Effectiveness of Home Blood Glucose Monitoring on Controlling Type II Diabetes Mellitus in Two University Hospitals, Riyadh

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ABSTRACT: Background: Home glucose monitoring is an opportunity for patients with type II diabetes to control their own blood glucose and health, testing blood glucose at home helps to prevent the immediate and potentially serious consequences of very high or very low blood glucose levels. **Objectives:** This study aimed at ascertaining diabetic patients' performance of home blood glucose monitoring (SMBG), its perceived benefits, and its effectiveness in controlling type II diabetes mellitus. **Methods:** A cross sectional study was conducted on a 300 type II diabetic patients who follow up in the diabetes clinics at two university hospitals in Riyadh, Saudi Arabia. Data were collected through a structured interview questionnaire and records review. **Results:** Out of the total 300 diabetic patients, 145 (48.3%) use SMBG and 51.7% of them used it according to the doctors advice, and 52.4% of them checked it by themselves. Only 55.2% received education about use SMBG. Educational level and employment were significantly related to SMBG. Most of the patients (66.3%) who had SMBG presented with normal HbA1c range (OR=4.86, 95% CI= 2.37-10.28). **Conclusion:** The study provides a proof supporting effectiveness of SMBG for diabetic patients, however, it recommends to launch further indepth research to provide evidence about the effectiveness of self-monitoring and identify patients who might derive most benefit from different forms of blood glucose monitoring.

INTRODUCTION

Diabetes mellitus (DM) is a major public health problem in many countries; it is the most common long-standing illness with high prevalence in both developed and developing countries. Current projections estimate that the number of people with DM will increase by 50.0% by 2010 and will nearly double by 2025.[1] In 2007, it is estimated that there are 246 million people with DM in the adult population, this figure is predicted to reach 333 millions by 2025 as a consequence of longer life expectancy, sedentary life style, and changing dietary patterns.[2,3] Presently

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more than 16 million people are living with diabetes in the Eastern Mediterranean Region. A staggering number which is expected to rise to almost 43 million by the year 2025.[4] The reported figures of DM prevalence in the Gulf region revealed varied but consistently high rates. The prevalence of diabetes has reached 25% in the Kingdom of Saudi Arabia, Sultanate of Oman, and the Kingdom of Bahrain.[5-7]

The epidemic nature of DM continues to affect ever-increasing numbers of people around the world while public awareness remains low.[5] To achieve optimal glucose control, treatment plans must include self-management training to help people with type II diabetes learn as much as possible about their condition and actively participate in their own health care decisions and treatment. Self-management education teaches them to assess the relationships among medical nutrition therapy, activity level, emotional, physical status, medications, and regular self-

monitoring of blood glucose (SMBG) levels, then respond appropriately and continually to those factors to achieve and maintain optimal glucose control. [8,9]

The main goal of DM treatment is to keep blood sugar (BG) level in the normal or near-normal range.[10] Home SMBG is one of the best ways of determining how well DM treatment plan is working and allows for making needed adjustments. Testing BG at home gives immediate feedback about BG level at any time and helps to prevent the immediate and long term consequences of very high or very low BG levels. The readings from these tests can help people with diabetes to mange their disease day by day or even hour by hour to see how food, physical activity, and medications affect their blood sugar. The readings can also tell them when their blood sugar is too low or too high, so they can work with their health care provider to change treatment plan.[11]

The glycoslated hemoglobin (HbA$_{1C}$) test is currently one of the best ways to check diabetes control; and is done on the spot in some clinics.[12] It used to measure the average BG level for the past three months and shows whether BG levels have been well-regulated over that period. This test should be done at least twice a year. The goal is to keep HbA$_{1C}$ less than 7% to guarantee diabetic control.[13] If the HbA1c value is above 7%, it means DM is poorly controlled with high values mean, with greater risk of diabetic complications, such as visual, renal, central nervous system, and cardiac complications.

In Saudi Arabia, general observations show that DM is poorly controlled in a large proportion of diabetic patients and there is a scarcity of research investigating the role of SMBG in the management of diabetic patients. So, this study aimed at ascertaining diabetic patients' performance of SMBG, its perceived benefits, and its relationship to type II DM control, so that,

determining whether it is worthwhile to educate patients to perform SMBG if its role in DM is demonstrated.

MATERIAL and METHODS

Study design and population: A cross sectional descriptive study was conducted at two major hospitals in Riyadh City - King Abdul Aziz University Hospital (KAUH) and King Khalid University Hospital (KKUH). All type II diabetic patients attending to follow up in the diabetic clinics, who have a stable health status [apparently well without severe complications] and accepted to participate were subjected to the study. The total sample size was estimated to be 271 diabetic patients on the assumption of a 50% prevalence of SMBG, a degree of precision of 5% and a 90% confidence level. Data collection took six weeks and was approximated to 300 patients.

Study tools: A structured interview questionnaire was designed to collect data about sociodemographic data, follow up pattern, treatment, patient conceptions

about elevated blood sugar, as well as perceives benefits and performance of SMBG, cues to perform SMBG, regularity, frequency, duration, and documenting of SMBG performance. Also, patients' records were reviewed to gather data about the last result of HbA$_{1c}$, and any diagnosed complications.

Data entry and analysis were done using Epi-info 3.3.2 software. Data were processed and presented as frequencies, percentages, and the effect of different explanatory variables on different outcome variables was estimated as odd ratio with 95% confidence interval.

RESULTS

The study involved interviewing 300 diabetic patients, with equal percentages of the patients from each of KAUH and KKUH. Their mean age was 53.2±9.95 years. Males represented 33.3% of the sample and 66.7% were females. Almost all them were married. More than half (55%) were illiterates, while 18% had primary education, and only 12.3% were university educated. Nearly all female patients were house wives, meanwhile 19% of the sample were retired, and employees constituted only (14.3%). About 27% of them had DM for ≤five years, 31% had DM with duration of 6 to 10 years, while the rest suffered from DM for more than 10 years. Most of them (64%) were on oral hypoglycemic medications, insulin alone was used by (22%) patients, while 13.3% were on both medications and only (0.7%) were under dietary control. Regarding other chronic diseases, most of the patients (66.3%) had chronic diseases other than DM. Hyperlipidemia and hypertension were the commonest (70.3% and 50.8%).

Table 1 shows that the majority of the patients (95%) reported their compliance to regular follow up at the diabetic clinic, however, only 24.2% paid a follow up visit every 3 or 4 months. The table also shows the last result of HbA$_{1c}$ where it was below

7.2 in less than one-third of the patients, while it was 7.3-10.2 among the half, and $\geq$10 among 19.7% of them.

Looking at the patients' awareness about having elevated glucose in their bodies in Table 2, it was evident that 56.3% thought that they have elevated glucose in the blood only, whereas 34% thought it is in both blood and urine, and 9.7% did not know. As regards diabetic patients' perceived benefits of SMBG, 74.7% thought it is beneficial, while 25.3% thought it is not beneficial. The topped benefits perceived by 72.3% and 55.7% of the patients were "helping to maintain BG level within normal range", and "increase their compliance to diabetes treatment". Out of the total sample, 48.3% were self-monitors. About 51.7% of them used SMBG kits as an advice from doctors, and only 4.1% was advised by diabetes educators. The majority were self-monitors (73.8%) for 1-5 years, and 23.4% were performing it for five years or more. It was evident that 52.4% of the patients are checking their BG by themselves, and 47.6% by a family member. Regarding frequency of monitoring, 41% are doing that on their subjective need, while 11.3% are monitoring it three times a day. Only few self-monitors used to record their BG level in a special card (2.1%) or anywhere (7.6%). Out of the total self monitors patients, only 55.2% had received teaching on how to use SMBG.

In this study it was found that educational level of the patients was influencing the performance of SMBG, such that highly educated and employed patients were significantly more likely to perform SMBG(OR=2.98, 95% CI=1.75-5.19) and (OR= 3.09, CI=1.67- 5.89), respectively. On the other hand, there was no significant relationship between marital status and regular follow ups and the performance of SMBG (Table 3).

The performance of SMBG and HbA$_{1c}$:

Out of the 100 diabetic patients who had normal HbA_{1C} 66.3% were self-monitors while 33.7% were not self-monitors. On the other hand only 28.6% of those who had abnormal HbA_{1C} were self-monitor and 71.4% were not self-monitors. The differences was statistically significant (OR= 4.86, CI= 2.37-10.28) (Figure 1).

SMBG and reported complications among diabetic patients:

Table 4 shows that cataract was found in 100 patients (33.3%), out of whom 48% were monitoring their BG at home and 52.0% do not, but the difference was not statically significant (OR=0.980, CI= 0.604-1.584). Numbness was reported in 225 (75.0 %) out of 300 diabetic patients, SMBG was performed by 110 (48.9 %) and not performed by 115 (51.1%) diabetic patients, but the differences was not statistically significant (OR=1.09, CI=0.648-1.485). Hyperlipidemia was diagnosed in 148 (49.8%) patients, of those 81 (54.7%) were self-monitors and 67 (45.3%) did not,

(OR= 1.66, CI=1.05- 2.622). Hypertension was reported in 148 (49.0 %) patients, of those 77 (52.0 %) were performing SMBG home glucose monitoring, while 71 (48.0%) did not have it but the differences was not statically significant (OR=1.34, CI=0.851-2.109).

DISCUSSION

Glucose monitoring is the most popular, the most accurate, at home method for measuring day-to-day glucose control.[14] In the present study, less than half of the studied sample (48.3%) used home SMBG. The effectiveness of home glucose monitoring was assessed by Leese *et al.*, 2005 in 158 diabetic patients over the age of 40 years. They found that of insulin-treated patients, 78% performed SMBG, 76.3% of non-insulin-treated patients performed urine testing alone at home, whilst only 5.6% failed to undertake any home glucose monitoring and these were all non-insulin-treated patients.[15] In the present study, about 51.7% did not have

home glucose monitoring which could be attributed in part to the expensive cost of the strips of the monitor and other perceived barriers against self-monitoring.

Educational level and employment played a role in using SMBG at home, such that educated employed individuals were more self-monitors, which is probably due to their higher awareness of the severity of DM, perceived important of SMBG in controlling DM and better financial resources.

The present findings revealed that more than half of self-monitors were advised by their doctors to do that. This spotlights to the strong influence and the important role of the physician who is the leader of the diabetes care. The role of diabetic educators is also important for their educational potentials however, only 4.1% mentioned that diabetic educator taught them about SMDG. This small percentage might most probably reflect the fact of scarcity of educators in Riyadh hospitals.

Another explanation is that many patients considers any person with white coat is a doctor. This is compounded by the finding that 55.2% of the patients mentioned that they received practical education about SMBG performance and recording.

Keeping records are advisable for the results of SMBG in a sheet or cards and reviewing such cards to the doctor or diabetic educator during follow up visits.[16] It was noticed that only 9.8% diabetic patients were recording their SMBG results, this might be probably due to reluctance of patients added to lack of interest of the care team to check such records during follow ups. It was argued that a patient aiming for achieving blood glucose levels within normal or near normal must monitor four to five times a day, this will help in adjusting the dose of medications and reducing complications.[17] Studies have shown that when monitoring drops to less than four times a day, glucose control worsens.[17] However,

frequency of monitoring in the present study was reported by most of patients to be only on need when they feel high or low blood sugar.

Home SMBG has become an established practice in the management of DM. However, there is a controversy about cost effectiveness of SMBG as indicated by its effect on HbA1c and lipid profiles.[15,18,19] In this study a significant association between home SMBG and HbA1c was documented in favor of SMBG. Most of diabetic patients who used SMBG had normal HbA1c range. Among those who did not use SMBG, an abnormal levels of HbA1c was found in up to 71.4% compared to 28.6% of those who were using SMBG. Consistent results were reported in a clinical trial which has shown that regular SMBG in people with Type II diabetes reduced overall HbA1c levels and had significant improvement in quality of life.[20] Evidence suggests that SMBG had a slight but significant improvement in long term metabolic control in people with Type II diabetes when given in conjunction with counselling on diet and lifestyle.[20,21] Including SMBG as an integral part of care and education was found to provide better glycaemic control in non-insulin treated Type II diabetes.[22] It should be stressed here that the present sample were following different therapeutic modalities: insulin, oral hypoglycemic, diet, and mixed modalities. It has been documented that patients treated with insulin can act promptly by adjusting either the insulin dose or the intake of carbohydrates in response to their BG readings, whereas patients treated with diet alone or with oral drugs are unable to take a similar action. Moreover, patients with type II DM treated with diet and/or oral drugs rarely manifest extreme excursions of diurnal glycemia[23] because of their continued ability to induce postmeal insulin secretion. Therefore, the cost-effectiveness of HBG monitoring in the management of type II DM is uncertain

because the outcome data in this population are sparse in the literature.[24]

Strict Glycemic control is important in delaying the onset and slowing the progression of complications.[25] Furthermore, diabetic complications such as cataract, numbness were less prevalent among those who use home blood glucose monitoring and this indicates effectiveness and importance of home blood glucose monitoring as indicative tool of control of DM Type II. However, the impetus for met-analysis study was the relative paucity of data supporting SMBG as part of usual care in community-based type II diabetic patients.[19] In the final analysis of Kabadi and Kabadi 2006, daily home SMBG prior to all meals and at bedtime is not likely to be cost-effective in management of type II DM with oral agents and/or diet a.[18,26-29] They recommended that HbA1C be monitored at intervals of 3 months in all subjects, irrespective of therapeutic strategies and type of diabetes and the four

times daily HBG monitoring be reserved only for subjects using multiple insulin injections. In subjects using oral agents, HBG monitoring should be conducted once or twice a week as well as in times of stress or if symptoms of hypoglycemia ensue, because both these circumstances require prompt attention by the patients themselves or their health care provider. However, if subjects desire daily monitoring of blood glucose, costs could be reduced by using visual strips alone or by substituting it with urine glucose testing.[18]

In conclusion, this study provides a primitive support to SMBG as one of the important measures in controlling DM type II, however, the results can not be generalized because of different limitations of the study. Therefore, the study recommends to launch further in depth research to inform practice about the effectiveness of self-monitoring and identify patients who might derive most benefit from different forms of blood glucose

monitoring. Education and training should be provided through structured and ongoing diabetes self-management education programs to teach people with diabetes how and when to test, interpret results, and take action based on these results. Also, hospitals should participate partially in the cost of these monitors since some diabetic patients could not afford the financial burden of medications, monitor and strips.

Table 1: Diabetic Patients Follow up at Diabetic Clinic and the Last HbA$_{1C}$ Result

Variables	Frequency (n=300)	%
Regular clinic follow up		
No	15	0.5
Yes	285	95.0
Every 12 month	(190)	(66.7)
Every 6 months	(26)	(9.1)
Every 4 months	(63)	(22.1)
Every 3 months	(6)	(2.1)
Last result of HbA1C		
4.2 – 7.2	90	30
7.3 – 10.2	151	50.3
≥10	59	19.7

Table 2: Diabetic patients' awareness about elevated blood sugar, Performance of SMBG, and related variables.

Variables	Frequency (N=300)	%
In your opinion do you have high amounts for sugar?		
Yes in blood	169	56.3
Yes in blood and urine	102	34.0
Don't know	29	9.7
Perceived benefits of SMBG		
Not beneficial	76	25.3
Beneficial for:	224	74.7
Maintaining BG level	217	72.3
Increase compliance to treatment	167	55.7
Reducing complications	116	38.7
Minimizing clinic visits	79	26.3
SMBG performance		
Performing	145	48.3
Not performing	155	51.7
SMBG education*	N=145	
Received	80	55.2
Not received	65	44.8
Duration of performing SMBG*	4	
< 1 year	107	2.8
1- years	34	73.8
>5 years		23.4
SMBG done by:		
Self	76	52.4
Help of family members	69	47.6
Frequency of SMBG*		
Once a day	45	29.8
Twice a day	27	17.9
Three times a day	17	11.3
On need	56	41.0
Record of SMBG*		
Yes anywhere	11	7.6
Yes in special recoding card	3	2.1
No	131	90.3
Cues for performing SMBG*		
My choice	39	26.9
Diabetes educator's Advise	6	4.1
Relatives' advise	25	17.2
Doctor's advise	75	51.7

Table 3: Educational level, regularity of follow up visits, and performance of SMBG

Variables	N	SMBG		OR	95 % CI
		Yes (%)	No (%)		
Educational level					
High educational	80	67.5	32.5	2.98	1.75 – 5.19
Low educational	220	40 .9	59.1		
Follow up at the diabetic clinic					
Yes	285	48.1	51.9	1.058	0.36 – 3.14
No	15	46.7	53.3		

Table 4: Relationship between performing home blood glucose monitoring and the most common chronic diabetic complications

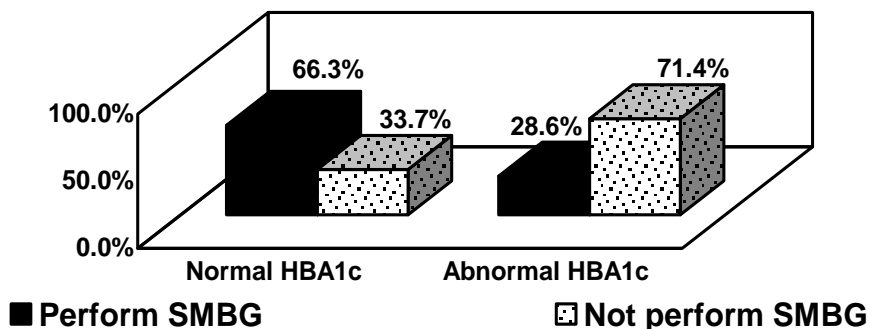| Complications	N	SMBG		OR	95 % CI
		Yes (%)	No (%)		
Cataract	100	48.0	52.0	0.980	0.606 – 1.584
Numbness	225	48.9	51.1	1.093	0.648 – 1.485
Hypertension	148	52.0	48.0	1.339	0.851 – 2.109
Hyperlipidemia	148	54.7	45.3	1.662	1.05-2.622

Figure1 :Effect of Performing of Home Blood Glucose Monitoring on the range of HBA1C

* **OR=4.86,   95 % CI=2.37 – 10.28**

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