JCN Journal of Clinical Nursing

Journal of Clinical Nursing

CLINICAL ISSUES

The impact of nurse short message services and telephone follow-ups on diabetic adherence: which one is more effective?

Mitra Zolfaghari, Seyedeh A Mousavifar, Shadan Pedram and Hamid Haghani

Aim. To compare the effectiveness of two methods of follow-up: short message service and telephone follow-up on type 2 diabetes adherence for three months.

Background. Using telemedicine approaches may preserve appropriate blood glucose levels and may improve adherence to diabetes control recommendations in diabetic patients.

Design. A quasi-experimental, two-group, pretest and post-test design was used in this study to evaluate the effectiveness of nurse's follow-up via cellular phones and telephones.

Methods. The sample consisted of 77 patients with type 2 diabetes that randomly were assigned to two groups: telephone follow-up (n = 39) and short message service (n = 38). Telephone interventions were applied by a researcher for three months; twice a week for the first month and every week for the second and third month. For three successive months, the short message service group that received messages about adherence to therapeutic regimen was examined. The data gathering instrument included data sheets – to record glycosylated haemoglobin – and the questionnaire related to adherence therapeutic regimen. Data gathering was carried out at the beginning of the study and after three and six months. The data were analysed using descriptive and inferential statistic methods with SPSS version 11.5.

Results. Results showed that both interventions had significant mean changes in glycosylated haemoglobin. For the telephone group ($p < 0{\cdot}001$), a mean change of $-0{\cdot}93$ and for the short message service group ($p < 0{\cdot}001$), a mean change of $-1{\cdot}01$. There was no significant difference in diet adherence ($p = 0{\cdot}000$), physical exercise ($p = 0{\cdot}000$) and medication taking ($p = 0{\cdot}000$) adherence in either groups.

Conclusion. Intervention using short message services of cellular phones and nurse-led-telephone follow-up improved HbA1c levels and adherence to diabetes therapeutic regimen for three months in type 2 diabetic patients.

Relevance to clinical practice. Both of follow-up intervention uses in this study can decrease HbA1c levels and escalate adherence to diabetes control recommendations in people with type 2 diabetes for three months.

Key words: adherence, glycosylated haemoglobin, nurse follow-up, short message service, telephone calls, type 2 diabetes mellitus

Accepted for publication: 15 February 2011

Introduction

Type 2 diabetes mellitus is a worsening epidemic in the worldwide and affecting 18·2 million people or 6·3% of the population (Faridi *et al.* 2008). Diabetes is a chronic disease requiring lifelong medical and nursing intervention and lifestyle adjustment (Kim *et al.* 2006). The National Survey of Risk Factors for Non-Communicable in Iran, conducted in

Authors: *Mitra Zolfaghari*, PhD, BSN, MSN, Lecturer, Nursing and Midwifery Care Research Center, Nursing and Midwifery School, Tehran University of Medical Sciences; *Seyedeh A Mousavifar*, BSN, MSN, Masters Student, Tehran School of Nursing and Midwifery, Tehran University of Medical Science; *Shadan Pedram*, BSN, MSN, Lecturer, Tehran School of Nursing and Midwifery, Tehran University of Medical Sciences; *Hamid Haghani*, BSc, MSc, PhD, Assistant Professor of Biostatistics, College of Management and Medical Information, Iran University of Medical Sciences, Tehran, Iran

Correspondence: Mitra Zolfaghari, Lecturer, Nursing and Midwifery Care Research Center, Nursing and Midwifery School, Tehran University of Medical Sciences, East Nosrat, St. Tohid Sq., PO Box 1419733171, Tehran, Iran. Telephone: +982166927171.

E-mail: zolfaghm@tums.ac.ir

2005, demonstrated that the prevalence of diabetes mellitus in Iranian citizens between 25–64 years of age was 7·7% (2 million individuals) (Amini & EhsanParvaresh 2008), among whom half were undiagnosed (Esteghamati *et al.* 2008). If these current trends continue, based on the World Health Organization forecast of Iran, there will be 5·2 million Iranians with diabetes mellitus in the year 2025 (Amini & EhsanParvaresh 2008). This high prevalence of diabetes for adults of old age is a threatening sign for this developing nation. As the relatively young Iranian population ages and urbanisation continues or accelerates, the prevalence of diabetes will likely escalate (Esteghamati *et al.* 2008). The control of hyperglycaemia may prevent, reduce or hold back the risks of chronic complications of diabetes (UKPDS 1998). Glycemic control to a near-normal level reduces the development and progression of micro-vascular and neuropathic complications by approximately 50% in type 2 diabetes mellitus (DCCTRG 1993). The American Diabetes Association (ADA) has recommended that all persons with diabetes should attempt to achieve a normal rate of blood glucose levels (ADA 1997). HbA1c is a more comprehensive measure of total glycaemic exposure than fasting plasma glucose and highly correlated with the presence of diabetic micro-vascular complications in prospective studies (UKPDS 1998). To achieve a satisfactory glycaemic control, treatment plans need to be integrated with patient's daily activities. The demand for lifestyle change and adherence to health behaviours poses a great challenge to patients with diabetic mellitus (Wong *et al.* 2005). Adherence has the largest effect on hyperglycaemia (Kim *et al.* 2006). Despite the benefits of adhering to a disease management programme for diabetes, compliance to such programmes is not optimal (Faridi *et al.* 2008). And non-compliance is a common phenomenon.

The care of people with diabetes should be organised as flexibly as possible to suit individual lifestyles (Halkoaho *et al.* 2007). WHO has recommended: 'innovative care for chronic conditions' (Duplaga & Winnem 2006) and it points to that patients should receive care whenever they need it and in many forms, not just face-to-face visits. This rule implies that the healthcare system should be responsive at all times, and that access to care should be provided over the Cell Phones, telephone and by other means in addition to face-to-face visits (Gentles *et al.* 2010).

Background

Patients with health conditions such as diabetes requiring follow-up (Gentles *et al.* 2010), and the literature reveals two strategies that are particularly effective in enhancing adherence to health behaviour and clinical outcomes: patient participation in care and continued follow-up. Therefore, continued follow-up is necessary to sustain the effects of a good care plan (Wong *et al.* 2005). Studies suggest that regular follow-ups by a nurse can help monitor patient progress and reinforce health behaviours related to diabetes care (Norris *et al.* 2002, Wong *et al.* 2005). Very often, this follow-up can be achieved using the telephone. Nurse telephone calls are useful to closely monitor the signs and symptoms of hypoglycaemia or hyperglycaemia, to review patient's compliance with drugs and healthy lifestyle practices and to provide health education (Wong *et al.* 2005). A systematic review has consistently shown that case management with telephone follow-ups helps to improve symptom control and complication screening and reinforces healthy lifestyles (Norris *et al.* 2002).

The analysis of systematic review and meta-analysis suggested that telephone follow-up interventions could have a positive impact on glycaemic control for type 2 diabetes (Wu *et al.* 2010). Results of a meta-analysis pooled strong evidence that mobile phone intervention led to statistically significant improvement in glycaemic control and self-management in diabetes care, especially for type 2 diabetes patients (Liang *et al.* 2010).

Although a nurse telephone intervention could improve glycosylated haemoglobin (HbA1c) levels and adherence to diet and blood glucose testing, it is time-consuming (Kim & Oh 2003, Kim 2007). To maintain a normal range of blood glucose and prevent diabetic complications, patients ought to contact more frequently with their healthcare providers, but this will in turn increase healthcare expenditure (Kwon *et al.* 2004). Therefore, we need to suggest some solutions for this problem. A growing body of literature suggests that information technology (IT), such as Internet and mobile phone technology, is very promising in enhancing diabetic care (Faridi *et al.* 2008).

Recently, mobile phones as a new delivery system can provide medical recommendations and prescriptions at the appropriate time, accommodate for a patient's behavioural changes and normalise blood glucose levels (Kim & Jeong 2007). Mobile phones are an integral part of everyday life. This method is becoming an important way of encouraging better nurse–patient communication and will undoubtedly increase in application over the coming years (Blake 2008). Mobile phones have various functions, and one of the most important of their applications is short message services (SMS) (Patrik *et al.* 2008). There are reports of the use of SMS in medicine. SMS allows rapid reception and reply at low cost (Ferrer-Roca *et al.* 2004). Using SMS enables users to send and receive text messages to and from mobile phones up to 160 characters (Kollmann *et al.* 2006). It is an interactive service and is simple, fast and confidential (Ferrer-Roca *et al.*

2004). It has been extensively used for patient reminders, psychological support and medical appointments to report critical medical events or laboratory results and even surveys in other countries (Kollmann *et al.* 2006).

In the medical literature, text messages are a well-described mode of communication and reported shows using text messaging for delivering health behaviour change interventions (Fjeldsoe *et al.* 2009), sending appointment reminders to reduce non-attendance rates and receiving uninterrupted care (da Costa *et al.* 2010), sending a daily text massage reminder on adherence to asthma treatment (Strandbygaard *et al.* 2010), antiretroviral treatment adherence (Lester *et al.* 2010), reduction in HbA1c in obese patients in Korea (Kim & Kim 2008) and following-up gestational diabetes (Pérez-Ferre *et al.* 2010). A systematic review identified 18 studies that evaluated the use of a cell phone to provide health information to persons with diabetes or obesity. This review concluded that providing care and support via cell phones and text messaging improved diabetes-related health outcomes by increasing knowledge and self-efficacy, improving the uptake of those carrying out required self-management behaviours. In nine of the 10 studies that measured effect on HbA1c, those that received education and care support via cell phone reported significant improvement in control (Krishna *et al.* 2009).

Considering the fact that health problems associated with diabetes mellitus are a growing source of concern in Iran, it is important to establish the current situation of diabetes in Iran (Amini & EhsanParvaresh 2008). Unfortunately, this worsening burden has not been met with an increase in healthcare providers dedicated to diabetes care (Azar & Gabbay 2009). Many Iranian diabetic patients do not adhere to health regimens (Esteghamati *et al.* 2008). Most Iranians use telephone and cellular phones. To develop a more efficient delivery system for diabetes care, our research designed a study using cellular phones and telephones.

Previous studies have investigated the use of telemedicine like SMS solely for medical management of diabetes; although to the authors' knowledge, no study has investigated and compared of SMS with telephone follow-up in diabetes patients. So we tried to evaluate and compare whether an intervention using SMS by cellular phone and telephone follow-up could improve HbA1c levels and adherence to treatment control recommendations in people with type 2 diabetes mellitus.

Methods

A quasi-experimental, two-group, pretest and post-test design was used in this study.

Participants

Participants were recruited from the Iranian Diabetes Association. We studied this intervention during a six-month period starting in May 2008. Diabetes was diagnosed according to the ADA criteria (The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus 1997). The age ranged from 18–65 year olds. Patients had to have telephone access in their homes and have their own personal mobile phones, or have access to one belonging to a relative. The selected criteria required that group of diabetics participants who only used oral anti-diabetic medications were able to read and write, had sufficient power vision, had no problem in hearing and vocalisation and did not have a 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 $>1{\cdot}5$ mg/dl, hepatic insufficiency, were mentally ill or had $<7\%$ of HbA1c.

Eighty patients met the above criteria and agreed to participate. They were randomised by random permuted block design using a random number table and assigned to one of two groups: SMS group (n = 39) or telephone group (n = 41). 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 drop out of the programme before completing the post-test and one passed away during intervention. One subject was lost before completing the post-test in SMS group because of the change in therapeutic regimen from oral anti-diabetic agents to insulin.

Intervention

The goal of the intervention was to maintain blood glucose levels within a normal range (HbA1c $<7\%$). Participants in both groups attended in three days of diabetes self-care education sessions. Before the intervention, in SMS group, each patient was instructed for 10 minutes by the researcher to learn how to use their own cell phones and to check their ability to read SMSs; and in telephone group, the time was matched for telephone follow-ups. The researcher provided the intervention for three months. Patients in the SMS group received about six messages every week (excluding holidays) that consisted information about taking a diet, exercising, diabetic medication taking, frequent self-monitoring of blood glucose levels and stress management. Overall 72 messages were sent to patients during intervention, and the length of each message was not more than 160 features. Participants in the SMS group could receive our messages at any place where access was possible by cellular phone. The researcher sent

optimal recommendations back to each patient, six times by SMSs of a cellular phone weekly.

Our messages were set in three priorities. Diet adherence such as: 'Do you know, the finest bread for you to consume is pebble bread?'; 'Please eat vegetables and salad with every meal'; 'Eat your meals in six stages instead of three stages'; 'Did you know that eating at regular times helps you to control your diabetes better?' and…medication adherence like: 'Please consume your drugs at prescribed times', 'Take your recommended diabetic medication timely'; 'If you consume Glybenclamide, please eat it 30 minutes before your meal'…and some samples of exercise adherence messages were: 'Lack of exercise may be the cause of the aggravated glucose level'; 'Try to exercises three times a day and at least 15 minutes every time'; 'Do at least 30 minutes of physical exercise or walking';…and stress management like: 'One of the best ways to decrease stress is laughing, so laugh as much as possible'; 'Take it easy and relax to increase the endorphin secretion and decrease stress'; and so on.

The intervention for the Telephone group was provided via telephone for three months. The intervention was provided by counselling scheduled appointments – whenever the time was convenient to the subject. The content of intervention consisted of counselling 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, hypoglycaemia 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 counselling averaged 16 times per subject. The average length of these contacts was 20 minutes per call. The researcher asked questions about the diet: 'Did you eat salad and vegetable before every meal?', 'How many days did you follow your recommended diet over the past days?' 'Did you eat your meals at regular times?' and…some recommendations about exercising such as: 'How many times did you do physical exercising or walking during the last days?' 'When is the best time to exercise'? 'Did you feel better after exercising?' 'Do you know that exercising is as important as diabetic medication?' and…medication related questions were: 'Did you take your recommended diabetic medication?' 'When did you consume your prescribed tablet? 'Do you know how your consuming medications, act in your body?'…and so on.

Before starting the recommendations, the researcher asked every patient about the problems they were facing during the last days and patients could ask their questions and solve their problems. Sometimes, they felt stress, so the researcher taught them some ways of decreasing stress such as: taking deep breaths, distraction methods, taking a bath, going to the countryside, concentrating on good points of their life, being more with their family members or loved friends, trying to laugh more and so on.

Procedure and measures

Before the intervention, demographic characteristics and HbA1c value and diabetes adherence were collected as the base-line data. The HbA1c and diabetes adherence were measured again three months later (without any intervention as pretest data) and again six months later (after three - months intervention as post-test data). The patients' blood was drawn in veins for HbA1c measurement. HbA1c was measured in the metabolism and endocrinology laboratory of the Tehran University – affiliated medical centre. HbA1c was determined by a high-performance liquid chromatography technique (DS_5). Self-reported adherence was measured by a self-care diabetes questionnaire (during three stages of the study: At the beginning, three months later and six months later). It included three items: demographic characteristics (12 items), disease characteristics (six items) and questions related to adherence therapeutic regimen namely diabetic diet (26 items), physical exercise (19 items) and diabetic medication taking (11 items). The score of '4' was given for an achieved goal and '0' for a non-achieved goal. The content validity of the questionnaire was verified by 12 instructors of Tehran University of Medical Sciences with a Masters or a PhD degree. The Cronbach α reliability of this questionnaire was 0·87.

Ethical considerations

The study was approved by the Medical Research Ethics Committee of the Tehran University of Medical Sciences, which the principal investigator was affiliated. Written consent was obtained from those patients who agreed to participate in the study. They could withdraw from the study any time during the process. Anonymity and confidentiality were guaranteed to the participants.

Data analysis

The data were analysed using the SPSS version 11.5 for Windows (SPSS Inc., Chicago, IL, USA) program. Chi-square test, paired *t*-test, independent *t*-test and fisher's exact test were used to test for the homogeneity of demographic and clinical characteristics between the SMS and the telephone

groups. A paired *t*-test was used for the comparison of differences between baseline with pretest and pretest with post-test values in the group. ANCOVA was used for comparing the differences between the SMS and the telephone group and controlling baseline variables.

Results

Sociodemographic and clinical findings

The characteristics of the participants in 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/m^2 and that of telephone group was 27·334 kg/m^2. There was no significant difference in age, gender, BMI, duration of diabetes, insurance support, occupation, financial income and haemoglobin glycosylated levels between the two groups.

Glycosylated haemoglobin

At the base-line and pretest, no significant differences were found in HbA1c between the groups (Table 1). HbA1c changes were not statistically significant between two groups ($p = 0{\cdot}227$). There was a significant percentage change in HbA1c for the SMS group ($p < 0{\cdot}001$), with a mean change of −1·01% (8·97% pretest to 7·96% after three months intervention as post-test). There was a significant percentage change in HbA1c for the telephone group ($p < 0{\cdot}001$), with a mean change of −0·93% (9·44% pretest to 8·51% post-test). HbA1c decreased 0·93% points at three months intervention compared with pretest in the telephone group and 1·01% points at three months intervention compared with the pretest in the SMS group (Table 2). By using ANCOVA, the effect of base-line was controlled and no significant difference was found between two interventions ($p = 0{\cdot}186$).

Adherence

Physical exercise ($p = 0{\cdot}000$), diabetic medication taking ($p = 0{\cdot}000$) and diet ($p = 0{\cdot}000$) adherence improved at post-test compared with that at pretest. At post-test, patients had a mean increase in physical exercise, diabetic medication taking and diet adherence compared with the pretest. By using ANCOVA, the effect of baseline was controlled and there was no significant difference in adherence in two groups (Table 2).

Limitations

Because our sample only included diabetic patients who referred to The Iranian Diabetes Association in an outpatient department in the city of Tehran, they were unlikely to represent all Iranian people with diabetes. This influences the generalisability of the results. Self-report of the adherence questionnaire may have biased the results. Another limitation

Table 1 Sociodemographic and clinical characteristic of study groups at enrolment

Characteristics	SMS group ($n = 38$)	Telephone group ($n = 39$)	t/χ^2	p
Gender: male/female	18/20	18/21	0·011	0·915
Insurance support				
Yes	31 (81·6)	30 (76·9)	0·253	0·615
No	7 (18·4)	9 (23·1)		
Occupation				
Employee	11 (29·7)	16 (41)	4·259	0·119
House worker	14 (37·8)	18 (46·2)		
Retired	12 (32·5)	5 (12·7)		
Financial income				
Sufficient	13 (34·2)	11 (28·2)	1·081	0·583
Semi-sufficient	17 (44·7)	22 (56·4)		
Non-sufficient	8 (21·1)	6 (15·4)		
Diabetes duration (months)	95·57 ± 72·96	74·55 ± 61·93	1·365	0·176
Glycosylated haemoglobin (%)	8·97 ± 1·65	9·44 ± 1·72	1·219	0·227
Adherence				
Diabetic diet	65·30 ± 7·25	63·95 ± 8·58	0·746	0·458
Physical exercise	31·81 ± 18·73	33·37 ± 14·03	0·412	0·682
Diabetic medication taking	75·48 ± 14·33	73·27 ± 14·75	0·665	0·508

Data are means ± SD (%).
SMS, short message service.

Table 2 Effect of the interventions on glycosylated haemoglobin (%) levels and adherence scores

Variables	Pretest (after 3 months)	Post-test (after 3 months intervention)	Difference (post-test) – (pretest)	ANCOVA
HbA1c (%)				
SMS group	8·97 ± 1·6	7·96 ± 1·75	−1·01 ± 0·01	F_{group} = 0·482 $F_{baseline}$ = 57·395 $p_{value\ group}$ = 0·489 p_{value} = 0·000
Telephone group	9·44 ± 1·72	8·51 ± 1·85	−0·93 ± 0·13	
Adherence				
Diabetic diet				
SMS group	65·30 ± 7·25	81·80 ± 5·27	16·50 ± 1·98	F_{group} = 0·609 $F_{baseline}$ = 25·640 $p_{value\ group}$ = 0·438 p_{value} = 0·000
Telephone group	63·95 ± 8·58	82·19 ± 6·12	18·24 ± 2·46	
Physical exercise				
SMS group	31·81 ± 18·73	71·83 ± 17·30	40·02 ± 1·43	F_{group} = 0·973 $F_{baseline}$ = 12·252 $p_{value\ group}$ = 0·327 p_{value} = 0·000
Telephone group	33·37 ± 14·03	69·03 ± 14·71	35·66 ± 0·68	
Diabetic medication taking				
SMS group	75·48 ± 14·33	91·13 ± 11·61	15·65 ± 2·72	F_{group} = 4·692 $F_{baseline}$ = 21·388 $p_{value\ group}$ = 0·034 p_{value} = 0·000
Telephone group	73·27 ± 14·75	94·73 ± 7·63	21·46 ± 7·12	

SMS, short message service.

of this study was that some patients may not have paid attention to their received messages, and for solving this problem, researchers clarified the aim of this study and try to encourage patients to read all of the messages. The other limitation was that researchers had no control of participants' access to other educational resources. Although a short-term intervention was offered, the question remains whether the progressions made in this intervention would be maintained in the long run. To further the development, more trials and studies are needed.

Discussion

This is, to our knowledge, the first study to use a SMS programme to promote diabetes control in any population in Iran. The findings of this study clearly indicates that both telephone follow-up and SMS interventions were effective in enhancing the levels of diet adherence, physical exercise and medication taking adherence and better in controlling HbA1c in Iranian adults with type 2 diabetes. In this study, HbA1c levels decreased 0·93% in the telephone group after three months. The effect of nurse follow-up by telephone on glycemic control revealed in this study is supported by some other researches (Kim & Oh 2003, Kim *et al.* 2005).

Similarly, HbA1c levels decreased 1·01% in SMS group after three months. These findings are consistent with those reported in previous studies in other countries (Kwon *et al.*2004, Kim 2007, Kim *et al.* 2007, Kim & Kim 2008, Yoon & Kim 2008, Krishna *et al.* 2009, Franc *et al.* 2010). The study of evaluating the impact of nurse's education by SMS of cellular phone and wire internet revealed a significant percentage change in a baseline HbA1c ≥7·0% for the intervention group at three-month follow-up (Kim 2007). During three-month follow-up, HbA1c levels in diabetic patients by web-based management system SMS caused to mean decrease of 0·9% in HbA1c level (Kwon *et al.* 2004). A SMS by cellular phone study in type 2 diabetic patients resulted in a decrease in HbA1c of 1·31% points at nine months and 1·32% points at 12 months (Yoon & Kim 2008). At the end of the study diabetic patient management study using SMS, A1C levels were significantly decreased in the intervention group (0·72%) (Kim *et al.* 2007). An intervention using SMSs of personal cellular phones and the internet showed great efficacy in HbA1c control in obese type2 diabetes. The intervention group showed a marked decrease in HbA1c levels after 12 months of follow-up vs. the baseline levels (Kim & Kim 2008, Cho *et al.* 2009).

There was no significant difference in diabetic diet adherence between two groups (p = 0·764) after three months, but

there were statistical differences in diabetic diet adherence in telephone groups pretest and post-test (p = 0·000) and diet adherence increased after three months. In a prior randomised trial, the telephone intervention group had a greater increase in diet adherence than the control group (Kim & Oh 2003). But the results of another study showed that there was no significant difference in diabetic diet adherence in the telephone group (Wong *et al.* 2005). The reason for this difference may be because patients in this study had – on average – six episodes of nurse contact and the average length of those contacts was 10–12 minutes; it seems this was not sufficient enough for telephone follow-up. However, in our study, the total regularity of telephone calling averaged 16 times per subject and the duration of each contact was an average of 20 minutes.

Also, there was a significant difference in diabetic diet adherence in the SMS group. After three months of using SMS via internet, Kim & Kim (2008), reported diabetic diet adherence improved, but after three months of SMS intervention by a nurse, no significant difference was detected in diabetic diet adherence. This non-compliance behaviour may be due to the low ages of the participants (mean age = 43·5 years old) and may be in this age group, and patients were unlikely to change their dietary habits when eating at work (Kim *et al.* 2006). Nonetheless, the results of a study does not synchronise with our study, and the results of this study showed that after three months intervention by Internet and cell phone, there was no statistical difference in diabetic diet adherence before and after intervention (Faridi *et al.* 2008). It seems that technical barriers, complicated programmes and low ease of the cell phones might account for the difference. Patients reported that there were too many menus to navigate on the cell phone. When uploading data, buttons were too small and that commands changed too frequently. They mentioned that interventional programmes for chronic diseases like diabetes ought to be easy, simple and patient-centred till they can follow them. This implies that diabetic patients need more frequent contacts with nurses and health givers, and only written programmes are not enough.

In this study, physical exercise adherence increased in both groups and there was no significant difference in physical exercise adherence between two groups and the exercise adherence increased after three months. In consistent with our study, the results of Wong *et al.* (2005) study showed that the nurse telephone follow-up group had a statistically significant score for exercise adherence in comparison with the control group. But in Kim and Oh's study (2003), there was no significant improvement in exercise adherence in the telephone group than the control group. This decline might be due to the old age of the participants. It seems old people are less interested in participating in exercise programmes.

Also, the scores related to exercise adherence elevated after three months in the SMS group. The finding of this study is similar to another research: a study reported that 30 minutes of physical exercise adherence increased after three months (Kim *et al.* 2006), and participants in the web-based group showed significant progress in physical activity levels (Kim & Kang 2006). However, the result of Faridi *et al.* study (2008) showed that after three months intervention by Internet and cell phone, there was no statistical difference in exercise adherence before and after intervention. It seems barriers were primarily technical and inhibited the use of the pedometer. Pedometers were considered uncomfortable and inconvenient, and also patients reported that: 'This machine (pedometer) keeps chafing on our leg and it is really uncomfortable'. However, all of them reported that if the system was improved, they would prefer using it for usual care. It seems that the SMS intervention was effective for exercise adherence.

In this study, adherence to taking diabetic medication increased after intervention by telephone and participants showed improvement in medication adherence, but the results of Wong *et al.* (2005) showed that there was no significant difference in medication adherence between telephone and control groups. Similarly, the results of Kim and Oh (2003) confirmed that there was no significant difference between telephone and control groups.

Adherence to taking diabetic medication increased after SMS intervention [in consistent with another study (Kim *et al.* 2006)]. It is unclear what factors might account for success in some studies and not in others.

IT has become a useful tool to support functional patient–professional relationships and improve care balance (Halkoaho *et al.* 2007). Finding a review suggests that SMS – has wide population reach, can be individually tailored and allows instant delivery with asynchronous receipt, suggesting potential as a delivery channel for health behaviour interventions and delivered interventions have positive short-term behavioural outcomes (Fjeldsoe *et al.* 2009).

Our results show SMS are at least as effective as telephone follow-ups. The using of SMS also has the advantage of being more cost-effective and requiring less labour than the other methods. With advances in cell phone technology has come the facility to connect directly to individuals and provide a means of giving self-management support at anytime and anywhere.

Conclusion

To sum up, this study found SMS intervention as improved as a nurse telephone follow-up, the levels of HbA1c and

diabetes adherence for three months in patients with type 2 diabetes. Considering this fact, the patients in the telephone group have more frequent contacts with the nurse than those in the SMS of cellular phone group and need to spend more time and money than SMS intervention. Not to forget the shortage of nurses and healthcare providers worldwide and specially in Iran, it seems that low-cost methods are required and SMS intervention can be used as an alternative way to face these problems. Another major advantage of SMS is that one could send SMSs without location limitations. An intervention that involves the use of SMSs and personal cellular phone can also be applicable to other chronic diseases such as hypertension, hyperlipidemia, obesity and metabolic syndrome.

Relevance to clinical practice

Overall, the findings suggest that SMS intervention and telephone follow-up equally improved HbA1c level and adherence to diabetic medication taking, exercising and taking diet. Patients with diabetes need more frequent contacts with nurses and health providers for managing the disease. Considering the shortage of professional heathcare givers and also that telephone follow-ups is more time-consuming, by using SMS, patients can receive useful information whenever they want to.

Acknowledgements

This research was supported by a grant from the Faculty of Nursing and Midwifery of Tehran University of Medical Sciences, Islamic Republic of Iran (project number: 7091-28-02-87). We thank all the project partners for their support and we would like to express our deep appreciation to the colleagues of Iranian Diabetes Association.

Contributions

Study design: MZ; data collection and analysis: SAM, HH, MZ, ShP and manuscript preparation: MZ, SAM.

Conflict of interest

There are no financial and personal relationships with other people or organisations that could inappropriately influence (bias) in our work, all within one year of beginning the work submitted. There are no conflicts of interest in our study.

References

American Diabetes Association (ADA) (1997) Standard of medical care for patients with diabetes mellitus. *Diabetes Care* **20**(Suppl. 1), S5–S13.

Amini M & EhsanParvaresh M (2008) Prevalence of macro and microvascular complications among patients with type 2 diabetes in Iran: a systematic review. *Diabetes Research and Clinical Practice* **8**, 18–25.

Azar M & Gabbay R (2009) Web-based management of diabetes through glucose uploads: has the time come for telemedicine? *Diabetes Research and Clinical Practice* **8**, 9–17.

Blake H (2008) Innovation in practice: mobile phone technology in patient care. *British Journal of Community Nursing* **13**, 160–165.

Cho JH, Lee HC, Lim DJ, Kwon HS & Yoon KH (2009) Mobile communication using a mobile phone with a glucometer for glucose control in Type 2 patients with diabetes: as effective as an Internet-based glucose monitoring system. *Journal of Telemedicine and Telecare* **15**, 77–82.

da Costa TM, Salomão PL, Martha AS, Pisa IT & Sigulem D (2010) The impact of short message service, text messages sent as appointment reminders to patients' cell phones at outpatient clinics in São Paulo, Brazil. *International Journal of Medical Informatics* **79**, 65–70.

Diabetes Control and Complications Trial Research Group (1993) The effect of intensive treatment of diabetes on the development and progression of long-term complication in insulin dependent diabetes mellitus. *New England Journal of Medicine* **329**, 977–986.

Duplaga M & Winnem OM (2006) Model of chronic care enabled with information technology. In *Information Technology Solutions for Healthcare, ser. Health Informatics* (Hannah KJ, Ball MJ, Zielinski K, Duplaga M & Ingram D eds). Springer, London, pp. 248–270.

Esteghamati A, Gouya MM, Abbasi M, Delavari A, Alikhani S, Alaedini F, Safaie A, Forouzanfar M & Edward WG (2008) Prevalence of diabetes mellitus and impaired fasting glucose in the adult population of Iran: the national survey of risk factors for non-communicable diseases of Iran. *Diabetes Care* **31**, 96–98.

Faridi Z, Liberti L, Shuval K, Northrup V, Ali A & Katz DL (2008) Evaluating the impact of mobile telephone technology on type 2 diabetic patient's self-management: the NICHE pilot study. *Journal of Evaluation in Clinical Practic* **14**, 465–469.

Ferrer-Roca O, Cardenas A, Diaz-Cardama A & Pulido P (2004) Mobile phone text messaging in the management of diabetes. *Journal of Telemedicine and Telecare* **10**, 282–286.

Fjeldsoe BS, Marshall AL & Miller YD (2009) Behavior change interventions delivered by mobile telephone short-message service [Review]. *American Journal of Preventive Medicine* **36**, 165–173.

Franc S, Dardari D, Boucherie B, Daoudi A & Charpentier G (2010) Telemedicine in diabetes: current results and perspectives. *Medecine des Maladies Metaboliques* **4**, 274–286.

Gentles SJ, Lokker C & McKibbon KA (2010) Health information technology to facilitate communication involving health care providers, caregivers and pediatric patients: a scoping review. *Journal of Medical Internet Research* **12**, e22.

Halkoaho A, Kavilo M & Pietilä M (2007) Information technology supporting diabetes self-care: a pilot study. *Euro Diabetes Nursing* **4**, 14–17.

Kim HS (2007) Impact of web based nurse education on glycosylated hemoglobin in type 2 diabetic patients. *Journal of Clinical Nursing* **16**, 1361–1366.

Kim HS & Jeong HS (2007) A nurse short message service by cellular phone in type-2 diabetic patients for six months. *Journal of Clinical Nursing* **16**, 1082–1087.

Kim CJ & Kang DH (2006) Utility of a web-based intervention for individuals with type 2 diabetes: the impact on physical activity levels and glycemic control. *Computers, Informatics, Nursing* **24**, 337–345.

Kim SI & Kim HS (2008) Effectiveness of mobile and internet intervention in patients with obese type 2 diabetes. *International Journal of Medical Informatics* **77**, 399–404.

Kim HS & Oh JA (2003) Adherence to diabetes control recommendation: impact of nurse telephone calls. *Journal of Advanced Nursing* **44**, 256–261.

Kim HS, Oh JA & Lee HO (2005) Effects of nurse-coordinated intervention on patients with type 2 diabetes in Korea. *Journal of Nursing Care Quality* **20**, 154–160.

Kim HS, Kim NC & Ahn SH (2006) Impact of a nurse short message service intervention for patients with diabetes. *Journal of Nursing Care Quality* **21**, 266–271.

Kim C, Kim H, Nam J, Cho M, Park J, Kang E, Ahn C, Cha B, Lee E, Lim S, Kim K & Lee H (2007) Internet diabetic patient management using a short messaging service automatically produced by a knowledge matrix system. *Diabetes Care* **30**, 2857–2858.

Kollmann A, Hayn D, Kastner P & Pand Scherier G (2006) Mobile phones as user interface in the management of chronic diseases. *Heft Jahrang* **4**, 121–123.

Krishna S, Boren SA & Balas EA (2009) Healthcare via cell phones: a systematic review. *Telemedicine Journal and E-Health* **15**, 231–240.

Kwon HS, Cho JH, Kim HS, Lee JH, Song BR, Oh JA, Han JH, Kim HS, Cha BY, Lee KW, Son HY, Kang SK, Lee WC & Yoon KH (2004) Development of web-based diabetic patient management system using short message service (SMS). *Diabetes Research and Clinical Practice* **66S**, S133–S137.

Lester RT, Ritvo P, Mills EJ, Kariri A, Karanja S, Chung MH, Jack W, Habyarimana J, Sadatsafavi M, Najafzadeh M, Marra CA, Estambale B, Ngugi E, Ball TB, Thabane L, Gelmon LJ, Kimani J, Ackers M & Plummer FA (2010) Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. *The Lancet* **376**, 1838–1845.

Liang X, Wang Q, Yang X, Cao J, Chen J, Mo X, Huang J, Wang L & Gu D (2010) Effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis. *Diabetic Medicine* **11**, 1464–5491.

Norris SL, Nichols PJ, Caspersen CJ, Glasgow RE, Engelgau MM, Jack L, Isham G, Synder SR, Carande-Kulis VG, Garfield S, Briss P & McCulloch D (2002) The effectiveness of disease and case management for people with diabetes: a systematic review. *American Journal of preventive Medicine* **22**, 15–38.

Patrik K, Griswold WG, Raab F & Intille SS (2008) Health and the mobile phone. *American Journal of Preventive Medicine* **35**, 177–181.

Pérez-Ferre N, Galindo M, Fernández MD, Velasco V, de la Cruz MJ, Martín P, del Valle L & Calle-Pascual AL (2010) A Telemedicine system based on Internet and short message service as a new approach in the follow-up of patients with gestational diabetes. *Diabetes Research and Clinical Practice* **87**, e15–e17.

Strandbygaard U, Thomsen SF & Backer V (2010) A daily SMS reminder increases adherence to asthma treatment: a three-month follow-up study. *Respiratory Medicine* **104**, 166–171.

The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (1997) Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care* **20**, 1183–1197.

United Kingdom Prospective Diabetes Study Group (UKPDS) (1998) Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* **352**, 837–853.

Wong FKY, Mok MPH, Chan T & Tsang MW (2005) Nurse follow up of patients with diabetes: randomized controlled trial. *Journal of Advanced Nursing* **50**, 391–402.

Wu L, Forbes A, Griffiths P, Milligan P & While A (2010) Telephone follow-up to improve glycaemic control in patients with Type 2 diabetes: systematic review and meta-analysis of controlled trials. *Diabetic Medicine* **27**, 1217–1225.

Yoon KH & Kim HS (2008) A short message service by cellular phone in type 2 diabetic patients for 12 months. *Diabetes Research and Clinical Practice* **79**, 256–261.