

## INCORPORATING RESULTS INTO DIABETES SELF-CARE PLAN RATHER THAN FREQUENCY OF GLYCEMIC MONITORING IMPROVES GLYCEMIC CONTROL IN INSULIN-TREATED SUBJECTS WITH TYPE 2 DIABETES MELLITUS

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### ABSTRACT

**Background:** Although most professional guidelines recommend self-monitoring of blood glucose (SMBG) in insulin-treated subjects with type 2 diabetes mellitus (T2DM), emphasis is often laid on the frequency rather than incorporating the results into diabetes self-care plan. It is unclear how these influence long term glycemic control.

**Aim:** to evaluate the relationship between SMBG frequency, ability to incorporate results into improved self-care and long term glycemic control.

**Methods:** 75 insulin-treated T2DM patients aged 18-65 years were interviewed to ascertain whether they practiced SMBG, testing frequency and ability to utilize SMBG results to adjust lifestyle and insulin dosage. Glycated hemoglobin (HbA1c) was measured in all the participants.

**Results:** The mean (SD) age and mean (SD) duration of diabetes were respectively 49.1 (8.9) and 5.6 (3.2) years. Glycemic control was generally poor [mean (SD) HbA1c 8.4 (1.9) %]. 71 subjects (94.7%) practiced SMBG. However, only 33.3% tested at a frequency of at least once daily. Previous participation in diabetes education ( $P < 0.001$ ) and ability to adjust insulin using SMBG results ( $P 0.03$ ) were significantly associated with higher SMBG frequency. Among SMBG performers, ability to engage in SMBG-guided self titration of insulin dosage but not SMBG frequency was significantly associated with lower HbA1c.

**Conclusion:** The study suggests that SMBG frequency is less influential on long-term glycemic control than incorporating the results into improved self-care practices.

**Keywords:** Self monitoring; blood glucose; glycemic control; type 2 diabetes mellitus; insulin; Nigeria

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### INTRODUCTION

The primary goal of proper diabetes care is to achieve long term and sustained glycemic control which has been shown to reduce the risk of complications, especially micro vascular, in both type 1 and type 2 diabetes mellitus.[1,2] One of the strategies that are being advocated in achieving this objective is self monitoring of blood glucose (SMBG). It refers to the practice of measuring the glucose in blood obtained by finger prick, using simple electronic device known as blood glucose meter. SMBG is currently regarded as an indispensable component of integrated diabetes care. Although the utility of frequent SMBG in non-insulin treated subjects remains a subject of

controversy. [3,4] its beneficial role in achieving long term metabolic control is generally proven in subjects with type 1 diabetes and insulin-treated patients with T2DM. [5,6] Unsurprisingly therefore, SMBG is endorsed by most professional guidelines. [7-10] The American Diabetes Association for instance recommends that subjects on multiple daily insulin regimens should perform SMBG at least 4-6 times daily while the frequency in those on less intensive insulin regimens should be based on individual needs.[8]

An estimated 2-3 million adult Nigerians are living with diabetes mellitus and over 90% of them have T2DM. [11] Although data on the proportion of insulin-using T2DM subjects in Nigeria is lacking, the number is likely to be substantial. Besides

improvement in glycemic control, one of the established utility of frequent SMBG in insulin users is prevention and detection of hypoglycemia, one of the feared and potentially life-threatening complications of insulin therapy [12]. Studies have shown that the frequency of SMBG among Nigerians with T2DM is generally poor [13,14]. However, none of these studies has focused on insulin users, the group of patients for whom SMBG is universally recommended. Therefore the Frequency of SMBG practice specifically in insulin-treated T2DM subjects in Nigeria is unknown, just as the relationship between testing frequency and metabolic control in this category of patients remains obscure. Moreover, the proportion of insulin-using T2DM patients who are able to incorporate SMBG results into diabetes self-care plan and the impact of such practice on glycemic control remains unclear. These formed the basis for this study.

**METHODS**

This was a cross sectional survey of 75 non-pregnant insulin-treated adults with T2DM aged 18-65 years who were consecutively recruited from out-patient diabetes clinic of Enugu State University Teaching Hospital (ESUTH). Subjects

with significant visual or memory impairment were excluded. After documenting their socio-demographic and diabetes-related information including gender, age, occupation, duration of DM, type of insulin regimen and previous participation in diabetes education, participants were then interviewed on SMBG practice and frequency. Those who reported that they practiced SMBG were further interviewed whether SMBG results influenced their diabetes self management behavior including adherence to diet and exercise regimens as well as self adjustment of insulin doses . All subjects had glycated hemoglobin (HbA1c) measurement using i-CHROMATM HbA1c auto-analyzer (Boditech Med Inc, Korea). Data were analyzed with the Statistical Package for Social Sciences (SPSS) version 20 (SPSS inc. Chicago Illinois). Numbers and percentages or means and standard deviations were computed for categorical and continuous variables respectively. Associations between patients’ characteristics and the frequencies of SMBG were tested by the Chi-square test for categorical variables and student’s t-test for continuous variables as appropriate. Statistical significance was established at P value < 0.05.

PRO-FORMA		S/No: ...
<b>(A): SOCIO-DEMOGRAPHIC INFORMATION</b>		
1. Age (years):	-----	
2. Sex	(a) Male <input type="checkbox"/>	(b) Female <input type="checkbox"/>
3. Occupation	(a) none (dependent <input type="checkbox"/>	(b) Civil servant <input type="checkbox"/>
	(c.) Business/trader <input type="checkbox"/>	(d) Artisan <input type="checkbox"/>
	(e) Farmer <input type="checkbox"/>	(f) Others -----
4. What is your highest level of education?	(a) None <input type="checkbox"/>	(b) Primary <input type="checkbox"/>
	(c.) Secondary <input type="checkbox"/>	(d) Tertiary and above <input type="checkbox"/>
5. Cigarette Smoking	(a) Never <input type="checkbox"/>	(b) Past Smoker <input type="checkbox"/>
	(c.) Current Smoker <input type="checkbox"/>	
<b>(B): DIABETES HISTORY:</b>		
6. Duration of Diabetes (years)	.....	
7. Have you ever participated in structured diabetes education?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
8. How long have you been injecting insulin (years)?	.....	
9. Current insulin regimen	(a) Basal <input type="checkbox"/>	(b) Premix <input type="checkbox"/> (c.) Basal-bolus <input type="checkbox"/>
<b>(C): SELF-MONITORING OF BLOOD GLUCOSE:</b>		
10. Have you heard about self-monitoring of blood glucose?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
11. Do you own a blood glucose meter?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
12. If yes, do you practice SMBG?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	If No, do not proceed further	
13. On the average, how often do you check your blood glucose?	(a) At least once daily <input type="checkbox"/>	
	(b) At least once weekly <input type="checkbox"/>	
	(c.) Less than once weekly <input type="checkbox"/>	
14. Are you able to adjust your insulin dosage based on SMBG results?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
15. Do the results of your SMBG influence your adherence to diet and exercise?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
16. Glycated Hemoglobin (%)	.....	

**RESULTS**

A total of 75 subjects participated in this survey. The mean (SD) age and duration of diabetes of the participants were respectively 49.1 (8.9) years and 5.6 (3.2) years. Majority of the participants (64.0%)

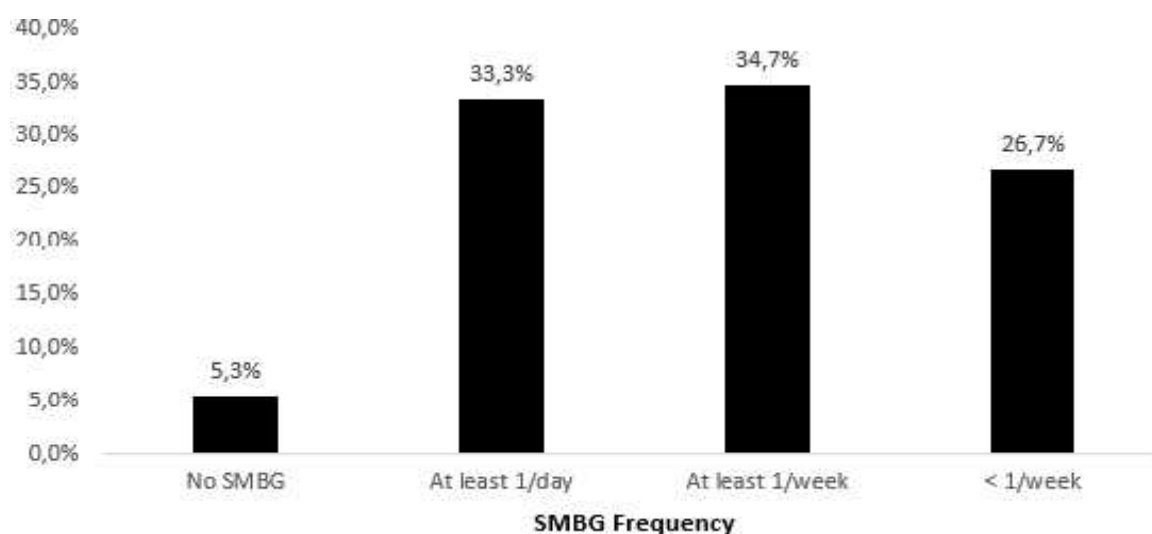
were on premix insulin regimen. Nearly half of the subjects (50.7%) reported that SMBG guided them to intensify lifestyle practices (diet and exercise). However, only 32.4% were able to engage in SMBG-guided self-adjustment of insulin dosage (**Table I**).

**Table I. Baseline characteristics of the study population**

Variable	Frequency	Percent
<b>Age group (years)</b>		
<45	21	28.0
45	54	72.0
<b>Gender (female)</b>	49	65.3
<b>Educational level</b>		
Uneducated	7	9.3
Secondary or less	44	58.7
Tertiary	24	32.0
<b>Occupation</b>		
Unemployed	9	12.0
Civil servants	29	38.7
Others (traders, artisans)	37	49.3
<b>DM duration (years)</b>		
<5	30	40.0
5	45	60.0
<b>Type of Insulin Regimen</b>		
Basal insulin only	21	28.0
Premix insulin	48	64.0
Basal-bolus	6	8.0
<b>Have Participated in DM Education</b>		
Yes	41	54.7
<b>Engage in SMBG-guided self-adjustment of insulin dose</b>		
Yes	23	32.4
<b>Intensify lifestyle based on SMBG results</b>		
Yes	36	50.7

Data are in numbers (percentages). DM = diabetes mellitus, SMBG = self monitoring of blood glucose

**Figure 1** shows the frequencies of SMBG among the study participants. Twenty-five patients (33.3%) monitored their blood glucose at least once daily, 34.7% monitored at least once weekly, 26.7% monitored less frequently than once weekly while 4 persons (5.3%) did not practice SMBG at all.



**Figure 1: the frequencies of SMBG among the study participants**

The frequency of SMBG according to insulin regimen is shown in **table II**. Only 3 out of the 18 subjects on basal insulin regimen tested their blood glucose at least once daily with majority (50%) testing at least once weekly. For subjects on premix insulin, 38.3% tested at least once daily, 34% once

weekly and 27.7% less than once weekly. Majority of the subjects on basal-bolus regimen (66.7%) tested at least once daily. Of the 4 subjects who did not practice any SMBG, 3 were on basal insulin and 1 on premix regimen.

**Table II. Frequency of SMBG according to insulin treatment regimen**

Insulin Regimen	SMBG Frequency			Total
	1/day	1/week	< 1/week	
Basal	3 (16.7)	9 (50.0)	6 (33.3)	18 (100)
Premix	18 (38.3)	16 (34.0)	13 (27.7)	47 (100)
Basal-bolus	4 (66.7)	1 (16.7)	1 (16.7)	6 (100)

Data are in numbers (percentages), SMBG = self monitoring of blood glucose

Comparing subjects who practiced SMBG at least once daily and those who monitored once weekly, there was no association between frequency of monitoring and participants' age, gender, level of education or duration of diabetes. HbA1c did not also differ significantly between the two groups

(8.2 (1.7) % vs. 8.4 (1.8) %; P = 0.68). However, having participated in diabetes education (P < 0.001) and ability to perform SMBG-guided self-titration of insulin dosage (P = 0.03) were significantly associated with more frequent monitoring (**Table III**).

**Table III. Associations between participants' characteristics and SMBG frequencies**

Variable	SMBG Frequency		$\chi^2/t$	P Value
	At least 1/day	At least 1/week		
<b>Age (years)</b>	49.4 (8.3)	48.8 (9.5)	0.283	0.78
<b>Gender</b>				
Male	11 (45.8)	13 (54.2)	1.793	0.18
Female	14 (29.8)	33 (70.2)		
<b>Level of education</b>				
Primary or less	5 (22.7)	17 (77.3)	2.178	0.14
Secondary & above	20 (40.8)	29 (59.2)		
<b>Duration of DM (years)</b>	5.8 (2.7)	5.7 (3.5)	0.180	0.86
<b>Ever participated in DM education</b>				
Yes	23 (56.1)	18 (43.9)	18.555	< 0.001
No	2 (6.7)	28 (93.3)		
<b>Intensify lifestyle based on SMBG results</b>				
Yes	15 (41.7)	21 (58.3)	1.334	0.25
No	10 (28.6)	25 (71.4)		
<b>Able to self-adjust Insulin based on SMBG results</b>				
Yes	12 (52.2)	11 (47.8)	4.865	0.03
No	12 (25.0)	36 (75.0)		
<b>HbA1c (%)</b>	8.2 (1.7)	8.4 (1.8)	0.416	0.68

Data are in means (standard deviations) or numbers (percentages). DM = diabetes mellitus, SMBG = self monitoring of blood glucose

## DISCUSSION

Self monitoring of blood glucose is now generally accepted as a vital component of integrated diabetes care. In contrast with subjects being treated with oral anti diabetic drugs (OAD), insulin-treated type 2 diabetic patients represent a special group for a number of reasons. Firstly, insulin treatment in subjects with T2DM often connotes disease progression and/or presence of complications (acute or chronic) requiring greater

attention both from the patients and their healthcare givers. Secondly, insulin is associated with a higher risk of hypoglycemia than any other anti-diabetic medication. Consequently, just like type 1 diabetic subjects, insulin-treated T2DM subjects, particularly those on multiple daily regimens, often require frequent blood glucose monitoring and this is endorsed by most professional guidelines [7-10]. This cross-sectional survey was undertaken to ascertain the SMBG behavior of young and middle-aged T2DM subjects being treated with insulin.

Findings from this study suggest that SMBG practice among this group of patients in our locality is very poor and require urgent attention. It was observed that only about a third of the subjects interviewed practiced SMBG at a minimum frequency of at least once daily while majority of the remaining subjects either practiced SMBG at least once weekly, less than once weekly or not at all. In contrast to the low SMBG frequency that was observed in this study, a Canadian study reported an average testing frequency of 3 tests per day among insulin-treated type 2 diabetic patients [15]. The reason for this low SMBG frequency among our study participants is not very clear. However, cost constraints, inadequate diabetes education, SMBG-associated inconveniences and possibly needle phobia may have a role to play. In a previous study of 318 T2DM adults who were mostly on OADs, Ugwu et al [13] reported that financial constraint and fear of needle prick were the commonest reasons for not engaging in SMBG. The above cited study also noted that those who had engaged in structured diabetes education were more likely to practice frequent SMBG, a finding that was also observed in this study. Other authors had similarly reported a direct relationship between income level and frequency of SMBG. [16,17]

The main essence of SMBG is to enable appropriate day-to-day modifications in diabetes therapy including adjustments to lifestyle and medications. It was noted in this study that only about a third of the respondents were able to undertake SMBG-guided self titration of insulin dose and only about half reportedly intensified lifestyle practices such as diet and exercise based on their SMBG results. This may explain the lack of association between SMBG frequency and long term glucose control (HbA1c) as was observed in this study. However, in a sub-analysis comparing HbA1c between subjects who could self-adjust insulin dosages and those who could not, the former was found to have a significantly better HbA1c ( $7.9 \pm 1.3\%$  vs.  $8.6 \pm 1.1\%$ ;  $P = 0.021$ ). These findings support previous studies which demonstrated that SMBG benefitted only those who were able to incorporate the results into better diabetes self care practices [18,19]. It is probably for this reason that the International Diabetes Federation states that SMBG should only be prescribed when the person living with diabetes and/or caregivers have the willingness, knowledge and skills to incorporate the results into their diabetes care plan [7].

In conclusion, this survey has demonstrated that even though most insulin-treated subjects with T2DM practiced SMBG, the frequency is very poor

and far from the recommendations by current professional guidelines. While the study suggests that diabetes education is crucial in improving SMBG practice among this group of patients and should be promoted by all diabetes care providers, incorporating test results into better self-care practices is probably more beneficial in achieving long term glucose control.

The limitations of this study include its cross-sectional design as well as small sample size. Caution should therefore be applied in generalizing the findings from this study to the entire population of insulin-treated subjects with type 2 diabetes.

### Conflict of Interest

I, Dr Ejiofor T. Ugwu hereby disclose that I have no conflict of interest. This research did not receive any funding from any source.

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