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The Impact of Health Literacy on Self-Monitoring of Blood Glucose in Patients With Diabetes Receiving Care in an Inner-City Hospital

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Abstract

Background—Self-monitoring of blood glucose (SMBG) is considered to be 1 of the cornerstones of diabetes self-management. It is unclear whether inadequate health literacy affects SMBG.

Objective—The objective of this study was to examine the relationship between health literacy and SMBG.

Methods—This was a cross-sectional survey of 189 patients with diabetes, aged 18 to 65 years, receiving care in a large urban, public health care setting. We measured health literacy using the shortened version of the Test of Functional Health Literacy in Adults. The diabetes care profile was used to determine the use of self-monitoring of blood glucose.

Results—Most (60.9%) of the survey participants were assessed as functionally health literate. The majority (90.9%) of the study participants reported testing their blood sugar at least once daily. Although adequate health literacy was associated with recording of blood sugar testing ($p = .049$), we found no statistically significant relationship between health literacy and the frequency of SMBG. Persons self-reporting having diabetes for more than 10 years were less likely to self-monitor blood glucose (odds ratio, 0.33; 95% CI, 0.11-0.99).

Conclusions—SMBG frequency is not independently associated with health literacy, but SMBG result recording is noted among patients with inadequate literacy.

Keywords

diabetes; behavior

Background

Mounting evidence indicates that limited health literacy, common in patients with diabetes, has been associated with worse diabetes knowledge and worse diabetes outcomes.^{1,2} The mechanisms whereby inadequate health literacy may result in worse diabetes outcomes are still not elucidated because diabetes care involves a complex array of concepts and skills. Factors determining the quality of diabetes care are multiple, often involving inputs at various patient, provider, and system levels.³

Diabetes self-management, an important aspect of diabetes management, is one of the most challenging management regimens of any chronic illness.⁴ Patients perform self-monitoring of blood glucose (SMBG), manage multiple medications, maintain foot hygiene, adhere to diet and meal plans, and engage in an exercise program.^{5,6}

SMBG is one of the valuable tools in the self-management of diabetes and has been shown to improve glycemic control.⁷ The American Diabetes Association consensus and position statements on SMBG state that monitoring of glycemic status, as performed by patients and health care providers, is considered a cornerstone of diabetes care.⁸ SMBG is recommended 3 or more times daily for most patients with type 1 diabetes but at least once daily for persons with type 2 disease. A large proportion of patients with diabetes do not test their blood glucose. A study in 1993 showed that 40% of patients with diabetes monitored their blood glucose at least 1 time per day, while only 26% of the patients treated with insulin monitored at least 1 time per day.⁹ Recent data, however, show improvements in the daily SMBG rate. A rate of 63.4% was reported among all adults with diabetes in a recent US survey.¹⁰

Performing highly technical tasks such as SMBG is likely to be affected by inadequate health literacy. Patients with inadequate health literacy skills may lack self-efficacy or comprehension of the rationale or implications of monitoring; or may simply be unable to perform, correctly interpret, or act on results of self-monitoring.¹¹ Inadequate health literacy appears to be an obstacle to effective self-management. For example, in a study of asthma patients, those with low literacy were observed to be less able to correctly use their metered-dose inhaler than literate patients.¹² Although previous studies reveal no association between health literacy and self-management behaviors, low-literacy patients with diabetes who participated in a diabetes education programs reported better adherence to SMBG behaviors.¹³

The objective of this study was to examine the relationship between health literacy and SMBG among a predominantly low-income patient population with diabetes receiving care in an urban, safety-net health care setting. Understanding the relationship between health literacy and SMBG could have tremendous implications for improving the delivery of diabetes care to patients with low health literacy skills.

Methods

Patient Selection and Recruitment

We conducted a survey of patients between February 2005 and April 2005 from 1 large hospital-based clinic in Atlanta. The clinic has approximately 20000 registered patients with diabetes with an average of 3000 visits monthly. The study location is a unique ambulatory diabetes clinic in a large urban, safety-net hospital, which serves racially and ethnically diverse uninsured and underinsured patients throughout the metropolitan Atlanta area, but primarily from 2 large urban counties.

All registered patients with diabetes, aged 18 to 65 years, were eligible to participate in the survey after registering in the clinic during a regularly scheduled visit. Individuals who were not comfortable speaking English, blind, living in a nursing home, or with severe cognitive impairment were excluded from the study participation.

We randomly sampled 218 patients from a sign-in list of more than 500 patients who received clinical care at the clinic within a 3-month period. We obtained institutional review board (IRB) approval for patient enrollment. From the sample of 218 patients, 189 participated in this interviewer-administered cross-sectional survey. Eligible individuals who agreed to participate in the study completed a 1-hour in-person interview.

Data Collection

The survey questionnaire was developed from published instruments.^{14,15} It consisted of questions to determine demographics, self-rated health, chronic conditions, health care utilization, social support, health behaviors, and health literacy skills.

The primary outcome variable of interest was the frequency of SMBG and was obtained from the diabetes care profile.¹⁴ This is an instrument that was developed to assess social and psychological factors related to diabetes and its treatment. It has been shown to have good to excellent internal consistency reliability (Cronbach's $\alpha = .60$ to $.95$ for the profile scales).

The questionnaire consisted of 234 items, including demographic information, self-care practices, and 116 questions divided into 16 profile scales with 4 to 16 questions per scale. The 16 profile scales assessed control problems, social and personal factors, positive attitude, negative attitude, self-care ability, importance of care, self-care adherence, diet adherence, medical barriers, exercise barriers, monitoring barriers, understanding management practice, long-term care benefits, support needs, support, and support attitudes.

The main exposure variable in this study was functional health literacy. We assessed participants' health literacy by the shortened version of the Test of Functional Health Literacy in Adults (S-TOFHLA), a reliable and validated instrument.¹⁵

Scores on the S-TOFHLA were classified and interpreted as follows: inadequate literacy (0-16, individuals are unable to read and interpret health texts; 17-22, marginal literacy—individuals have difficulty reading and interpreting health texts; 23-36, adequate literacy—individuals can read and interpret most health texts).

Prior to completing the S-TOFHLA section, each patient's vision was examined using a Pocket Vision Guide (MIS Inc, 2004). Those whose corrected vision was 20/50 or better were administered the standard S-TOFHLA (12-point font). Those whose vision was 20/70 to 20/100 were administered the large-print version (14-point font). Participants whose corrected vision was worse than 20/100 could not have their reading skills accurately assessed and were excluded from participation in the survey.

Statistical Analysis

Using descriptive statistics, we examined the patient characteristics, frequency of SMBG, and the S-TOFHLA scores. The categorical variables were summarized with frequency and percentages and the continuous variables were summarized with the mean and standard deviation (SD).

All the patients' characteristics were also examined by health literacy status; Student's *t* test was used for continuous variables and χ^2 test for categorical variables.

Bivariate analyses were implemented to determine the relationship between each of the patient characteristics and functional health literacy as well their relationship with the frequency of SMBG. We used multiple logistic regression analysis to examine the association between health literacy and SMBG accounting for the effects of patient sociodemographic characteristics.¹⁶ Missing values for some variable, when observed, were included in the reference group in logistic regression analyses.

Results

Of the 218 patients who were approached about participating in the study, 189 self-identified African Americans and whites agreed to participate in the survey and were interviewed. Ten

patients did not participate due to poor vision. The average age of the participating patients was 51.2 years. The study participants were primarily African American, female, and of low income (Table 1). The majority of the study participants had a high school (33.9%) or less than high school education (32.3%), and 84.7% reported receiving diabetes education. More than 90.0% of the study participants reported testing their blood sugar at least once daily, with 75.6% testing twice a day or more.

About sixty percent (60.9%) of study population had adequate functional health literacy, and 39.1% had inadequate to marginal functional health literacy (16.2% marginal, 22.9% inadequate). Inadequate functional health literacy was associated with being older ($p < .001$), having less education ($p < .020$), and being uninsured ($p < .004$) (Table 1). Persons who indicated having diabetes longer were also more likely to have inadequate health literacy levels ($p < .005$).

There was no difference in blood sugar monitoring among participants by health literacy levels. However, those who kept a record of their blood sugar testing results (64.6%) were more likely to have adequate functional health literacy (%) ($p = .049$).

In multivariate logistic modeling, we found no statistically significant relationship between health literacy and the frequency of SMBG (Table 2). SMBG was dichotomized in final logistic model: once daily vs 2 or more times daily. The final logistic modeling results was only suggestive of an association between functional health literacy and SMBG (odds ratio [OR], 1.50; 95% confidence interval [CI], 0.57-3.94), adjusting for age, insurance, years with diabetes, and sugar testing record-keeping. SMBG was statistically significantly associated with having diabetes for more than 10 years; persons self-reporting having diabetes for more than 10 years were less likely to self-manage blood glucose (OR, 0.33; 95% CI, 0.11-0.99).

Discussion

Our study demonstrates that among patients with diabetes and access to diabetes subspecialty clinic, there was no significant association between functional health literacy and rates of SMBG. Inadequate health literacy was not significantly associated with a lower likelihood of SMBG. This is similar to other studies that reported no association between health literacy and diabetes self-management behaviors (including SMBG).¹³

However, our patients with inadequate health literacy had lower rates of keeping a record of blood glucose testing results. This may be explained by the complex nature of SMBG, often challenging in patients with inadequate health literacy, who were less likely to correctly interpret or act on self-monitoring results.¹⁷

The reported rate of SMBG was very high in the study population compared to the reported rates in the general population. This disparity noted between the rates of SMBG is likely attributed to the fact that the majority of the study population reported receiving diabetes education. The high rates of our study are consistent with those of other studies in which having had patient education class in diabetes management and making frequent physician visits for diabetes care were positively related to self-testing.⁵

Similar to other studies, financial barriers associated with income, employment status, and health insurance do not appear to impede SMBG. Although the duration of having diabetes was associated with SMBG, this finding should be interpreted with caution because the confidence interval was wide and duration was self-reported.

The following limitations of this study should be acknowledged. First, selection bias is a potential confounding factor because our respondents were selected from 1 specialty hospital-

based practice, and the observed results may not be generalizable elsewhere. Second, bias due to self-reporting may have influenced the results. Third, although we hypothesized that health literacy predicted SMBG, our lack of confirmation could be due to the relatively small sample size of our study and the concurrent attendance of many subjects to a subspecialty diabetic clinic where they were already receiving intensive diabetes education. Finally, the cross-sectional design of this survey only captures the reported rates of SMBG of patients receiving intensive education at 1 point in time and may not reflect the actual rates in the population over time periods.

In summary, our findings suggest that inadequate health literacy may have, at best, only a marginal impact on the frequency of SMBG. However, these patients had a high rate of record keeping of blood glucose monitoring results but may have a low rate of understanding how to use the results to manage their disease. Although inadequate health literacy has been associated with worse outcomes in persons with diabetes, these findings may suggest that not understanding the results of SMBG steps may contribute to the mechanisms by which inadequate health literacy is associated with worse diabetes outcomes. Further research is needed to elucidate the mechanisms by which inadequate use of SMBG results worsens diabetes outcomes.

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Table 1

Patient Characteristics According to Functional Health Literacy Status

Characteristics	Total	Inadequate	Adequate	P Value
	N = 189 (100%)	N = 74 (39.1%)	N = 115 (60.9%)	
Mean age, y (SD)	51.2 (10.0)	55.79 (8.97)	48.23 (9.55)	<.001
Sex				
Male	78 (41.3)	32 (41.0)	46 (59.0)	.658
Female	111 (58.7)	42 (37.8)	69 (62.2)	
Marital status				
Never married	71 (37.57)	17 (25.0)	51 (75.0)	
Married	27 (14.29)	12 (50.0)	12 (50.0)	.154
Separated/divorced	71 (37.57)	23 (35.4)	42 (64.6)	
Widowed	20 (10.58)	5 (33.3)	10 (66.7)	
Race				
White	10 (5.3)	2 (20.0)	8 (80.0)	.202
African American	179 (94.7)	72 (40.2)	107 (59.8)	
Education				
< High school	61 (32.3)	25 (45.5)	30 (54.5)	
High school graduate	64 (33.9)	18 (31.0)	40 (69.0)	.040
Some college	64 (33.9)	14(23.7)	45 (76.3)	
Household income				
Annual <\$20000	148 (78.3) ^a	62 (41.9)	86 (58.1)	.658
Annual ≥\$20000	38 (20.1)	11 (28.9)	27(71.1)	
Insurance status				
Insured	90 (47.6)	45 (50.0)	45 (50.0)	.004
Uninsured	99 (52.4)	29 (29.3)	70 (70.7)	
Employment status				
Employed	34 (17.9)	12 (35.3)	22 (64.7)	.611
Unemployed	155 (82.1)	62 (40.0)	93 (60.0)	
Years with diabetes, SD	8.5 (8.05)	10.39 (8.2)	11.30 (7.0)	.010
Received diabetes education				
Yes	160 (84.7) ^a	59 (36.9)	101 (63.1)	.200
No	26 (13.8)	13 (50.0)	13 (50.0)	
Sugar testing/day				
None	17 (9.1)	6 (40.0)	9 (60.0)	
Once daily	29 (15.3)	7 (28.0)	18 (72.0)	.854
Twice daily	101 (53.4)	32 (34.4)	61 (65.6)	
3 or more daily	42 (22.2)	12 (30.8)	27 (69.2)	
Sugar testing record				
Yes	144 (76.1) ^a	51 (35.4)	93 (64.6)	.049
No	27 (14.3)	15 (55.6)	12 (44.44)	

^aSome missing values.

Table 2The Association Between Patient Characteristics and Self-Management of Blood Glucose^{a,b}

Characteristics	Odds Ratio	95% Confidence Interval
Functional health literacy		
Inadequate	1.00	
Adequate	1.50	0.57-3.94
Age		
<45	1.00	
46-55	1.05	0.36-3.09
>55	1.63	0.52-5.13
Insurance status		
No	1.00	
Yes	1.75	0.73-4.18
Education		
Some college	1.00	
<High school	1.96	0.65-5.87
High school	1.36	0.46-4.00
Years with diabetes		
≤5	1.00	
6-10	0.39	0.11-1.32
>10	0.33	0.11-0.99
Sugar testing record keeping		
No	1.00	
Yes	1.98	0.80-4.88

^a Multivariate logistic regression analysis.^b Self-management of blood glucose is dichotomized: once daily vs 2 or more times daily.