DialBetics: Smartphone-based Self-management for Type 2 Diabetes Patients

Kayo Waki¹, Hideo Fujita¹, Yuji Uchimura¹, Eiji Aramaki¹, Koji Omae¹, Takashi Kadowaki¹, and Kazuhiko Ohe¹
¹ The University of Tokyo, Tokyo, Japan
² Frontier Services Department, NTT DOCOMO, INC., Tokyo, Japan

Abstract. Healthcare providers lack the time to provide the continuous life-style education necessary for diabetes patients to gain enough skill in diabetes self-management. We developed a real-time, partially automated interactive smartphone-based system (DialBetics)—combining IT and “natural language processing”—to interpret patients’ blood glucose, blood pressure, weight, exercise, and dietary content calculated from a message and photo of a meal sent by patients, and respond with communication of findings and advice, achieving diabetes self-management. We examined safety, usability, and impact of a remote health-data monitoring and education system on self-management. Five patients with type 2 diabetes were recruited for a one-month feasibility study. The patients were provided with smartphone, glucometer, blood pressure monitor, pedometer, and weight scale. Patients’ measurements were automatically transmitted to a server; exercise and diet information with a meal photo were sent by patients. Patients had excellent compliance for measurements; patients’ interest in, and willingness to make, life-style changes improved by receiving real-time findings and advice from DialBetics. Considering the four-week time period of this intervention, results are encouraging in improving self-management. We also plan to assess the impact of DialBetics on patient HbA1c outcomes.

Keywords. Type 2 diabetes, mobilephone, self-management, telemedicine

Introduction

Self-management skill is critical for diabetes patients in order to let them assess the interplay among nutrition therapy, physical activity, emotional and physical stress, and medications [1]. However, various limitations—including the fact that healthcare providers lack the time to provide continuous education, the high cost of evidence-based lifestyle interventions, and difficulty in arranging patients’ access to healthcare providers—all are barriers to providing the diabetes education necessary for patients to obtain that skill. Our aim was to develop a real-time automated interactive system, the first system—a combination of IT and a natural language processing method (NLP)—that interprets patients’ data and performs real-time automated text communication with patients, achieving diabetes self-management. We conducted a feasibility study designed to assess the safety, usability, and impact of the system on patient’s diabetes self-management.

¹ Corresponding Author: Kayo Waki, the University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan, 113-8655; E-mail: kwaki-tky@umin.ac.jp.
1. Methods

DialBetics is composed of four modules: (1) Data transmission: patients’ data—blood glucose (BG), blood pressure (BP), body weight (BW), and pedometer counts—are measured at home and sent to the server twice a day. (2) Evaluation: data are automatically evaluated following the Japan Diabetes Society (JDS) guideline’s targeted values; DialBetics determines if each reading satisfies guideline requirements, then sends those results to each patient’s smartphone. (3) Communication: (a) the patient’s voice/text messages about meals and exercise are sent to the server; (b) message processing; (c) advice on life-style modification matched to the patient’s input about foods and exercise is sent back to each patient. (4) Dietary evaluation: patients’ photos of meals are sent to the server; the nutritional values of their meals are calculated by diabeticians, and sent back to each patient (Figure 1). A NLP method was used in (b) and (c) [2]. Voice/text messages that patients send may contain various orthographical and terminological ambiguities; it is an extremely heavy task for the database to anticipate all synonyms for all foods. To reduce the burden, we employed the NLP-based disambiguate system, which allows DialBetics to choose the word in the database with the highest agreement rate for the patients’ input.

A one-month pilot study was designed. To be eligible for the study, patients could not have any severe complications and had to be able to exercise. The study was approved by the Institutional Review Board. We met with patients twice, at week 0 and 4. At week 0, participants were provided with a smartphone, a NFC-enabled glucometer and Bluetooth-enabled devices—a BP monitor, a pedometer, and a weight scale. A clinical team trained each participant on techniques necessary to take proper clinical measurements, to transmit biological information, and to understand outputs. All devices were paired with a unique communicator, which transmitted the readings thorough a wireless network to a server.

2. Results

DialBetics was tested with five type 2 diabetes patients (age, 58.8±8.8 years, and HbA1c 6.76±1.92%), and was found accurate and safe in data transmission, evaluation and text communication. Patients’ data measurement rate was 97.6%. Average HbA1c decreased 0.24% (p=0.3, one-tail). The mean BP measured at home did not meet the JDS goal of hypertension therapy in four patients. The message processing success rate was 67.6% for food (exact match 53.1%, partial match 14.5%, unmatched 32.4%), and
79.1% for exercise (exact match 76.4%, partial match 2.7%, unmatched 20.9%). Since there were no serious adverse events, no physician’s time was required.

All patients were satisfied with DialBetics; they were enthusiastic about receiving real-time advice on life-style modification. They reported that having continuous real-time communication with DialBetics, supported by smartphone, was a promising tool for improving efficiency of diabetes self-management—choosing healthier diet and being more physically active. Despite their low level of previous experience with technology, the patients quickly became comfortable with the use of the equipment.

3. Discussion

DialBetics was effective in improving diabetes self-management skill. A previous IT-based system instructed patients to adjust medication dosage; our system focused on life style modification [3]. When patients received text messages to their smartphone almost as they made measurements and reported meals and exercise, that reinforcement demonstrated to them the improved self-care they were achieving. In contradistinction, current IT-based systems for diabetes management have limited interaction with patients to improve self-care [4]. Because DialBetics allowed patients to examine time-relevant data in conjunction with their diet and exercise, they were more likely to make life-style modifications. A multifaceted intervention of education, patient feedback, and real-time data and communication between patients and DialBetics may eliminate barriers to providing diabetes education. Although the decrease of HbA1c was not statistically significant, the values did tend to decrease in most patients. None of the previous studies assessed the effects of home BP monitoring [4]; our results showed that home BP monitoring might improve care of diabetes by revealing uncontrolled BP, which was frequently overlooked in regular hospital visits. DialBetics could be a way of managing and preventing cardiovascular complications associated with hypertension for diabetes patients. Improvements: The message processing success rate can be improved by revising and expanding the database after analyzing patients’ input. More personalized intervention adapted to patients’ needs and interests may be effected by processing biological and life-style information of each patient. In the larger randomized controlled trial of longer duration that is in progress, we plan to improve our study findings; physical activity levels will be assessed more accurately.

In conclusion, DialBetics—a new medical ICT model—may lead to better control of diabetes, improving blood glucose as well as blood pressure, and improving patient life-style by offering continuous real-time suggestions for improvements.

References