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Effect of Mobile Phone Short Text Messages on Glycemic Control in Type 2 Diabetes

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Background: Mobile phone text messaging has rapidly become a socially popular form of communication. Several studies showed that mobile phone might offer a useful means of providing information between clinic visits and might increase adherence to diabetes therapy regimens.
Objectives: We conducted a study to evaluate the effect of mobile phone short message service (SMS) on glycemic control in Saudi patients with type 2 diabetes.
Patients and Methods: One hundred patients (mean age, 41 ± 9.5 years) were selected at the Security Forces Hospital, Riyadh, Saudi Arabia, and provided with daily educational, reminding SMS messages for four months. Glycosylated hemoglobin (HbA1c) level, frequency of hypoglycemic and hyperglycemic attacks, and compliance with blood glucose monitoring were recorded before and after the trial.
Results: In addition to significant improvement in patients' knowledge, mean fasting blood glucose level improved from 8.60 ± 3.16 to 7.77 ± 3.11 mmol/L and mean HbA1c decreased from 9.9% ± 1.8% to 9.5% ± 1.7%.
Conclusions: Mobile phone text messaging increased adherence to diabetes therapy and improved the clinical outcome in Saudi patients with type 2 diabetes.

Keywords: Diabetes Mellitus, Type 2; Cellular Phone; Health; Glycemic; Text Messages

1. Background

Mobile phone text messaging has rapidly become a socially popular form of communication. It is personal, highly transportable, and widely used, particularly in the Western countries (1, 2). However, text messaging coupled with specific management strategies has yet to be utilized effectively in developing countries with high prevalence of diabetes. Several studies showed that mobile phone might offer a useful means of providing information between clinic visits and might increase adherence to diabetes therapy regimens (3-5).

2. Objectives

The aim of this study was to evaluate the feasibility of short message service (SMS) and its effect on glycemic control in adults with type 2 diabetes.

3. Patients and Methods

It was a prospective nonrandomized experimental trial for a four-month period. A total of 100 patients with type 2 diabetes with disorder duration of more than one year and no end organ complications who were on oral hypoglycemic agents and were followed at the Diabetes Clinics, Security Forces Hospital, were recruited. The following parameters were recorded before initiating sending SMS: glycosylated hemoglobin (HbA1c), frequency of simple hypoglycemic attacks (defined as blood glucose level < 2.22 mmol/L), frequency of severe hypoglycemic attacks (hypoglycemia associated with seizure or come), frequency of hyperglycemic attacks (defined as blood glucose of > 9.99 mmol/L), mean fasting blood sugar (FBS) level, mean postprandial blood glucose level, and frequency of blood glucose monitoring. Twenty educational multiple-choice questions for assessing patients' knowledge were distributed. After four month of sending SMS, the above parameters were recorded again and ten scoring questions to assess the quality of SMS were answered by the participants.

The content of the SMS program short messages prepared in simple, understandable, constructive Arabic language. Five to seven messages were sent each week. The educational messages covered general diabetes care

knowledge that included diabetes symptoms, signs, pathophysiology, etiology, diagnosis, diet therapy, psychotherapy, press news concerning diabetes, etc. These messages were considered as reminding messages about blood glucose check-up and medications intake. The main educational goal was to improve knowledge and subsequently attitude and practice. The messages were written by specialist in diabetes and diabetic educators, and then reviewed by the authors. Phone calls were made to ensure that SMS had been received. All SMS submitted to the participants during the four-month period were recorded.

Statistical analyses were performed using the Wilcoxon signed rank test, to evaluate the differences in HbA1c, FBS, postprandial blood glucose levels, incidence of hypoglycemic/hyperglycemic episodes, and other variables before and after the intervention. The tests were two tailed and $P < 0.05$ was considered as significant deviation from the null hypothesis. The study was approved by the Research Ethics Committee. A written informed consent with the Security Forces Hospital Institutional Board Review approval was obtained from participants.

4. Results

The average number of submitted SMS messages was six messages (range, 5-7) per patient per week with the total number of approximately 9600 messages over four months for all patients. A total of 100 phone calls were primarily made to ensure that the patients had received the messages at the middle the trial. One month prior to SMS delivery, the mean FBS level was 8.60 ± 3.16 mmol/L, the mean postprandial blood glucose level was 10.98 ± 4.03 mmol/L, the median frequency of documented simple hypoglycemic and hyperglycemic attacks per week were respectively zero and two, the mean HbA1c was 9.9% ±1.8%, the median frequency of blood glucose monitoring per day was zero, and the median score at the patient's knowledge testing was 17 (the maximum score was 20).

Post-SMS delivery and during the last month of the teleeducational period were as follow: the mean FBS level, 8.60 ± 3.16 mmol/L; the mean postprandial blood glucose level, 10.65 ± 3.20 mmol/L; the median frequency of documented simple hypoglycemic and hyperglycemic attacks per week, zero and two, respectively; the mean HbA1c, 9.5% ± 1.7%, the median frequency of blood glucose monitoring per day, one; and the median score at the patients' knowledge testing, 19. There was no report of severe hypoglycemic attacks (Table 1). The mean score of SMS quality, assessed by the parents, was 8.7 out 10.

5. Discussion

Growing evidence suggests that utilizing mobile phones might improve diabetes self-management and clinical outcomes (6-10). A meta-analysis examined the effectiveness of mobile phone technology in diabetes mellitus care by reviewing 15 English-language articles, published between January 2002 and March 2012. Studies that used mobile phone intervention and reported changes in diet, physical activity, and blood glucose and/or HbA1c levels were retrieved. Overall, significant improvements were observed in blood glucose and/or HbA1c concentration, adherence to medication, healthy lifestyle, and self-efficacy (11). These studies took place in several countries including the United States. Our Study is probably among the first ones to be conducted in the Arab peninsula where diabetes prevalence is very high. In our study, the change in post prandial blood sugar was remarkable, which significantly decreased the level of HbA1c.

Holtz et al. identified peer-reviewed articles published between 2000 and 2010 and analyzed 21 articles in a systematic literature review. Overall, 71% of the studies had used a study-specific application, which had supplemental features in addition to text messaging. The outcomes varied considerably across studies, but some positive trends such as improved self-efficacy, HbA1C, and self-management behaviors were noted (12). In our cohort, SMS positively modified patients' behavior. Although the frequency of blood glucose monitoring was not increased significantly, the rate of glycemic control was improved.

A feasibility study was conducted to evaluate the utility of SMS in supporting 42 Iraqi adults with newly diagnosed type 2 diabetes over 29 weeks. HbA1c decreased from 9.3% (SD, 1.3%) to 8.6% (SD, 1.2) (P = 0.001). Mean knowledge score rose from 8.6 (SD, 1.5) at baseline to 9.9 (SD, 1.4) six months after receipt of SMS (P = 0.002). All patients were satisfied with the text messages and wished the service to be continued after the study (13). Our study demonstrated similar benefits of this technology on diabetes education and management.

Table 1. Effects of Short Message Service on Glycemic Control, Knowledge, and Monitoring Compliance of Patients With Type 2 Diabetes [a,b]

Variable	Pre-SMS Initiation	Post-SMS Initiation	P Value
FBS, mmol/L	8.60 ± 3.16	7.76 ± 3	0. 001
Postprandial blood glucose, mmol/L	10.98 ± 4.03	10.65 ± 3.20	0.195
Frequency of simple hypoglycemic attacks per week	0 (1)	0 (0)	0.436
Frequency of hyperglycemic attacks per week	2 (2)	2 (2)	0.052
HbA1c, %	9.9 ± 1.8	9.5 ± 1.7	0.014
Frequency of blood glucose monitoring per day	0 (1)	1 (1)	0.428
Score of the patients' knowledge test	17 (6)	19 (5)	< 0.0001

[a] Data are presented as median (interquartile range) or mean ± SD.
[b] Abbreviations: SMS, short message service; FBS, fasting blood sugar; and HbA1c, glycosylated hemoglobin.

The effect of distance education via mobile phone text messaging on knowledge, attitude, practice, and self-efficacy was evaluated in patients with type 2 diabetes mellitus in Iran. The results in the experimental group showed significant improvement in HbA1c (P = 0.024), low density lipoprotein (P = 0.019), cholesterol (P = 0.002), and micro albumin (P ≤ 0.001). The knowledge (P ≤ 0.001), practice (P ≤ 0.001), and self-efficacy (P ≤ 0.001) were also improved (14).

In a randomized study in India, the acceptability and feasibility of using SMS via cell phones to ensure adherence to management prescriptions was tested. Medications adherence improved and positively affected HbA1c and plasma lipids levels (15). We did not test medications adherence in our study; however, the patients admitted that their compliance with drug intake was better. A one-way video message about diabetes self-care was sent to 65 patients with type 2 diabetes for one year. Participants were randomized to receive the usual care or the self-care video messages from their diabetes nurse practitioner. Participants who received the messages had a larger rate of decline in HbA1c than people who received usual care had (0.2% difference over 12 months) (16). We believe that multimedia message service might have a better audio-visual effect in comparison to regular SMS; however, it should be tested in further studies.

Mobile phone text educational and interactive messaging service might provide benefit in supporting diabetes self-management. The results of this study might help to design future text message interventional support programs for other chronic illnesses.

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