Behavioral Analysis of Chinese Adult Patients with Type 1 Diabetes on Self-monitoring of Blood Glucose

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Abstract

Background: The information-motivation-behavioral skills (IMB) model of health behavior is an effective tool to evaluate the behavior of diabetes self-management. The purpose of this study was to explore behavioral factors affecting the practice of self-monitoring of blood glucose (SMBG) within the frame of IMB model of health behavioral among adult patients with type 1 diabetes in a single diabetes clinic in China.

Methods: A questionnaire with three subscales on SMBG information, motivation, and behavioral skills based on IMB model was developed. Validity and reliability of the measures were examined and guaranteed. Adult patients with type 1 diabetes visiting our diabetes clinic from January to March 2012 ($n = 55$) were consecutively interviewed. The self-completion questionnaires were administered and finished at face-to-face interviews among these patients. Both descriptive and correlational analyses were made.

Results: Fifty-five patients finished the questionnaires, with the median duration of diabetes 4.5 years and the median of SMBG frequency 2.00. Specific SMBG information deficits, motivation obstacles, and behavioral skill limitations were identified in a substantial proportion of participants. Scores of SMBG motivation ($r = 0.299$, $P = 0.026$) and behavioral skills ($r = 0.425$, $P = 0.001$) were significantly correlated with SMBG frequency. The multiple correlation of SMBG information, SMBG motivation, and SMBG behavioral skills with SMBG frequency was $R = 0.411$ ($R^2 = 0.169$, $P = 0.023$).

Conclusions: Adult patients with type 1 diabetes in our clinic had substantial SMBG information deficits, motivation obstacles, and skill limitations. This information provided potential-focused education targets for diabetes health-care providers.

Key words: Information-motivation-behavioral Skills Model; Self-monitoring of Blood Glucose; Type 1 Diabetes

INTRODUCTION

Self-monitoring of blood glucose (SMBG) provides real-time glucose readings for insulin and diet/exercise adjustments, and thus plays an important role in diabetes management for insulin-treated patients.[1,2] Its role in type 1 diabetes is well recognized and is recommended to practice at a certain frequency in different guidelines.[1-4] However, as a voluntary behavior, the practice of SMBG among patients with type 1 diabetes is not satisfactorily implemented. Many studies have shown a significant gap between recommended SMBG utilization and the real-world practice.[5-7]

Previous studies shown that many factors have been associated with the frequency of SMBG practice, including gender,[5,6] age of onset,[8,9] length of time since diagnosis,[5,10] insulin regimen,[9] economic status,[5,11] and insurance coverage.[7,12] However, these observational studies were not conceptually integrated and did not reveal the ultimate elements generating SMBG behavior, thus hardly suggested any actionable intervention target. A more integrated and systemic method is required to better understand SMBG behavior and to provide directions for practical interventions.

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The information-motivation-behavioral skills (IMB) model of health behavior is a well-researched theoretical model derived from behavioral science.[13] The model has been widely applied in both observation and intervention studies of HIV risk behaviors and antiretroviral therapy adherence and is known to be an effective tool in this field.[14-16] Recently, other fields of health care related to health behaviors,[17-19] especially those have a lot to do with self-management like diabetes,[20,21] have been exploring the use of this successful model.

Guided by IMB model of health behavior, this questionnaire-based survey was designed to study SMBG behavior systemically among a sample of Chinese adult patients with type 1 diabetes.

METHODS

Subjects

Participants were selected from the Guangdong Type 1 Diabetes Mellitus Translational Medicine Study,[22] of which our diabetes clinic is one of the 16 registry centers. Adult (older than 18 years) patients with type 1 diabetes visiting our diabetes clinic from January to March 2012 ($n = 63$) were consecutively interviewed, except for those newly diagnosed patients (duration <3 months) ($n = 6$), pregnant patients ($n = 2$), and patients with severe complications or comorbidities that could not cooperate with the survey ($n = 0$). Altogether, 55 patients were interviewed, and all of them finished the questionnaire, response rate 100%. Clinical characteristics and frequency of SMBG practicing were collected. The study was approved by the Ethics Committees of the Third Affiliated Hospital of Sun Yat-sen University, and written informed consent was obtained from all participants.

Measures

Measure development

Guided by the theory of IMB model, and referring to an English version of IMB-SMBG questionnaire, a team of endocrinologists together built an IMB-SMBG questionnaire in Chinese. Specific steps are listed in Table 1. Sample items from each section (translated from Chinese) are shown in Table 2.

Validity and reliability examination

The first 15 respondents were invited during a diabetes event at our hospital to complete the same questionnaire again 1–3 weeks away from their initial test. The retest response rate was 100%. Test–retest reliability was evaluated using interclass correlation coefficient, which was greater than 0.80 for the total scale (0.92) and the three subscales (0.91, 0.93, and 0.85, respectively), indicating good reliability. Cronbach's alpha, used to test internal consistency, was greater than 0.80 for all subscales (0.86, 0.87, and 0.83, respectively), indicating the scale is internally consistent. Content validation was examined based on correlations between item score and total score of each subscale, proving items had stronger correlation with their own domain ($r > 0.50$ for 70% of the items, $P < 0.001$) than the other two.

Questionnaire administration

All respondents completed the questionnaire at the same clinical setting, which was a separate quiet examination room with desks and chairs. Two interviewers were trained before the study to standardize the interview process and interviewed the 55 patients (70 person-times) throughout the study. Brief introduction and necessary explanations about the study purpose and design were given first, written consent was obtained afterward, and then the questionnaire was delivered to the patient for self-completion.

Statistical analysis

Negative (incorrect) and neutral responses to statements in information and motivation sections were coded as "deficient." Negative responses to statements in behavioral

Table 1: Steps of developing the IMB-SMBG questionnaire

Steps	Contents
Step 1	Specified three subscales of the questionnaire
	Information module: Measure the individual's information relevant to SMBG practice, including purpose of the behavior, recommended frequency and patterns, interpretation of the readings, and proper response actions
	Motivation module: Measure positive personal beliefs and attitudes toward the SMBG practice and its outcome, and perceived social support for SMBG practice
	Behavioral skills module: Measure the abilities to self-cue SMBG, to accomplish the practice and to engage in effective response actions based on testing results
Step 2	Wrote concrete measures on the three part, discussed and revised
	Foundation: Most of the items were revised from an established set of measures developed by the modeler Fisher *et al.*[23] Taken into account differences in cultures and health-care environments, certain changes to the items were made accordingly
	Evaluation index: 5-point Likert scale from strongly agree to strongly disagree was adopted for answers of all items, with lower score indicating higher degree of information/motivation/skill insufficiency
Step 3	Pretest
	Specific process: Three patients with Type 1 diabetes and two diabetes educators did a pretest to evaluate the questionnaire for its expression clarity, content appropriateness, and representativeness
	Items: 30 items on information, 25 items on motivation, and 21 items on SMBG skills, altogether 76 items

SMBG: Self-monitoring of blood glucose; IMB: Information-motivation-behavioral skills.

Table 2: Sample items from each section of the IMB-SMBG questionnaire

Items	1 (strongly agree)	2 (somewhat agree)	3 (neutral)	4 (somewhat disagree)	5 (strongest disagree)
Section I: Information					
1. I don't know why do I need to test my blood sugar every day	1	2	3	4	5
2. I don't have to test my blood sugar every day now since I get HbA1c	1	2	3	4	5
Section II: Motivation					
Part A: Personal attitudes					
1. It is a constant reminder that I have diabetes every time I test my blood sugar	1	2	3	4	5
2. It is too expensive to test my blood sugar as often as my doctor recommended	1	2	3	4	5
Part B: Social support					
1. My husband or wife knows that I have type 1 diabetes	1	2	3	4	5
2. My husband or wife thinks that I should test my blood sugar as often as my doctor recommended	1	2	3	4	5
Section III: Behavioral skills					
1. It is inconvenient for me to buy meters/test strips	1	2	3	4	5
2. It is painful when I test my blood sugar	1	2	3	4	5

SMBG: Self-monitoring of blood glucose; IMB: Information-motivation-behavioral skills.

skills section were coded as "deficient." For each item, proportions of patients that were "deficient" in that particular information/motivation/skill were described. Spearman's correlation was used to analyze relationships between each module and SMBG frequency as well as interrelationships between the three modules. Multiple correlation analysis was used to evaluate the impact of SMBG information, motivation, and behavioral skills as a whole on SMBG frequency.

RESULTS

Sample characteristics and practice of self-monitoring of blood glucose

Clinical characteristics of the survey participants are shown in Table 3. The median of the average SMBG frequency was 2.00 (0.57, 3.00). The compliance rate of the American Diabetes Association recommendation (to test at least three times daily) was 36.4%, 27.3% of participants tested less often than once a day, 5.4% (n = 3) reported they barely practice SMBG.

The information-motivation-behavioral skills analysis

SMBG information deficits, motivation obstacles, and behavioral skill limitations were identified in a substantial proportion of participants [Table 4], of which the most prevalent deficits/obstacles/limitations included: The meaning of high blood sugar before exercises (not understood in 50.9% of participants), kind of food that should be taken when blood sugars was low (47.3%); views of the cost of testing being "too expensive" (85.5%) or "painful" (72.7%) if adhered to the doctor's recommendation; feeling difficult to talk with colleges about diabetes (63.6%) and to buy test strips conveniently (58.2%).

Table 3: Characteristics of the survey participants

Items	Results
n	55
Age (years)	28.0 (24.0, 38.0)
Female, n (%)	34 (61.8)
BMI (kg/m^2)	20.8 ± 2.2
Education level, n (%)	
College and higher	35 (63.6)
Middle school	17 (30.9)
Primary and lower	3 (5.5)
Years since diagnosed	4.5 (2.0, 11.0)
Insulin regimen, n (%)	
CSII	24 (43.6)
MDI	25 (45.5)
Premix insulin injection twice	6 (10.9)
Insulin dosage (U/kg)	0.68 ± 0.19
HbA1c (%) (mmol/mol)	7.7 ± 1.7 (61 ± 5)

BMI, insulin dosage (U/kg), and HbA1c were normally distributed variables: Mean ± SD; age, years since diagnosis were nonnormally distributed variables: Median (25th percentile, 75th percentile); gender, education level, and insulin program were categorical variables: n (%). BMI: Body mass index; CSII: Continuous subcutaneous insulin infusion; MDI: Multiple daily injection; SD: Standard deviation.

The relationship between information-motivation-behavioral skills' scores and self-monitoring of blood glucose frequency

Scores of SMBG motivation (r = 0.299, P = 0.026) and behavioral skills (r = 0.425, P = 0.001) were significantly correlated with SMBG frequency while score of SMBG information was not (r = 0.255, P = 0.060). Figure 1 shows the relationship between each module and the frequency of SMBG and interrelationship between the modules. The multiple correlation of SMBG information, SMBG motivation, and SMBG behavioral skills with SMBG

Table 4: SMBG information, motivation, and skills deficits among adult patients with type 1 diabetes

Items	Information/motivation/behavioral skills	Deficient (%)
	Information section	
a19	I could do more exercise when my blood sugar is very high	50.9
a23	I need to eat protein when my blood sugar is low	47.3
a3	My body feels it when my blood sugar is high or low without me testing it	43.6
a18	I know how to find out my blood sugar patterns from the monitoring data	40.0
a2	I don't have to test my blood sugar every day now since I get HbA1c	20.0
a12	I know how often I should test my blood sugar	18.2
a21	If the tested blood sugar is high, I can increase my insulin dosage	18.2
a16	I know how to react when my tested blood sugar is high	16.4
a4	I don't think that diet and exercise can do much to my blood sugar	14.5
a9	I don't think it is very important to record all my testing results	14.5
	Motivation section	
b1	It is too expensive to test my blood sugar as often as my doctor recommended	85.5
b2	It is too painful to test my blood sugar as often as my doctor recommended	72.7
b3	It is unpleasant to test my blood sugar as often as my doctor recommended	56.4
b5	It makes me feel more anxiety to test my blood sugar as often as my doctor recommended	56.4
b20	It would affect my working to test my blood sugar as often as my doctor recommended	54.5
b7	It consumes too much time to test my blood sugar as often as my doctor recommended	52.7
b18	It interferes with many aspects of my life to test my blood sugar as often as my doctor recommended	52.7
b22	My workmates think I should test my blood sugar as often as my doctor recommended	50.0
b19	It would interfere with many things I like to do if I test my blood sugar as often as my doctor recommended	43.6
B23	My friends think I should test my blood sugar as often as my doctor recommended	41.8
	Behavioral skill section	
c9	I feel difficult to talk about having diabetes with my workmates	63.6
c1	It is very inconvenient for me to buy test strips	58.2
c4	It usually hurts when I test my blood sugar	58.2
c5	It is difficult for me to keep the meter available whenever I need to use it	58.2
c8	I feel difficult to talk about having diabetes with my friends easily	52.7
c16	I know how to use all the functions of my meter	47.3
c18	I know how to seek help from my doctor for blood sugar monitoring	41.8
c17	I know what information in my meter I should bring to my doctor when I visit him/her	38.2
c20	I know how to talk to my doctor about my blood sugar monitoring records even if he/she doesn't ask	38.2
c2	I often run out of test strips	30.9

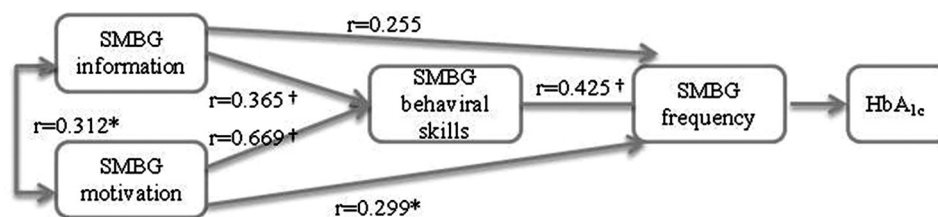SMBG: Self-monitoring of blood glucose.

Figure 1: Correlations between modules of the IMB-SMBG model and SMBG frequency (*$P < 0.05$, †$P < 0.01$). IMB: Information-motivation-behavioral skills; SMBG: Self-monitoring of blood glucose.

frequency was $R = 0.411$ ($R^2 = 0.169$, $P = 0.023$). SMBG information, motivation, and skills together accounted for 16.9% of the variation in SMBG frequency among our participants.

DISCUSSION

Guided by the IMB model, the current study developed an SMBG questionnaire, carried out a survey among adult patients with type 1 diabetes in our hospital, and disclosed considerable deficiencies in SMBG information, personal attitudes, and social support in regard to SMBG, and SMBG performing skills among surveyed population. Over half of the patients deemed it was OK to increase exercises when blood glucose is very high. Nearly half of the patients had wrong ideas about the kind of food that should be taken when blood glucose is low and were not against the idea of "feel" the blood sugar without testing. One-fifth did not understand the different meanings of HbA1c and SMBG results and the necessity to practice both. More than half of the patients

found that practicing SMBG as recommended would be too expensive, painful, unpleasant, causing anxiety, or interfering with their work. A considerable proportion of patients did not feel support of regular SMBG from surrounding and/or important people. Behavioral skill obstacles mainly included difficulties in talking about having diabetes with workmates and friends, buying test strips conveniently, practicing SMBG painlessly, and keeping glucose meter available. Correlation analysis showed significant correlation between SMBG motivation and frequency as well as between SMBG skill and frequency, and the latter correlation was stronger, suggesting that behavior skills were ultimately the most closely associated factors with SMBG behavior.

The deficiencies revealed were similar with the findings in an earlier study[23] carried out among the US citizens with type 1 diabetes, but with a substantial higher proportion of patients having them, especially in the sections of motivation and behavioral skills. In that particular study, mean adherence to recommended SMBG frequency was 90% ($n = 208$), much higher than the 36.4% recommendation adherence in this study. As could be expected, the mean HbA1c level was lower in the US study than that in this study, 7.3% (56 mmol/mol) versus 7.7% (61 mmol/mol).

All behavioral factors could not be encompassed within one single theoretical model. The IMB model emphasizes the subjective perspectives from the patients without studying the objective requisite conditions in performing the behavior, making it less fitting in study settings where requisite requirements cannot be met at first place. For SMBG behavior, such requirements might include possessing a glucose meter, having been recommended a proper blood glucose monitoring pattern and frequency by a professional, having the basic economic condition or insurance coverage to pay for the monitoring supplies, and reach ability of a diabetes doctor to discuss over the glucose monitoring results. Thus, future studies in attempt to observe or improve SMBG practice among diabetes patients, these and maybe other prerequisites should be investigated in the beginning, especially in developing areas.

Most of the participants in this survey (54/55) were from Guangzhou city, a relatively developed district in China. The study may be relatively more helpful for diabetes educators in our clinic and other clinics in Guangzhou. The results of this study cannot be extrapolated to patients from other districts with different economic and health-care environments. Another limitation lies in its observational nature. Interventional research in this area remains to be carried out.

In conclusion, the study shown that adult patients with type 1 diabetes in our clinic had substantial SMBG information deficits, motivation obstacles, and skill limitations. These deficiencies accounted for a respectable proportion of the variation in SMBG frequency, which may provide potential-focused education targets for diabetes health-care providers.

Conflicts of interest

There are no conflicts of interest.

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