMBG among diabetic patients on insulin in Hospital Serdang and factors that influence it. We would also like to determine the association between practice and frequency of SMBG and HbA1c levels.

MATERIALS AND METHODS

This was a cross-sectional study in the diabetic clinic of Hospital Serdang. Subject recruitment was done by convenient sampling. One-hundred and sixty diabetic patients were interviewed over a 3 months period (from 6th April 2015 to 7th August 2015). However, only 137 questionnaires were completed and included in the analysis. Inclusion criteria were insulin-treated T1DM and T2DM patients who were under follow-up. Exclusion criterion was T2DM patients who were on oral hypoglycaemic agents only. The dependent variables were practice and frequency of SMBG and haemoglobin A1c (HbA1c). The latter was retrieved from the laboratory information system. Practice of SMBG was defined as the use of a glucose meter to enable a patient to recognize glycaemic variations. Respondents were classified as self-monitoring if they were current SMBG users (16). The independent variables were factors identified as being predictive of SMBG, which include age, gender, ethnicity, economic status, education level, disease duration, type of treatment and frequency of hypoglycaemic episodes. Following informed consents, eligible patients were invited to fill in structured and validated bilingual (Bahasa Malaysia and English) questionnaires assessing whether or not they practice SMBG and the independent variables. We also assessed the frequency of SMBG testing, recording of the results and actions taken subsequently. It has been validated among investigators' family members with known DM on insulin. Confidentiality of patient's identification was ensured. The study had been approved by the ethical committees of Jawatankuasa Etika Universiti Penyelidikan UPM (FPSK (EXP15-MEDIC) U029) and the Medical Research Ethical Committee (MREC), Ministry of Health, Malaysia (NMRR-15-622-25516). Both verbal and written consents were obtained on the enrolment day. Statistical analyses were done using statistical software package, SPSS 22.0. The Kolmogorov-Smirnov test was used to assess normality of the distribution of the data. A 'p' value of < 0.05 (95% confidence interval) was considered to be statistically significant. Chi-square test or Fisher's exact test were used to assess the association between the frequency of SMBG and HbA1c levels. It was also used to test the association between the factors associated and the frequency of SMBG.

RESULTS

We received a total of 137 completed and 23 incomplete questionnaires. The response rate was 85.63%. Table 1 shows the sociodemographic characteristics of recruited patients. The majority of patients were above 60 years old with the mean age of 58 (SD±15.18). Most were Malays with equal distribution of gender. Majority attained secondary education and monthly income of less than RM3000. Association between the factors and SMBG practice was analysed among 137 respondents while that of SMBG frequency was analysed among 91 respondents who practiced SMBG.

Our results showed that 91 out of 137 patients (66%) practiced SMBG and Table 2 shows the details of their SMBG practice.

Table 3 shows the association between socio-demographic factors and SMBG practice. Ethnicity was significantly associated with practice of SMBG ($p<0.05$).

Table 4 shows the association between clinical and sociodemographic (only significant factor is shown) characteristics and SMBG frequency. Weekly hypoglycaemic episodes and monthly income were significantly associated with SMBG frequency ($p<0.001$).

91 patients practiced SMBG and 46 did not. There was no statistically significant association between practice of SMBG and HbA1c level ($p>0.05$), as shown in Table 5.

Among patients who practiced SMBG, there was no statistically significant association between frequency of SMBG and HbA1c ($p>0.05$), as shown in Table 6.

DISCUSSION

SMBG practice was seen in 91 out of 137 (66%) insulin-treated diabetic patients. The prevalence of SMBG practice in this study was higher than previously reported by Mastura et al. of 15.3%, which was, however, done among Type 2 diabetics (16). Mafauzy et al. 2011 reported a prevalence of regular self-monitoring among all diabetic patients of 26.8% and 58.7%, in

Table 1: Sociodemographic characteristics of diabetic patients on insulin (N=137).

Characteristic	n (%)
Age (Years)	
<40	24 (18)
40 to 49	17 (12)
50 to 59	38 (28)
≥60	58 (42)
Race	
Malay	78 (57)
Chinese	27 (20)
Indian	32 (23)
Gender	
Male	67 (49)
Female	70 (51)
Educational level	
No formal education	12 (8)
Primary education	38 (28)
Secondary education	64 (47)
Tertiary education	23 (17)
Monthly income (RM)	
<1000	45 (33)
1000-3000	69 (50)
3001-5000	18 (13)
>5000	5 (4)

Table 2: SMBG characteristics among diabetic patients who practiced SMBG (N=91).

SMBG characteristic	n (%)
SMBG frequency	
<3x/day	78 (86)
≥3x/day	13 (14)
SMBG timing	
Pre-meal	50 (55)
Post-meal	27 (30)
Pre- & Post-meal	14 (15)
SMBG recording	
Yes	56 (62)
No	35 (38)
Treatment alteration	
Yes	42 (46)
No	49 (54)
Showing doctor	
Yes	49 (54)
No	42 (46)
Seen diabetic nurse	
Yes	75 (82)
No	16 (18)
Weekly hypoglycaemia	
1x	50 (55)
>1x	41 (45)

Table 3: Association between socio-demographic factors and SMBG practice (N=137).

Characteristic	Practice of SMBG		Total	X^2	P-value
	Yes n (%)	No n (%)			
Age					
<40	18 (75)	6 (25)	24	2.090	0.554
40 to 49	10 (59)	7 (41)	17		
50 to 59	27 (71)	11 (29)	38		
>60	36 (62)	22 (38)	58		
Race					
Malay	46 (59)	32 (41)	78	8.060	0.018
Chinese	24 (89)	3 (11)	27		
Indian	21 (66)	11 (34)	32		
Gender					
Male	40 (60)	27 (40)	67	2.657	0.103
Female	51 (73)	19 (27)	70		
Level of education					
No formal education	7 (58)	5 (42)	12	1.678	0.642
Primary education	23 (60)	15 (40)	38		
Secondary education	44 (69)	20 (31)	64		
Tertiary education	17 (74)	6 (26)	23		
Monthly income (RM)*					
Below 5000	87 (66)	45 (34)	132	-	0.663
Above 5000	4 (80)	1 (20)	5		

* Fisher's exact test was used.

Table 4: Association between clinical and sociodemographic* characteristics and SMBG frequency among diabetic patients who practiced SMBG (N=91).

Characteristic	SMBG frequency	Total	X^2	P-value	
	<3 daily n (%)	≥3 day n (%)			
Diabetic duration					
≤10 years	38 (90)	4 (10)	42	1.444	0.229
>10 years	40 (82)	9 (18)	49		
Daily insulin**					
1x	14 (74)	5 (26)	19	-	0.135
>1x	64 (89)	8 (11)	72		
Weekly hypoglycaemia					
1x	37 (74)	13 (26)	50	12.437	<0.001
>1x	41 (100)	0 (0)	41		
Monthly income**					
Below 5000	78 (90)	9 (10)	87	-	<0.001
Above 5000	0 (0)	4 (100)	4		

*Only statistically significant factor is shown **Fisher's exact test was used

Table 5: Association between SMBG practice and HbA1c levels (N=137).

SMBG practice	HbA1c level		Fisher's Exact Test	
	6.5% n (%)	>6.5% n (%)	Total	*P*
Yes	9 (10)	82 (90)	91	0.334
No	2 (4)	44 (96)	46	
Total	11 (8)	126 (92)	137	

Table 6: Association of SMBG frequency and HbA1c levels (N=91).

SMBG frequency	HbA1c level		Fisher's Exact Test	
	6.5% n (%)	>6.5% n (%)	Total	*P*
<3 per day	6 (8)	72 (92)	78	0.116
≥3 per day	3 (23)	10 (77)	13	
Total	9 (10)	82 (90)	91	

2003 and 2008, respectively (17). Meanwhile, the DCCT/Epidemiology of Diabetes Interventions and Complications (EDIC) studies reported a lower prevalence of SMBG practice among T1DM patients of 36% (18).

SMBG practice should include interpretation of and response to the SMBG results, such as self-adjustment of insulin dosage accordingly (8). Although 82% of patients practicing SMBG had seen diabetic nurses, only 42 (46%) patients altered their insulin dosage accordingly (Table 2), which may partially explain the lack of association between SMBG practice and lower HbA1c levels (Table 5). Furthermore, among those who practiced SMBG, only 56 patients (62%) recorded their SMBG reading and 49 (54%) discussed their SMBG recordings with their doctors (Table 2) during their regular clinic visits. These findings may reflect either inertia or incompetency in patients' self-management, thus hindering achievement of a good glycaemic control. As shown by Bjorsness et al.,(19) diabetic patients often poorly understood the significance of SMBG practice in their disease management. It has been shown that proper SMBG practice was more likely if they did (20).

In our study, there was no significant association between age and SMBG practice (Table 3) and frequency (Table 4). Similarly, in a study among adults, Mastura et al. (16) showed that age was not predictive of SMBG practice. However, Gomes et al. (10) demonstrated that SMBG practice was more prevalent in younger in children and adolescents than in adults. In addition, Franciosi et al. (21) found that patients older than 65 years were less likely to perform self-monitoring.

Our study showed that the percentage of SMBG practice was higher among Chinese respondents compared to other ethnicities. There was a significant association between ethnicity and practice (Table 3) but not frequency of SMBG (Table 4). However, Mastura et al. (16) showed no association between ethnicity and practice of SMBG.

In our study, neither SMBG practice (Table 3) nor frequency (Table 4) showed significant association with gender. Gomes et al. (10), however, suggested that there was a female preponderance in performing SMBG. In contrary to other studies (9,16), we found that the level of education, diabetic duration and insulin regime did not influence SMBG practice. However, similar to previous studies, hypoglycaemic episodes (12) and monthly income (16) were significantly associated with SMBG frequency (Table 4).

Previously, Gomes et al. (10) showed that there was a weak correlation between HbA1c levels and SMBG frequency (rs = –0.13; P = 0.001). Gomes et al. (10) and Ziegler et al. (12) also stated that more frequent SMBG was significantly associated with better glycaemic control. A 0.20% drop of HbA1c for an additional SMBG per day (P< 0.001) was observed (12). However, our results showed that there was no statistically significant association between SMBG frequency and HbA1c level (p=0.334) (Table 6), in agreement with Urbach et al. (13) Improvement in HbA1c level was by and large attributed to corresponding insulin dose adjustment (13). Indeed, Franciosi et al. (21) showed that the benefit of SMBG for metabolic control was seen in those who adjusted their insulin doses. The absence of association between SMBG frequency and HbA1c in our study may be explained by failure of 54% of patients in taking appropriate action based on their SMBG readings (Table 2). In addition, findings by Hsieh et al. (11) further supported our result by suggesting that SMBG had limited effectiveness towards patients without adequate patient education regarding treatment alteration.

We identified a few limitations in our study. Self-reporting of SMBG practice may not reflect actual performance. Being a single-centred study, the data obtained may not be representative of the whole diabetic patient population in Malaysia. In addition,

patients' refusal to participate and exclusion of a number of patients due to incomplete medical records may lead to non-response bias.

CONCLUSION

Almost two-third of insulin-treated diabetic patients in Hospital Serdang practiced SMBG, which was higher than previously shown (16,17). However, SMBG was not followed by proper treatment alteration in about half of them. There was no association between SMBG practice and frequency with HbA1c level. Hypoglycaemia significantly influenced the practice and frequency of SMBG. We recommend that SMBG practice should be promoted among insulin-treated patients as it has been shown to reduce the occurrence of hypoglycaemia.

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