Mobile Phone Text Messaging and Telephone Follow-Up in Iranian Type 2 Diabetic Patients for 3 Months: A Comparative Study

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ABSTRACT

OBJECTIVE: This study was performed to compare the effectiveness of two methods of follow-up: Short Message Service (SMS) versus telephone call on glycosylated hemoglobin (HbA1c) in type 2 diabetes.

MATERIAL AND METHODS: This semi-experimental study consisted of 77 patients with type 2 diabetes who were randomly assigned into two groups: telephone follow-up (n = 39) and Short Message Service (n = 38). Telephone interventions were applied by researchers for 3 months. SMS group received message daily for 12 weeks. Data were collected using data sheet to record HbA1c and a questionnaire consisted of demographic characteristics. Data gathering was performed at two points: at the baseline of the study and after 12 weeks. Data were analyzed by SPSS 11.5 using descriptive and inferential statistics methods.

RESULTS: Demographic variables were confirmed to be homogenous. The results of this study showed that both interventions had significant mean changes in HbA1c; for the telephone group (P = 0.001) with a mean change of -0.93% and for the SMS group (P = 0.001) with a mean change of -1.01%.

CONCLUSION: The findings of this research showed that intervention using SMS via mobile phone and nurse-led-telephone follow-up improves HbA1c for three months in type 2 diabetic patients and it can be considered as an alternative method for diabetes control.

KEY WORDS: Glycosylated hemoglobin, Cellular phone, Short Message Service, Type 2 diabetes mellitus, Telephone follow-up.

INTRODUCTION

The prevalence of diabetes has been alarmingly increasing (1). Each year, 7 million people are diagnosed with the disease, and every 10 seconds, a person dies from diabetes-related causes (1). Diabetes is a chronic disease requiring lifelong medical and nursing intervention and lifestyle adjustment (2). The National Survey of Risk Factors for Non-Communicable of Iran, conducted in 2005, demonstrated that the prevalence of diabetes mellitus in Iranian citizens aged 25–64 years was 7.7% (2 million individuals) (3), among whom half are undiagnosed.(4) An additional 16.8% (4.4 million) of Iranian adults have impaired fasting glucose (4). If current trends continue, based on the World Health Organization forecast for Iran, there will be 5.2 million Iranians with diabetes mellitus in 2025 (3). The high prevalence of diabetes in working aged adults is an ominous sign for this developing nation (4). As the relatively young

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Iranian population ages in the future, and urbanization continues or accelerates, the prevalence of diabetes will likely escalate (4). Control of hyperglycemia may prevent, reduce or retard the risks of chronic complications of diabetes (5). Glycemic control to a near normal level reduces the development and progression of microvascular and neuropathic complications by approximately 50% in type 2 diabetes mellitus (6). HbA1c is a more comprehensive measure of total glycemic exposure than fasting plasma glucose and highly correlates with the presence of diabetic microvascular complications in prospective studies (5).

Epidemiological analysis of the United Kingdom Prospective Diabetes Study data showed a continuous relationship between the risk of microvascular complications and hyperglycemia, so that for every percentage point decrease in HbA1c levels, there was a 35% reduction in the risk of microvascular complication (5). The Diabetes Control and Complications Trial showed that for every 1% reduction in the HbA1c levels, there was a 40% to 50% reduction in risk for microvascular and neuropathic complications (6). The American Diabetes Association (ADA) has recommended that all persons with diabetes should attempt to achieve near normal levels of blood glucose (7).

There are algorithms for diabetes care which may be complex and difficult for physicians to follow, given the patient load, diversity of patient seen, lack of information systems, and time constraints(8). In addition, economic and technical barriers to providing diabetes care in the community health system are recognized (9). Since control of diabetes has been shown to decrease mortality and prevent long-term complications, it is critical that healthcare systems develop innovative ways to improve diabetes management, and provide timely care to patients (1).

Several research studies have shown that various telemedicine approaches can have a positive impact on blood glucose control and that over the long-term these approaches can result in reduction or elimination of the complications related to diabetes mellitus (10). Telemedicine has, in particular, caught the attention of patients and caregivers (1). For patients, it has the advantage of providing a quick, efficient way to communicate with their providers (1). The latter can, in turn, provide feedback and advice in a timely manner, therefore making care more efficient and responsive to patient needs (1). Indeed, close monitoring of blood glucose at home is a key component of diabetes management, but without timely provider feedback, it has somewhat of a lesser value (11). For those patients living in rural areas, it is potentially invaluable to have access to their caregiver from the comfort of their homes, thus sparing them the time and cost of traveling (11). Although the magnitude of the impact of telemedical support on diabetes care remains debatable (11).

Telemedicine can be a useful tool to provide diabetes care and represents a potential solution for long distances and provider shortage (1). It cannot replace patient visit and direct interaction with providers, but can be regarded as a supplement to visit care and improve 'quality of care' (1). Telemedicine can also potentially save time and travel expenses for patients (1). Patients suffering from chronic diseases in general and diabetes in particular, have benefited from support systems and telephone education with improved clinical outcomes (11). A telephone care program has been shown to be a viable strategy for bringing diabetes management services into patients' homes, improving their glycemic control and provide timely care to patients (8). To maintain normal range of blood glucose and prevent diabetic complications, patients ought to contact more frequently with their health care providers, but this will in turn increase health care expenditure (12), and the telephone intervention is more time-consuming than an Internet-based blood glucose monitoring system (13).

Recently mobile phones as a new delivery system, can provide medical recommendations and prescriptions at the appropriate time, accommodate for patients' behavioral changes and normalize blood glucose levels (14). Mobile phones are an integral part of everyday life, although their technology is a relatively new and innovative methodology (15). This method is becoming an important way of encouraging better nurse-patient communication and will undoubtedly increase in applica-

tion over coming years (15). Because of widespread usage and ubiquitous availability of mobile phones, these devices may maximize the efficiency (16). However, the most challenging part still is to provide the patients with a method to interact with the system with good applicability in terms of learning, efficiency, memorability, low error rate, and user satisfaction (16). Using Short Message Service (SMS) enables users to send and receive text messages to and from mobile phones up to 160 characters (16). SMS allows rapid reception and reply at low cost (17). It is an interactive service, and is simple, fast and confidential (17). There are reports of the use of SMS in medicine (17). Although it has been used for patient reminders, psychological support, medical appointments, reporting critical medical events or laboratory results and even for surveys in other countries (17), no research has been done to test the direct effects of SMS on controlling HbA1c in patients with type 2 diabetes and in healthcare delivery in Iran, as far as we are aware.

The present study evaluated and compared whether an intervention using mobile phone SMS by a nurse and nurse-led telephone follow-up could improve HbA1c levels in patients with type 2 diabetes.

MATERIALS AND METHODS

Participants: This study is quasi-experimental research. Participants were recruited from the Iranian Diabetes Association. We studied this intervention during a three-month period starting in May, 2008. Diabetes was diagnosed according to the American Diabetes Association (ADA) criteria. The age range was 18-65 years. Patients were supposed to have telephone access in their homes and their own mobile phone, or have access to one belonging to a relative. Other selection criteria were as follows: diabetic patients that only use oral anti-diabetic medications, ability to read and write, sufficient vision power, having no problem in hearing and vocalization and no history of psychiatric diseases. Patients were excluded if they had a clinical history of an important illness such as renal insufficiency with a creatinine level >1.5 mg/dl, hepatic insufficiency, mental illness or HbA1c of less than 7%.

Eighty patients met the above criteria and agreed to participate in the study. They were randomized by random permuted block design using a random number table and assigned to two groups: SMS group (n = 40) and telephone group (n = 40). Of the study population, only 77 subjects completed the entire study, 38 in SMS group and 39 in telephone group. Two subjects were lost before completing the post-test in the telephone group; one decided to opt out of the program before completing the post-test and one expired during intervention. One subject was lost before completing the post-test in the SMS group because of the change of therapeutic regimen from oral anti-diabetic agents to insulin.

For ethical considerations, the research protocol was approved by the Medical Research Ethics Committee of Tehran University of Medical Sciences. Written consent was obtained from those patients who agreed to participate in the study. Anonymity and confidentiality were guaranteed to participants.

Intervention: The goal of the intervention was to maintain blood glucose levels within a normal range. Participants attended three-day diabetes self-care education in Iranian Diabetes Association. Before the intervention, each patient was instructed by a researcher for 10 minutes about how to use their own mobile phones and to check their ability to read SMS and match the time for telephone follow-up. The researcher provided the intervention for 12 weeks. Patients in the SMS group received about 4 messages weekly consisted of diet, exercise, diabetic medication taking and frequent self-monitoring blood glucose levels. Overall 48 messages were sent to patients during intervention. Participants in SMS group could receive the messages at any place where access was possible by mobile phone. The researcher sent optimal recommendations back to each patient 4 times by mobile phone SMS weekly. Sample recommendations were as follows: ‘Do you know, the best bread for you is pebble bread’; ‘Please eat vegetables and salad in every meal’; eat your meals in six times instead of three times’; ‘Please consume your drugs on prescribed times’, ‘Do at least 30 minutes of physical exercise or walking’

and so on.

The intervention for Telephone group was provided via telephone for 12 weeks which consisted of counseling on the nature of the disease, risk factors, importance of maintaining blood glucose levels within a near-normal range, continuous education and reinforcement of diet, exercise, medications taking, hypoglycemia management, illness management, how to record daily blood glucose and frequent self-monitoring of blood glucose levels. The researcher contacted the telephone group at least twice a week for the first month and then weekly for the second and third month. The total frequency of telephone counseling averaged 16 times per subject. The duration of each counseling session was an average of 20 minutes. The researcher asked questions such as: "Did you take your recommended diabetic medication?", "When did you consume your prescribed tablet?", "Do you eat salad and vegetable before every meal?", "How many times did you do physical exercise or walking during last days?", "When is the best time to do exercise?" and so on. Before initiation of recommendations, the researcher asked the patients about the problems they faced during last days and patients could ask their questions and solve their problems. Sometimes they felt stressed, so the researcher educated some ways of decreasing stress such as deep breathing, distraction methods, taking a bath, going to the country, concentrating on good points of their life, being more with their family members or close or lovely friends, trying to laugh more and so on.

Procedure: Before the intervention, demographic characteristics and HbA1c value were collected as pre-test data at the Iranian Diabetes Society. The intervention was provided to the telephone group with counseling appointments scheduled when convenient to the subject. HbA1c level was measured again three months later in the Metabolism and Endocrinology Laboratory of Tehran University-affiliated Medical Center. Patients' blood was drawn in veins for HbA1c measurement. HbA1c was determined by a high-performance liquid chromatography technique. HbA1c level was measured after 12 weeks as post-test data.

Data Analysis: The data were analyzed using SPSS 11.5. Chi square test, paired T-test, independent T-test and Fisher's exact test were used to test the homogeneity of demographic and clinical characteristics between the SMS and telephone groups. Paired T-test was used to compare differences between pre-test and post-test values in the group. The independent sample T-test was used for comparing the differences between the SMS and telephone groups.

RESULTS

Sample Characteristics: The characteristics of SMS and telephone groups are shown in Table 1. The mean age of the SMS group was 51.07 years and that of telephone group was 53.71 years. The mean BMI of the SMS group was 29.008 kg/m2 and that of telephone group was 27.334 kg/m2. There was no significant difference in age, gender, BMI, duration of diabetes, treatment method and blood glucose levels between the two groups.

Table 1- Baseline demographic and clinical data of the SMS and intervention groups

Characteristics	SMS group (n = 38)	Telephone group (n = 39)	t/χ^2	*P* value
Age (years)	51.70 ± 9.90	53.71 ± 9.04	1.221	0.226
Sex: male/female	18/20	18/21	0.011	0.915
Body Mass Index (kg/m^2)	29.008 ± 6.65	27.334 ± 3.53	1.374	0.175
Diabetes duration (months)	95.57 ± 72.96	74.55 ± 61.93	1.365	0.176
Glycosylated hemoglobin (%)	8.97 ± 1.65	9.44 ± 1.72	1.219	0.227

Data are Means ± SD (%).

Blood glucose levels: At the pre-test, no significant differences were found in HbA1c between the groups in Table 1. HbA1c changes were not statistically significant (P = 0.227). There was a significant percentage change in HbA1c for the SMS group (P =

0.001), with a mean change of -1.01% (8.97% pre-test to 7.96% after three months), and also there was a significant percentage change in HbA1c for the telephone group (P = 0.001), with a mean change of -0.93% (9.44% pre-test to 8.51% three months). HbA1c decreased 0.93% at three months compared with baseline in the telephone group and 1.01% at three months compared with baseline in the SMS group (Table 2). No significant difference was found between two interventions (P = 0.186).

Table 2- Effect of the intervention on HbA1c (%) levels

Variable HbA1c (%)	Baseline	3 months	Difference (Post-test) – (Pre-test)	t	*P* value
SMS group	8.97 ± 1.65	7.96 ± 1.75	-1.01 ± 0.01	4.254	0.001
Telephone group	9.44 ± 1.72	8.51 ± 1.85	-0.93 ± 0.13	4.150	0.001

DISCUSSION

HbA1c has become a standard assessment of glycaemia and a standard part of diabetes management (7). Therefore, large studies about this relationship, such as the Diabetes Control and Complications Trial Research Group (1993) and the United Kingdom Prospective Diabetes Study Group (UKPDS, 1998), have used HbA1c as the primary index of glycaemia (5,6). This study evaluated and compared whether an intervention using SMS of mobile phone by a nurse and nurse-led-telephone follow-up would improve HbA1c levels in patients with type 2 diabetes for three months.

In this study, HbA1c levels decreased 1.01% in SMS group and 0.93% in telephone group after 12 weeks compared with the baseline. Previous studies showed the following results: Kwon et al. (2004) reported that the 12-week follow-up examination of HbA1c levels in diabetic patients by web-based management system SMS caused mean decrease of 0.9 % in HbA1c level. A Short Message Service by mobile phone study in type 2 diabetic patients resulted in a decrease of HbA1c of 1.31% at nine months and 1.32% at twelve months (18). At the end of the diabetic patient management study using SMS, A1C levels were significantly decreased in the intervention group (0.72%) (19). The study of evaluating the impact of nurse's education by SMS of mobile phone and wire internet revealed a significant percentage change in a baseline HbA1c ≥7.0% for the intervention group with a mean change of -2.15 (9.35% pre-test to 7.20% post-test) at a 3-month follow-up (13). An intervention using SMS of mobile phone and Internet showed great efficacy in HbA1c control in obese type 2 diabetes. The intervention group showed a marked decrease in HbA1c levels after 12 months of follow-up versus the baseline levels (a mean percentage change of -1.22 at 3 months, -1.09 at 6 months, -1.47 at 9 months and -1.49 at 12 months) (20). Kim et al. (8) reported that a nurse-coordinated intervention by telephone decreased HbA1c levels 1.2% after 12 weeks. In a prior randomized trial, the effect of nurse telephone calls on HbA1c levels was evaluated. After 12 weeks, patients in the telephone intervention group had a mean decrease of 1.2 % in HbA1c levels (21). These results confirm that the use of various telemedicine approaches can have a positive impact on patients' HbA1c control.

Therefore, mean end-point HbA1c levels in the intervention groups of the two studies were essentially the same. However, in the telephone intervention group, nurses spent more time and money with patients than the SMS intervention by nurse. Overall, the findings of this study suggested that SMS intervention improves HbA1c level the same as telephone intervention. The patients in the telephone group had more frequent contact with the nurse than those in the SMS group. In addition, the patients in the telephone group received advice according to their most recent data, confirming their current state. These factors may have stimulated and motivated the patients to control glucose levels enthusiastically.

These results have important clinical implications because the service for diabetic patients provided via mobile phone is now increasing, whereas the efficacy of SMS for glucose control has not been evaluated exten-

sively. Also, this study results show the evidence that SMS is as effective as telephone calls guidance in managing diabetes. One major advantage of SMS is that the researcher could send SMS without location limitations. This study adds that a nurse follow-up program using the telephone calls and an SMS by mobile phone improved levels of HbA1c after three months in patients with type 2 diabetes.

Because participants were recruited from the Iranian Diabetes Association in an outpatient department in Tehran city of Iran, they were unlikely to represent all Iranian people with diabetes; this influences the generalizability of the results. Another limitation of this study was that some patients may not have been paid attention to their received messages and for solving this problem researchers clarified the aim of this study and tried to encourage patients to read all the messages.

CONCLUSION

In this study, Iranian patients with type 2 diabetes who received short massages and followed by telephone had improved HbA1c levels. The results of this study suggest that both telephone follow-up intervention and using mobile phone SMS improve HbA1c levels remarkably during three months in type 2 diabetic patients. Regarding convenience and simplicity of SMS, it can be used as an appropriate alternative method for follow-up in diabetic patients.

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