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

Zhao-Yi Qin1,2,3, Jin-Hua Yan1,2,3, Dai-Zhi Yang1,2,3, Hong-Rong Deng1,2,3, Bin Yao1,2,3, Jian-Ping Weng1,2,3, on behalf of the Guangdong Type 1 Diabetes Mellitus Translational Study Group

1Department of Endocrinology and Metabolic Disease, The Third Affiliated Hospital of Sun Yat-sen University, Guangzhou, Guangdong 510630, China
2Guangdong Diabetes Center, Guangzhou, Guangdong 510630, China
3Guangdong Provincial Key Laboratory of Diabetology, Guangzhou, Guangdong 510630, China

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 (R² = 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. Its role in type 1 diabetes is well recognized and is recommended to practice at a certain frequency in different guidelines. 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.

Previous studies shown that many factors have been associated with the frequency of SMBG practice, including gender, age of onset, length of time since diagnosis, insulin regimen, economic status, and insurance coverage. 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.

Address for correspondence: Prof. Jin-Hua Yan, Department of Endocrinology and Metabolic Disease, The Third Affiliated Hospital of Sun Yat-sen University, No. 600, Tianhe Road, Guangzhou, Guangdong 510630, China E-Mail: yanjh79@163.com

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com
© 2017 Chinese Medical Journal • Produced by Wolters Kluwer • Medknow

Received: 23-08-2016 Edited by: Li-Shao Guo
How to cite this article: Qin ZY, Yan JH, Yang DZ, Deng HR, Yao B, Weng JP, on behalf of the Guangdong Type 1 Diabetes Mellitus Translational Study Group. Behavioral Analysis of Chinese Adult Patients with Type 1 Diabetes on Self-monitoring of Blood Glucose. Chin Med J 2017;130:39-44.
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.
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%).

**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
The 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. Intervventional 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.

**Acknowledgment**

We would like to thank all the doctors, nurses, technicians, and patients for their dedication to this study.

**Financial support and sponsorship**

This work was supported by grants from the Sun Yat-sen University Clinical Research 5010 Program (No. 2007030), the Science and Technology Planning Project of Guangdong Province (No. 2014A020212065, No. 2015A030401034), and the Chinese National Natural Science Foundation (No. 81100556).

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Chinese Diabetes Society. CDS guideline for blood glucose monitoring (2011 Version). Chin J Diabetes Mellitus 2011;3:13-21. doi: 10.3760/cma.j.issn.1674-5809.2011.01.004.

2. American Diabetes Association. Executive summary: Standards of medical care in diabetes-2012. Diabetes Care 2012;35 Suppl 1:S4-S10. doi: 10.2337/dc12-s004.

3. IDF/ISPAD 2011 Global Guideline for Diabetes in Childhood and Adolescence. Available from: http://www.idf.org/guideline-diabetes-childhood. [Last accessed on 2016 Jun 28].

4. Handelsman Y, Mechanick JI, Blonde L, Grunberger G, Bloomgarden ZT, Bray GA, et al. American Association of Clinical Endocrinologists Medical Guidelines for Clinical Practice for developing a diabetes mellitus comprehensive care plan. Endocr Pract 2011;17 Suppl 2:1-53. doi: 10.4158/EP.17.S2.1.

5. Karter AJ, Ferrara A, Darbinian JA, Ackerson LM, Selby JV. Self-monitoring of blood glucose: Language and financial barriers in a managed care population with diabetes. Diabetes Care 2000;23:477-83. doi: 10.2337/diacare.23.4.477.

6. Hansen MV, Pedersen-Bjergaard U, Heller SR, Wallace TM, Rasmussen AK, Jørgensen HV, et al. Frequency and motives of blood glucose self-monitoring in type 1 diabetes. Diabetes Res Clin Pract 2009;85:183-8. doi: 10.1016/j.diabres.2009.04.022.

7. Lecomte P, Ronom I, Fosse S, Simon D, Fagot-Campagna A. Self-monitoring of blood glucose in people with type 1 and type 2 diabetes living in France: The Entred study 2001. Diabetes Metab 2008;34:219-26. doi: 10.1016/j.diabet.2007.11.005.

8. Guilfoyle SM, Crimmins NA, Hood KK. Blood glucose monitoring and glycemic control in adolescents with type 1 diabetes: Meter downloads versus self-report. Pediatr Diabetes 2011;12:560-6. doi: 10.1111/j.1399-5448.2010.00735.x.

9. Ziegler R, Heidtmann B, Hilgard D, Hofer S, Rosenbauer J, Holl R, DVP-Wiss-Initiative. Frequency of SMBG correlates with HbA1c and acute complications in children and adolescents with type 1 diabetes. Pediatr Diabetes 2011;12:11-7. doi: 10.1111/j.1399-5448.2010.00650.x.

10. Mbaezue N, Mayberry R, Gazmararian J, Quashie A, Ivonye C, Heisler M. The impact of health literacy on self-monitoring of blood glucose in patients with diabetes receiving care in an inner-city hospital. J Natl Med Assoc 2010;102:5-9. doi: 10.1016/S0027-9684(15)30469-7.

11. Levine DA, Allison JJ, Cherrington A, Richman J, Scarinci IC, Houston TK. Disparities in self-monitoring of blood glucose among low-income ethnic minority populations with diabetes, United States. Ethn Dis 2009;19:97-103.

12. Vincze G, Barner JC, Lopez D. Factors associated with adherence to self-monitoring of blood glucose among persons with diabetes. Diabetes Educ 2004;30:112-25. doi: 10.1177/014572170403000019.

13. Wagner J, Malchoff C, Abbott G. Invasiveness as a barrier to self-monitoring of blood glucose in diabetes. Diabetes Technol Ther 2005;7:612-9. doi: 10.1089/dia.2005.7.612.

14. Fisher JD, Fisher WA, Misovich SJ, Kimble DL, Malloy TE.
Changing AIDS risk behavior: Effects of an intervention emphasizing AIDS risk reduction information, motivation, and behavioral skills in a college student population. Health Psychol 1996;15:114-23. doi: 10.1037/0278-6133.15.2.114.

15. Ferrer RA, Morrow KM, Fisher WA, Fisher JD. Toward an information-motivation-behavioral skills model of microbicide adherence in clinical trials. AIDS Care 2010;22:997-1005. doi: 10.1080/09540121003623719.

16. Amico KR, Toro-Alfonso J, Fisher JD. An empirical test of the information, motivation and behavioral skills model of antiretroviral therapy adherence. AIDS Care 2005;17:661-73. doi: 10.1080/09540120500038058.

17. Rivet Amico K. A situated-Information Motivation Behavioral Skills Model of Care Initiation and Maintenance (sIMB-CIM): An IMB model based approach to understanding and intervening in engagement in care for chronic medical conditions. J Health Psychol 2011;16:1071‑81. doi: 10.1177/1359105311398727.

18. Zarani F, Besharat MA, Sareeghian S, Sarami G. The effectiveness of the information-motivation-behavioral skills model in promoting adherence in CABG patients. J Health Psychol 2010;15:828-37. doi: 10.1177/1359105309357092.

19. Zarani F, Besharat MA, Sareeghian S, Sarami G. An information-motivation-behavioral skills (IMB) model-based intervention for CABG patients. Int J Behav Med 2012;19:543-9. doi: 10.1007/s12529-011-9193-2.

20. Osborn CY, Egede LE. Validation of an information-motivation-behavioral skills model of diabetes self-care (IMB-DSC). Patient Educ Couns 2010;79:49-54. doi: 10.1016/j.pec.2009.07.016.

21. Osborn CY, Rivet Amico K, Fisher WA, Egede LE, Fisher JD. An information-motivation-behavioral skills analysis of diet and exercise behavior in Puerto Ricans with diabetes. J Health Psychol 2010;15:1201-13. doi: 10.1177/1359105310364173.

22. Li J, Yang D, Yan J, Huang B, Zhang Y, Weng J; Guangdong Type Diabetes Translational Study Group. Secondary diabetic ketoacidosis and severe hypoglycaemia in patients with established type 1 diabetes mellitus in China: A multicentre registration study. Diabetes Metab Res Rev 2014;30:497-504. doi: 10.1002/dmrr.2547.

23. Fisher WA, Kohut T, Schachner H, Stenger P. Understanding self-monitoring of blood glucose among individuals with type 1 and type 2 diabetes: An information-motivation-behavioral skills analysis. Diabetes Educ 2011;37:85-94. doi: 10.1177/0145721710391479.