



A PROSPECTIVE STUDY ON EFFECTIVENESS OF TELEMEDICINE IN THE MANAGEMENT OF TYPE II DIABETES MELLITUS

Litty Rosa Alex*, G. Sathyaprabha

Kovai Medical Center and Hospital
KMCH College of Pharmacy
Coimbatore, Tamil Nadu, India

Abstract:

Diabetes mellitus is a growing public health problem worldwide and is considered as one of the main threats to human health in the 21st century. Telemedicine approaches can have a positive influence on patient blood glucose. The aim of the study was to evaluate the effectiveness of SMS and telephone calls on glycaemic control and its influence on medication adherence in type 2 diabetic patients. The prospective study consisted of 81 type 2 diabetes patients, assigned to three groups: Telephone group (n = 30), SMS group (n = 27) and control group (n = 24). SMS group received 4 messages weekly for 3 months and Telephone group received calls twice weekly. Their effects in reducing the HbA_{1c} and FBS after twelve weeks of intervention were found to be higher in Telephone and SMS group than control group. Similarly, patients in the intervention group showed a significant increase in adherence after three months. Thus it was concluded that telemedicine represents a new approach to the management of type 2 diabetes.

Keyword: Telemedicine, Type 2 diabetes mellitus, HbA_{1c}, Fasting blood sugar, Medication adherence, SMS, Telephone calls.

Introduction

Diabetes mellitus is a serious condition with potentially devastating complications which affects all age group worldwide. Type 2 diabetes mellitus (Non-Insulin Dependent

Diabetes Mellitus) is the most common type of diabetes and accounts for 90-95% of overall diabetes cases. Primary prevention of type 2 diabetes is necessary to reduce its growing prevalence, mainly in low income and middle-income countries. People with diabetes live with incurable diseases that require not only drug therapy and blood glucose control, but also a healthy lifestyle and demanding modifications in cultural patterns. On the long-term, elevated blood glucose level in type 2 diabetes patients can cause macrovascular

For Correspondence:

littyrosaalex12ATgmail.com

Received on: August 2014

Accepted after revision: October 2014

Downloaded from: www.johronline.com

complications such as renal disease, blindness, foot ulceration and nerve damage. This study is aimed to educate about the importance of lifestyle modification and adherence to oral anti diabetic medications and its influence on HbA_{1c}, FBS and PPBS in type 2 diabetes patients. One of the key strategies in achieving glycaemic control is long-term adherence to oral anti-diabetics. Theory based mobile e-health behavioral interventions are more likely to succeed and have the potential of lowering the health care cost than those of the traditional interventions which have not been successful in reaching out to all. The WHO recommended implementation on innovative service model that is not limited to face-to-face services for managing chronic diseases; they have recommended the usage of cell phones that will offer timely services. New models of diabetes management system by means of Short Message Services (SMS) by mobile phone communication is the most cost-effective tool for improving the quality of care in patients with type 2 diabetes. Communication by mobile phone is less expensive than alternate options such as land telephones or internet. India has a high prevalence of type 2 diabetes and widespread mobile phone ownership. Mobile phone messaging or telephonic calls are an alternative method of conveying the educational advice and inspiration to achieve lifestyle modification.

Materials and Methods

Participants: Participants were recruited from the endocrinology out-patient department of a multi-speciality hospital located in Coimbatore, according to the inclusion and exclusion criteria. The hospital is a university-affiliated medical center with 750 beds. All participants in this study had their own personal mobile phones. The age range was 18-65 years. The data was collected from January 2014 to April 2014. Diabetes was diagnosed according to the American Diabetes Association (ADA) criteria. Selection criteria required that both male and female patients diagnosed as type 2 diabetic patients that only use oral hypoglycaemic agents, should be able to communicate, should

possess a personal cell phone and knows how to receive text messages and ability to read and understand mobile phone messages in English or Tamil. Patients were excluded if they had important illness like renal insufficiency, hepatic dysfunction, mental illness or if pregnant and lactating, pre-diabetic patients and those with vision and hearing problem.

A total of 135 type 2 diabetic patients who visited the outpatient diabetic department of the hospital were included in the study. Out of which 40 patients were assigned into the SMS group, 45 patients into the telephone group and 50 patients into the control group. After duration of 3 months, 27 patients from SMS group, 30 patients from telephone group and 24 patients from control group came for review.

Procedure: The goal of the intervention was to maintain blood glucose levels within a normal range. Before intervention, demographic characteristics like age, sex, literacy, occupation, medical conditions, social habits, physical activity, diet, adherence and baseline laboratory data like HbA_{1c}, FBS and PPBS were collected. Patients in the SMS group received three messages weekly. The 12 weeks of intervention consisted of continuous education and reinforcement of diet, exercise, medication taking, as well as frequent self-monitoring of blood glucose levels. For example: 'Physical activity helps you to maintain normal blood sugar'; 'Take short walks to relax your body and mind'; 'Avoid snacks while watching TV'; 'Take fruits as whole and not as juice'; 'Skipping breakfast will make you overeat at lunch'; 'Practice good foot and skin care'; 'It's time to check your blood sugar'; 'Stop eating big meals'; 'Have an eye exam once a year'.

The intervention for telephone group was provided via mobile for 12 weeks. The 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 and

frequent self-monitoring of blood glucose levels. The Telephone group was contacted at least twice a week for the first month and then weekly for the second and third month. Questions like “How many times did you do physical exercise or walking during last days?” “Do you know that doing exercise is as important as diabetic medication?” were also asked.

Data Analysis

The data were analysed using the SPSS (Version 16) program. Chi-square test, Paired t-test and Independent t-test test were used to test for the homogeneity of demographic clinical characteristics between the SMS, Telephone and Control groups. The paired t test was used for comparison between baseline and review values in the groups. The unpaired t test was used for comparing the differences between the three groups.

Tables and Figures

Table 1: Mean difference between baseline and review values of HbA_{1c} in each study group

S.No	Study group	Baseline HbA _{1c} value (mean±sd) mg/dl	HbA _{1c} value at review (mean±SD) mg/dl	Percentage Reduction	p value
1.	SMS	8.25±1.84	7.70±1.50	6.7	0.023*
2.	TELEPHONE	7.84±1.68	7.16±1.01	8.7	0.001*
3.	CONTROL	7.87±1.85	7.35±1.48	6.6	0.130

*shows p value < 0.05

Table 2: Mean difference between baseline and review values of FBS in each group

S.No	Study group	Baseline FBS value (mean±SD) mg/dl	FBS value at review (mean±SD) mg/dl	Percentage Reduction	p value
1.	SMS	154.29±59.1	131.59±44.29	14.7	0.016*
2.	TELEPHONE	129.73±52.2	111.6±25.69	14.0	0.017*
3.	CONTROL	131.80±49.02	121.20±39.24	8.0	0.078

Table 3: Mean difference between baseline and review values of PPBS in each study group

S.No	Study Group	Baseline PPBS values (Mean±SD) mg/dl	PPBS values at review (Mean±SD) mg/dl	Percentage Reduction	p Value
1.	SMS	222.03±93.2	206.1±77.0	6.9	0.337
2.	TELEPHONE	226.56±99.9	187.86±34.3	17.5	0.030*
3.	CONTROL	219.09±85.84	199.18±63.50	9.0	0.704

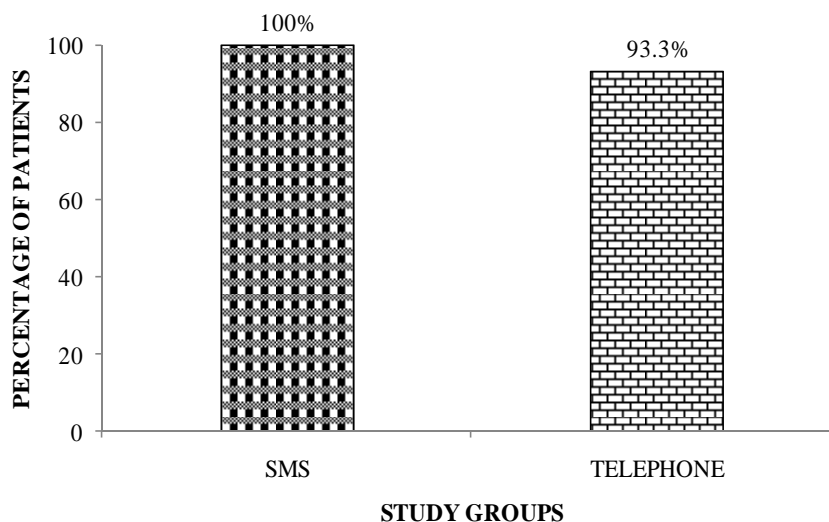
Table 4: Mean difference between baseline and review values of adherence in each study group

S.No	Study group	Baseline values of adherence (Mean±sd)	Review values of adherence (Mean±sd)	Percentage Increase	p Value
1.	SMS	7.09±0.88	7.5±0.09	5.8	0.005*
2.	TELEPHONE	6.69±0.7	7.44±0.56	11.2	0.002*
3.	CONTROL	6.88±0.94	7.05±0.14	2.5	0.119

Table 5: Shows independent t test for the review values between different study groups

S.No	Blood profile	Study groups	p Value
1.	HbA _{1c}	Telephone & control	0.037*
		SMS & control	0.704
		Telephone & SMS	0.115
2.	FBS	Telephone & control	0.011*
		SMS & control	0.638
		Telephone & SMS	0.040*
3.	PPBS	Telephone & control	0.047*
		SMS & control	0.483
		Telephone & SMS	0.245

Figure 1: Patients satisfied in each group



Results and Discussion

The mean age of the SMS group was 50.28 ± 9.05 , the mean age of telephone group was 50.16 ± 8.21 and of control group it was 51.29 ± 11.46 . Among the participants 34.6% were males and 65.4% were females. There was no significant difference in age, gender, literacy, occupation, social habits, physical activity and duration of diabetes between the three groups.

There was a significant percentage change in HbA_{1c} for the SMS group ($p = 0.023$) with a reduction of 6.7% and Telephone group ($p = 0.001$) with a reduction of 8.7%. But no significant percentage change in HbA_{1c} for the control group ($p = 0.13$) was found {Table 1}. HbA_{1c} did differ significantly with telephone and control group ($p = 0.037$) {Table 5}. Previous studies showed the following results: **Zolfaghari et al. (2012)** reported that after the three month follow up examination, HbA_{1c} level in diabetic patients in SMS and nurse led telephone groups decrease to 1.01% points and 0.93% points respectively. **Seung**

Kim et al. (2006) in their study revealed that SMS and telephone intervention by a nurse improved HbA_{1c} in type 2 diabetes patients after 12 weeks, with a decrease of 1.1% and 1.2% respectively.

There was a significant percentage change in FBS for the SMS ($p = 0.016$) and telephone group ($p = 0.017$) with a percentage reduction of 14 and 14.5 respectively. However, there was no significant percentage change found in the control group ($p = 0.078$) {Table 2}. Fasting blood sugar did differ significantly with telephone and control group ($p = 0.011$) as well as SMS and Telephone group ($p = 0.040$) {Table 5}. **Ferrer Roca et al. (2004)** in their trial suggested that SMS may provide a simple, fast and efficient adjunct to the management of diabetes. The present study adds that an educational interventional program using telephone call and SMS improves levels of glycosylated hemoglobin and fasting blood sugar for three months in patients with type 2 diabetes.

A significant percentage change of post prandial blood sugar was only noted in Telephone group ($p = 0.030$) with a decrease of 17.5% mg/dl {Table 3}. PPBS did differ significantly with telephone and control group ($p = 0.047$) {Table 5}. Although PPBS level of the Telephone group decreased after intervention, it was still above the target PPBS level. **Ilknur Cinar et al. (2010)** revealed that a nurse led telephone intervention may improve glycaemic parameters including HbA_{1c}, FBS, PPBS, diet, exercise, medication adherence in patients with type 2 diabetes mellitus after 12 weeks.

Similarly patients in Telephone group ($p = 0.00$) and SMS group ($p = 0.005$) showed a significant increase in adherence with 5.8, 11.2% increase after 3 months {Table 4}. It was suggested that beside telephone follow-up, increased disease awareness, positive lifestyle modifications (diet, exercise and drug) could be the reason for improvements in glycaemic parameters. **Samir Patel et al. (2013)** reported that a mobile phone based automated medication reminder system shows promise in improving medication adherence and blood pressure in high cardiovascular risk individuals. **Fenerty et al. (2012)** in their study reported that reminder based interventions improved adherence to daily medications.

According to the questionnaire determining the patient satisfaction in this study, it was found that all patients in the SMS group were satisfied with short service message and 93.3% of the patients in the Telephone group were satisfied with telephone call {Fig.1}. In a study about "Automated Telephone Disease Management (ATDM)" 85% of patients reported that they were satisfied with the ATDM calls and 76% of patient's reported that they personally would choose to receive such calls in the future (**Piette et al. 2000**).

At the end of the study, a statistically significant reduction was observed in the HbA_{1c} and FBS levels of patients in the telephone and SMS group while a small reduction, which is statistically not significant,

was detected in the control group. This result confirms that the use of telemedicine approaches has a positive impact on patient's glycemic control.

Conclusion

Telemedicine is a quick and efficient way to communicate with their providers, especially for those patients living in rural areas. This study shows evidence that telephone calls are as effective as SMS in managing diabetes in the intervention group and is helpful in reminding patients about their medication as well as timely visit to the out-patient department. This study indicates that SMS and telephone intervention may improve glycaemic parameters like HbA_{1c}, fasting blood sugar, postprandial blood sugar as well as diet, exercise and medication adherence and also eliminate complications related to diabetes mellitus. Thus implementation of telemedicine in hospitals and clinics will result in good glycemic control compared to usual medical care. Although this study confirmed that an SMS and telephone intervention could maintain and reduce glycaemia during a short term study period of 12 weeks, the long term effectiveness remains to be determined.

Acknowledgement

Authors are thankful to Faculty of Pharmacy and management of Kovai Medical Centre and Hospital, Coimbatore, for their continuous support throughout this work.

References

1. Blackburn. D. F., Swidrovich. J., Lemstra. M. 2013. *Non-adherence in Type II Diabetes: Practical Considerations for Interpreting the Literature*. Patient Preference and Adherence. 7:183-189.
2. Malkawi. A. M. 2012. *The Effectiveness of Physical Activity in Preventing Type II Diabetes in High Risk Individuals Using Well-Structured Interventions: A Systematic Review*. Journal of Diabetology. 2(1).
3. Ramachandran. A., Snehalatha. C., Ram. J., Selvam. S., Simon. M., Nanditha. A.etal.2013. *Effectiveness of Mobile Phone Messaging in Prevention of Type II*

- Diabetes by Lifestyle Modification in Men in India: A Prospective, Parallel-group, Randomised Control Trial.* Lancet Diabetes Endocrinol. 1: 191-98.
4. Pera. I. P. 2011. *Living with Diabetes: Quality of Care and Quality of life.* Patient Preference and Adherence. 5: 65–72.
 5. Vervloet. M., Dijk. L. V., Santen-Reestman. J., Vlijmen. B., Wingerden. P., Bouvyc. M. L. et al. 2012. *SMS Reminders Improve Adherence to Oral Medication in Type II Diabetes Patients who are Real Time Electronically Monitored.* International Journal of Medical Informatics. 81(9):594-604.
 6. Goodarzi. M., Ebrahimzadeh. I., Rabi. A., Saedipoor. B. and Jafarabadi. M. A. 2012. *Impact of Distance Education via Mobile Phone Text Messaging on Knowledge, Attitude, Practice and Self-efficacy of Patients with Type II Diabetes Mellitus in Iran.* Journal of Diabetes & Metabolic Disorders. 11:10.
 7. Jo Wu. C. J., Sung. H. C., Chang. A. M., Atherton. J., Kostner. K., Courtney. M. et al. 2013. *Protocol for a Randomised Blocked Design Study Using Telephone and Text Messaging to Support Cardiac Patients with Diabetes: A Cross Cultural International Collaborative Project.* BMC Health Services Research. 13:402.
 8. Zolfaghari. M., Mousavifar. S. A., Haghani. H. 2012. *Mobile Phone Text Messaging in Type II Diabetic Patients for 3 Months: A Comparative Study.* Journal of Diabetes & Metabolic Disorders. 11:7.
 9. Kim. H. S., Kim. N., Abn. S. H. 2006. *Impact of a Nurse Short Message Service Intervention for Patients with Diabetes.* Journal of Nursing Care Quality. 2(3): 266-271.
 10. 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.
 11. Ilknur. F., Akbayrak. N., Muhammet, Karadurmufi. N., Fiahin. M., Dooruetal. T. 2010. *The Effectiveness of Nurse-led Telephone Follow-Up in Patients with Type II Diabetes Mellitus.* Turkish Journal of Endocrinology and Metabolism. 14:1-5.
 12. Okuboyejo. S. and Eyesan. O. 2014. *mHealth: Using Mobile Technology to Support Healthcare.* Online Journal of Public Health Informatics. 5(3).
 13. Patel. S., Kantor. J., Marshall. L., Ritchie. C., Kaplinski. M., Khurana. P. S., et al. 2013. *Mobilizing Your Medications: An Automated Medication Reminder Application for Mobile Phones and Hypertension Medication Adherence in a High-Risk Urban Population.* Journal of Diabetes Science and Technology. 7(3):630-639.
 14. Fenerty. S. D., West. C., Davis. S. A., Kaplan. S. G., Feldman. S. R. 2012. *The Effect of Reminder Systems on Patient's Adherence to Treatment.* Patient Preference and Adherence. 6: 127–135.
 15. Piette. J. D. 2000. *Satisfaction with automated telephone disease management calls and its relationship to their use.* Diabetes education. 26: 1003-10