



The Effectiveness of the Telehomecare for Self-care Behaviors of Patients with Diabetes in Taiwan: A Consecutive Observational Study

Szu-Han Chiu^{1,2}, Po-Jen Hsiao^{3,4}, Jenq-Shyong Chan^{3,4}, Hung-Che Lin⁵, Hsiu-Mei Tu², Chih-Jen Cheng⁴, Cheng-Ping Shih⁵, Yuan-Yung Lin⁵, Chun-Hsiang Chiu⁶, Chih-Chien Wang⁷, Chen-Yin Tung², Chieh-Hsing Liu²

¹Department of Internal Medicine, Division of Metabolism, and Endocrinology, Taoyuan Armed Forces General Hospital, ²Department of Health Promotion and Health Education, National Taiwan Normal University, ³Department of Internal Medicine, Division of Nephrology, Taoyuan Armed Forces General Hospital, ⁴Department of Internal Medicine, Division of Nephrology, National Defense Medical Center, Tri-Service General Hospital, ⁵Department of Otolaryngology-Head and Neck Surgery, Tri-Service General Hospital, National Defense Medical Center, ⁶Division of Infectious Diseases and Tropical Medicine, National Defense Medical Center, Tri-Service General Hospital, ⁷Department of Orthopedics, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan, Republic of China

Background: Poor glycemic control in patients with diabetes mellitus can increase associated complications and mortality. We use the telehomecare system in patients with diabetes and investigate the associated impact in clinical practice. **Materials and Methods:** The purpose of the study is to examine the effectiveness of the telehomecare system on diabetic self-care. The telehomecare system incorporated into the daily care program in the experimental group. A cloud health-care platform designed for information storage and exchange be constructed and monitored by case managers. Comprehensive care instructions and in-time consultation in case of abnormalities were provided. The patients in the control group adopted conventional care program. Self-care questionnaires were completed by both groups before and after the study. All participants measured before the experiment and at 4 months after. **Results:** The participants were 117 patients (including 56 at the experimental and 61 at the control group), which recruited from a community hospital in New Taipei city, Taiwan. In two-way mixed design ANCOVA, in self-care behaviors, there are significant differences between two groups. The outcome of experimental group is superior to the control group both in posttest. However, there is no significant difference between two groups in subscales of foot care and athletics care. Moreover, there is no delayed effect in self-care behaviors of drug adjustment and blood sugar surveillance. **Conclusions:** This observational study revealed early intervention model to the health education strategy, the telehomecare might strengthen self-care behaviors of the participants. To the future study, we can put emphasis on the diabetes mellitus patient's foot care and exercise behaviors. The telehomecare model could also become the important health-care policy for the government in the future.

Key words: Telehomecare, diabetes mellitus, self-care behaviors

INTRODUCTION

Previous studies have shown that patients with type 2 diabetes mellitus tend to have increased risk for major and minor vascular complications. Studies have also shown that satisfactory blood glucose control can significantly reduce complications in patients with diabetes. One of the keys to maintain proper blood glucose levels is for the patients to receive diabetes self-management education, which

should address the topics of medication, healthy diets, adequate exercise, glucose self-monitoring, sound social and psychological attitudes, resolution of acute complications, and reduction of risk factors. Despite the efforts of diabetes educators, many diabetes patients find it difficult to achieve

Received: December 17, 2016; Revised: April 26, 2017;
Accepted: June 13, 2017

Corresponding Author: Dr. Chieh-Hsing Liu, No. 162, Ho-Ping E. Road, Sec 1, Taipei 106, Taiwan, Republic of China. Tel: 886-2-7734-1721; Fax: 886-2-2363-0326. E-mail: t09010@ntnu.edu.tw

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Chiu SH, Hsiao PJ, Chan JS, Lin HC, Tu HM, Cheng CJ, *et al.* The effectiveness of the telehomecare for self-care behaviors of patients with diabetes in Taiwan: A consecutive observational study. J Med Sci 2017;37:245-52.

Telehomecare for self-care behaviors in diabetic patients

these objectives. Therefore, the goal of finding more varied and more convenient medical service methods to help diabetes patients perform long-lasting self-care in everyday life has become exceptionally important.

Telecare equipment is one way to overcome temporal and spatial restrictions through the real-time transmission of physiological data such as blood pressure, blood glucose, and heart rate.¹ Online transmission also enables patients with chronic conditions to receive real-time health education and consulting services, while providing immediate solutions to senior patients' general medical care and dietary health management problems.² Hometelecare can help diabetes patients to perform continuous self-monitoring of blood glucose, helping to achieve the following goals: (1) achieving and maintaining individual blood glucose target; (2) preventing and detecting low glucose levels, enabling patient to avoid dangerously low blood glucose levels; (3) adjusting care depending on responses to changes in lifestyle for patients requiring medication; and (4) estimating how blood glucose levels respond to physical activities and types and quantities of foods.³ Studies in Western countries have confirmed that the use of hometelecare can significantly improve chronic disease care; apart from helping to effectively reduce average blood pressure in hypertension care, the use of telecare can help significantly reduce blood glucose before meals in diabetes control.⁴

The availability of information and technology support through telecare services allows direct provision of health- and social-care services to the users, enabling users to receive care in their own homes.⁵ Among various models of hometelecare services, most involve established technological care service networks that aim to assist residential patients and their caregivers by extending care services to the residential living environment.⁶ Hometelecare allows ordinary people to receive needed care services in their own homes to help with diet, clothing, living, traveling, education, and entertainment while providing high-tech management of self-care behaviors. Service recipients include patients confined to bed or with impaired mobility, patients requiring assistance in everyday life, patients with mild dementia, hypertension, early phase diabetes, or poorly controlled blood glucose levels as well as primary family caregivers of the foregoing patient categories. Caregivers of patients who have used hometelecare equipment have experienced improved care flexibility and quality of life. The transmission of physiological and lifestyle information to patients at home through the telephone or the Internet overcomes the barriers of time and distance. This approach can reduce long-term care costs and National Health Insurance payments, while

increasing the healthcare and support services accessible to elderly patients living in isolated areas and areas deficient in health-care resources.²

The Ministry of Health and Welfare in Taiwan states that the application of the Internet, information, and communications technology, and digital medical equipment provides the public with a wide range of health-care services and also establishes effective communication services for patients. Since telecare is a fairly new health-care model and has emerged only recently, empirical research on telecare is still largely at the embryonic stage. In particular, studies are lacking in Taiwan and internationally concerning the effectiveness of hometelecare service models on the self-care behaviors and monitoring of glycosylated hemoglobin A1c (A1c) in patients with diabetes. Therefore, we hypothesized that it would be especially timely and significant to design a residential telecare model and an evaluation system suitable for the residents of Taiwan. Because the "Shared Care Network Model" promoted by the Ministry of Health and Welfare still constitutes only a single intervention measure, it may not result in significant changes in patients' ways of thinking and behaving. Research indicates that effective intervention measures are multifaceted, and it is especially important that they include educational, behavioral, and social/psychological factors and goals, account for influencing factors connected with changes in lifestyles and the environment, and provide self-efficacy and self-management skills. A recent study urges that health education interventions should take into consideration factors that influence behaviors at different levels simultaneously and have the goal of establishing self-care skills by means of enhancing patients' self-efficacy and strengthening the supporting environment.⁷ The purpose of the present study was to design and evaluate the effectiveness of a residential telecare model and an evaluation system suitable for use in Taiwan.

MATERIALS AND METHODS

This observational study was performed with the Declaration of Helsinki and approval by the Institutional Review Board. All enrolled patients provided signed informed consent. The data were collected in one teaching hospital, Taiwan, from February 1, 2013 to August 31, 2013.

Diabetic patients with A1c >8% were the study population. Patients were considered eligible according to all the following criteria: age ≥ 18 years and A1c >8% in the last 3 months. Control group patients received regular outpatient department follow-up without telecare intervention. Experimental group patients received hometelecare intervention for 3 months starting on the date on which patients signed the hometelecare project consent form, which was taken as the 1st day. During

the first few days, the intervention focused on teaching the patients how to use the telecare equipment and providing instruction on diabetes self-care techniques. On the 4th day after acceptance of each participant, telephone interviews were conducted to confirm the participants' living environments and equipment transmission. On the 12th day, participants were assigned behavioral change targets, and the intervention personnel sought to understand the participants' self-care behaviors and improve their situation as needed. On the 30th day, the researchers assessed the participants' self-care behaviors performance targets. On the 60th day, patient support group activities were conducted. The posttests of self-efficacy and self-care behaviors were conducted starting on the 90th day, and a post-post-test assessing delayed effects were administered on the 180th day. In addition, telephone reminders and consulting services were provided throughout the intervention period. Figure 1 is a flow chart illustrating the intervention strategy and processes of the hometelecare service model. We purposed patients with different backgrounds could have the impact of the study results. Basic demographic information including age, education, marital status, income, living situation, associated diabetes complications, associated other chronic disease, and duration of illness were analyzed.

Research instrument

The instrument used in this study was a modification of the diabetes self-care behavior scale developed by Wang *et al.*⁸ The original instrument contained 27 questions and was

scored using a five-point Likert scale. Internal consistency was demonstrated by Cronbach's α coefficient of 0.82. The participants were asked to answer the questions based on the "actual states" of implementing diabetes self-care activities during the past 3 months. The diabetes self-efficacy scale was a modification of Wang's diabetes self-care behavior scale; the modified scale contained 15 questions and similar to the Wang scale, was scored using a five-point Likert scale. After completing questionnaire form as designed, five experts reviewed the appropriateness and clarity of expression of the questionnaire's content, and revisions were made in accordance with the experts' recommendations. The diabetes self-care behavior scale and self-efficacy scale both contained the five aspects of diet, exercise, medication and blood glucose self-monitoring, foot care, and handling of high and low blood glucose levels. A1c was analyzed by DCCT-aligned assays, a high-performance liquid chromatography assay (Tosoh G7; Tosoh Bioscience, Tokyo, Japan).

Data processing and statistical analysis

After the pretest, posttest, and post-post-test questionnaires were recovered from participants, SPSS for Windows Version 18.0 (SPSS, Chicago, IL, USA) was used to create and analyze data files. Descriptive statistical analysis was performed employing frequency distribution, mean, and standard deviation, and inferential statistical analysis was performed using Chi-square distribution, *t*-test, and two-way mixed-design ANCOVA.

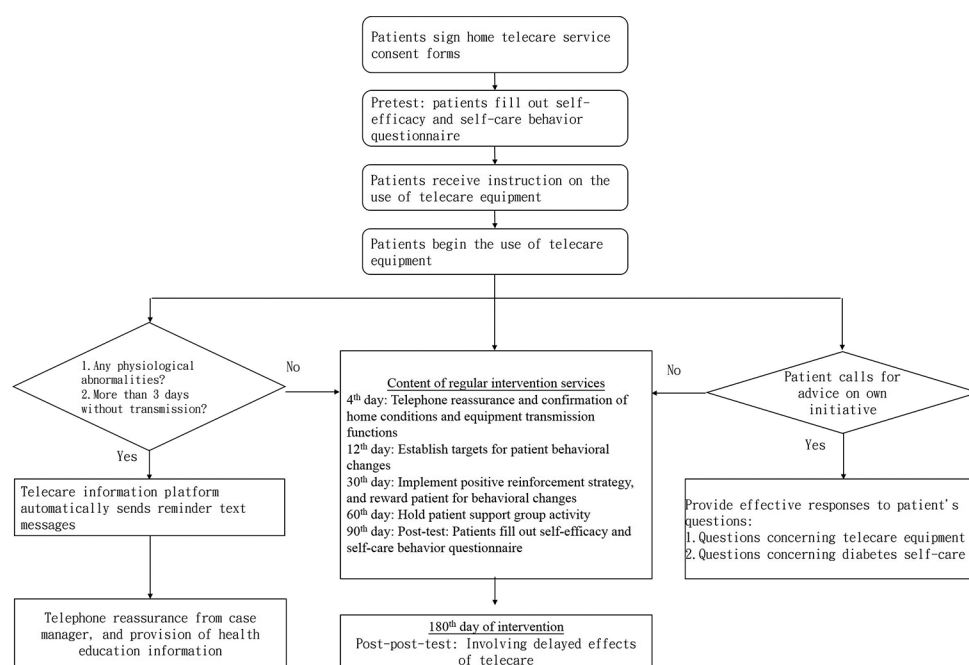


Figure 1: The intervention strategy and processes of the home telecare service model

RESULTS

Demographic information of research subjects

This study enrolled 117 participants, including 56 patients in the experimental group and 61 in the control group. To ensure accuracy of the experimental results by determining whether differences in demographic data existed between the experimental and control groups, the Chi-square test and independent sample *t*-test were used to test homogeneity of the two groups [Table 1]. The mean patient

age was 59.7 years for the experimental group members and 63.13 years for those in the control group ($P = 0.060$). Male was 46.4% and 44.3% individually in the experimental and control group ($P = 0.814$) [Table 1]. No instances of significant variance were found between the two groups ($P > 0.05$) with regard to gender, level of education, marital status, source of economic support, household situation, diabetes complications, age, and duration of illness. As a consequence, data of the experimental group and control group could be compared on an unbiased basis during this study [Table 1].

Table 1: Participants' demographic information and test of homogeneity

Variable	Experimental group (n=56), n (%)	Control group (n=61), n (%)	χ^2/t	P
Gender				
Male	26 (46.4)	27 (44.3)	0.06	0.814 ^a
Female	30 (53.6)	34 (55.7)		
Education				
Junior high school and below	37 (66.1)	49 (80.3)	3.05	0.081 ^a
High school and above	19 (33.9)	12 (19.7)		
Marital status				
Single	3 (5.4)	0	7.07	0.132 ^a
Married	46 (82.1)	46 (75.4)		
Divorced	3 (5.4)	3 (4.9)		
Separated	0	1 (1.6)		
Widowed	4 (7.1)	11 (18.0)		
Income provider				
Self	38 (67.9)	41 (67.2)	0.01	0.941 ^a
Family or children	18 (32.1)	20 (32.8)		
Living situation				
Living alone	2 (3.6)	5 (8.2)	5.70	0.337 ^a
Living with spouse	8 (14.3)	6 (9.8)		
Living with children	6 (10.7)	12 (19.7)		
Living with spouse and children	37 (66.1)	34 (55.7)		
Living with friends and/or relatives	3 (5.4)	2 (3.3)		
Living in institution	0	0		
Other	0	2 (3.3)		
Diabetes complications				
No	27 (48.2)	33 (54.1)	0.40	0.525 ^a
Yes	29 (51.8)	28 (45.9)		
Other chronic diseases				
No	1 (1.8)	4 (6.6)	1.63	0.202 ^a
Yes	55 (98.2)	57 (93.4)		
Age (mean±SD), years	59.70±9.86	63.13±9.67	-1.90	0.060 ^b
Duration of illness (mean±SD), years	11.27±6.72	11.21±6.68	0.04	0.965 ^b

Categorical data are shown as numbers and percentages, and continuous data are shown as mean and SD; ^aChi-square test, ^bIndependent sample *t*-test;

* $P < 0.05$. SD=Standard deviation

Effects of hometelecare service intervention on each research variable

Taking baseline preintervention scores as covariants, this study used two-way mixed-design ANCOVA to analyze the effects of telecare intervention versus no telecare intervention (experimental group vs. control group), at postintervention testing stages (posttest and post-post-test), and the associated effects between groups and testing stages on each research variable (self-efficacy, self-care behaviors, and A1c).

Self-efficacy

Results show that only drug and blood glucose self-monitoring was significantly associated with two factors group and testing stage ($F = 5.79$, $P < 0.05$), and the simple main effect test was consequently performed for the dependent variable [Table 2]. It also shows that the remaining four variables and overall self-efficacy were not significantly associated with group and testing stage ($P > 0.05$), indicating that evaluating only the main effect was sufficient [Table 2]. The group main effects for exercise, diet, handling of high and low blood glucose, and overall self-efficacy reached the level of significance ($F = 9.88, 17.89, 15.84, 39.97$, $P < 0.05$). No significant main effects were found for foot care, suggesting that the intervention had no significant effect on foot care self-efficacy [Table 2].

Simple main effect testing and *post hoc* between-group comparisons of the significant associations with drug and blood glucose self-monitoring revealed that the experimental group had a significantly higher score for drug and blood glucose self-monitoring at the posttest and post-post-test stages ($M = 4.55, 4.10$) than the control group ($M = 3.62, 3.55$) [Table 3]. In addition, the experimental group had a significantly higher score after intervention ($M = 4.55$) than during the post-post-test stage ($M = 4.10$), while no significant differences were shown between different testing stages for the control group [Table 3].

Self-care behaviors

Results show that only the association between the factors of group and testing stage reached the level of significance for drug and blood glucose self-monitoring ($F = 5.95$, $P < 0.05$). It was therefore necessary to perform simple main effect testing to determine the dependent variables reaching the level of significance [Table 4]. The association between the two factors group and testing stage did not reach the level of significance ($P > 0.05$) for the remaining four variables and overall self-care behaviors, and evaluating only the main effect was therefore sufficient [Table 4].

Simple main effect testing and *post hoc* comparison of the significant associations between drug and blood glucose self-monitoring revealed that the experimental group had significantly higher scores for drug and blood glucose self-monitoring in the posttest ($M = 4.15$) than the control group ($M = 3.53$), but no significant differences existed between the two groups at the post-post-test stage [Table 5]. The experimental group had significantly higher score in posttest ($M = 4.15$) than at the post-post-test stage ($M = 3.67$), but no significant differences were found between the different testing stages in the control group [Table 5].

Glycosylated hemoglobin A1c (A1c)

A1c is 9.46% in the experimental group and is 9.08% in the control group in pretest. There is no different at baseline ($P > 0.05$). The averages (posttest combined post-post-test) after adjustments indicate that although the experimental group had better glycosylated hemoglobin (A1c) performance ($M = 8.27$) than the control group ($M = 8.54$), no significant differences were found in A1c between the two groups [Table 6].

DISCUSSION

In the present study, the experimental group that received hometelecare services intervention for 3 months achieved

Table 2: Summary of two-way mixed-design ANCOVA analysis of self-efficacy

Source of variation	df	F					
		Exercise	Diet	Drug and blood glucose self-monitoring	Handling of high and low blood glucose	Foot care	Overall self-efficacy
Between subjects		[1>2] ^a	[1>2] ^a		[1>2] ^a		[1>2] ^a
Group	1	9.88*	17.89*	38.22*	15.84*	2.31	39.97*
Test subjects	114	(2.03)	(0.97)	(0.83)	(1.23)	(1.28)	(0.50)
Among subjects				[2>1, 3] ^b			
Stage	1	0.003	0.08	6.07*	0.006	0.10	2.25
Group × stage	1	1.55	0.01	5.79*	2.02	1.47	0.07
Stage × test	114	(1.01)	(0.56)	(0.36)	(0.63)	(0.69)	(0.27)

Numbers in parentheses are MSE, the values in square brackets are the results of LSD *post hoc* comparison, * $P < 0.05$, ^a1=Experimental group; 2=Control group, ^b1=Pretest; 2=Posttest; 3=Post-post-test. MSE=Mean square error; LSD=Least significant difference

Telehomecare for self-care behaviors in diabetic patients

significantly better overall self-efficacy and self-care behaviors results than the control group that received routine homecare for the same period. Two-way mixed design ANCOVA analysis showed that intervention with a homotelecare service model resulted in a significant improvement in participants' overall self-efficacy ($F = 39.97$, $P < 0.05$) and self-care behaviors ($F = 23.77$, $P < 0.05$) in the experimental group compared with results in the control group.

The main emphasis of the homotelecare service model is to collect blood glucose monitoring data and other care-related information while patients are at home, allowing case managers to monitor patients' blood glucose levels in real-time. Therefore, case managers may have follow-up visits and timely discussions with patients, determine individualized care targets together, and provide real-time healthcare information. This allows case managers to promote behavioral changes regarding patients' diet, exercise, use of medication, and handling of blood glucose abnormalities, strengthening patients' knowledge and ability in the self-management of blood glucose levels, and ultimately improving patients' self-care behaviors.

Table 3: Summary of simple main effect analysis for self-efficacy

Source of variation	Drug and blood glucose self-monitoring		
	Average after adjustment		F
	Experimental group	Control group	
Group			
Posttest	4.55	3.62	44.02*
Post-post-test	4.10	3.55	14.10*
	Posttest	Post-post-test	
Stage			
Experimental group	4.55	4.10	4.02*
Control group	3.62	3.55	1.90

* $P < 0.05$

The results of our statistical analyses indicated that, after homotelecare service intervention, the experimental group experienced significant improvement in both self-efficacy and diabetes self-care behaviors. This suggests that this telecare model has advantages over traditional care in that patients can receive real-time health education and blood glucose monitoring information from their case managers, gradually learn self-care skills, change their diets and living habits, and incorporate diabetes care into their everyday lives. In addition, the interaction between case managers and patients in routine reassurance calls and in face-to-face discussion and feedback during follow-up visits resulted in the elimination of the psychological distance between medical personnel and patients. Patients tend to see the telemedicine teams as an important source of social support, and feel more confident in maintaining their ability to provide quality care. Therefore, homotelecare provides a service environment that is technologically advanced, user-friendly, and timely, resulting in patients' improved self-care capability and self-confidence.

Significant delayed effect on self-efficacy and self-care behaviors

In the present study, homotelecare intervention was associated with a significant delayed effect on the experimental group, resulting in significantly better self-efficacy and self-care behaviors than in the control group at both the posttest and post-post-test stages. Results of the two-way mixed design ANCOVA analysis suggest that there was no association between self-efficacy and self-care behaviors. After inspecting their direct effects, we find that group exerts a direct effect, and that group effects exist both in the posttest ($F = 39.97$, $P < 0.05$) and in the post-post-test stages ($F = 23.77$, $P < 0.05$). The experimental group exhibited better performance than the control group, indicating a delayed effect.

Table 4: Summary of two-way mixed-design ANCOVA analysis of self-care behaviors

Source of variation	df	F					
		Exercise	Diet	Drug and blood glucose self-monitoring	Handling of high and low blood glucose	Foot care	Overall self-care behavior
Between subjects			[1>2] ^a		[1>2] ^a	[1>2] ^a	[1>2] ^a
Groups	1	1.93	4.02*	16.76*	18.46*	15.02*	23.77*
Test subjects	114	(1.95)	(0.83)	(0.55)	(1.00)	(0.70)	(0.36)
Among subjects				[2,3>1] ^b			[2, 3>1] ^b
Stage	1	3.50	1.17	5.95*	0.54	0.47	4.49*
Group × stage	1	1.72	0.71	13.47*	1.33	0.28	0.87
Stage × test	114	(0.96)	(0.34)	(0.18)	(0.47)	(0.37)	(0.35)

Numbers in parentheses are MSE, the values in square brackets are the results of LSD *post hoc* comparison, * $P < 0.05$, ^a1=Experimental group; 2=Control group, ^b1=Pretest; 2=Posttest; 3=Post-post-test; MSE=Mean square error; LSD=Least significant difference

Table 5: Summary of main effect analysis for self-care behaviors by group

Source of variation	Drug and blood glucose self-monitoring		
	Average after adjustment		<i>F</i>
	Experimental group	Control group	
Group			
Posttest	4.15	3.53	29.51*
Post-post-test	3.67	3.46	3.05
	Posttest	Post-post-test	
Stage			
Experimental group	4.15	3.67	10.09*
Control group	3.53	3.46	0.06

* $P < 0.05$

Table 6: Summary of descriptive statistics showing main effects for Glycosylated hemoglobin A1c (A1c) by group

	Experimental group		Control group	
	A1c	SD	A1c	SD
Pretest	9.46	1.40	9.08	1.09
Posttest	8.49	1.14	8.55	1.29
Post-post-test	8.31	1.56	8.29	1.46

SD=Standard deviation; A1c=Glycosylated hemoglobin A1c

Significantly improved drug and blood glucose self-monitoring

The intervention had no delayed effect on drug and blood glucose self-monitoring behaviors since it was significantly improved in the experimental group compared with the control group only in the posttest stage. Among all variables of self-care behaviors, a drug and blood glucose self-monitoring was significantly associated with effects of the telecare services intervention.

Hometelecare service model intervention has no significant effect on Glycosylated hemoglobin A1c (A1c)

Analysis employing two-way mixed design ANCOVA shows that glycosylated hemoglobin (A1c) ($F = 2.27$, $P > 0.05$) did not differ significantly between the two groups following intervention using the hometelecare service model. *Post hoc* comparison of the main effect revealed that although the average glycosylated hemoglobin (A1c) after adjustment of the experimental group ($M = 8.27$, $P > 0.05$) was better than that of the control group ($M = 8.54$), no significant differences were found between the two groups, indicating that the intervention had no significant effect on A1c.

The fact that no significant difference in A1c was found between the control and experimental groups may be due to

the times of testing; if the testing periods were extended, or if the intervention duration was prolonged, then the posttest and post-post-test would have been implemented at later times, and perhaps, more significant differences in A1c would have been observed. During the intervention period, the A1c of the experimental group decreased from 9.46% in the pretest to 8.49% in the posttest and further decreased to 8.31% during the post-post-test. These values suggest that the experimental group's average blood glucose levels and A1c values indeed had decreasing trends.

Recently, a cluster randomized controlled trial demonstrated that telemedicine consultation was better to conventional consultation for glycemic control in diabetic patients. Telemedicine consultation was also reported to be associated with better patient and primary care provider satisfaction.⁹ In addition, Diabetes Prevention Program-based lifestyle interventions delivered through mobile, electronic, and other types of telehealth in clinical practice. They also suggested that the future research should focus on ways to optimize behavioral support.¹⁰ Furthermore, the new Internet-based U-Healthcare system was proven to be successfully applied in diabetic patients. It not only achieved better glycemic control, improved A1c levels, but also increased patients' compliances to the medical team's instructions.¹¹

This study has several limitations in the interpretation of results. First, no significant differences were found in A1c between the control and experimental groups. It is possible that other factors (such as insulin use and follow-up periods) may be involved. Since different treatment methods may have different effects, we recommend that future research may take patients' medication use as a criterion for assigning participants to groups, which will allow further comparison of different treatment methods. Second, the post-post-test in this study was implemented during the 6th month after the beginning of intervention, which was only 3 months after the posttest. Future research may consider increasing duration of the intervention and conducting the post-post-test at a later time, which may possibly allow observation of more significant changes in patient's behavior. Researchers may be able to determine whether delay of assessment time affects A1c levels, and whether any significant differences in A1c occur between the two groups. Third, the sample size in this study was relatively small and the study was done only on patients in one teaching hospital of Taiwan. We think it may have variant study results from other different ethnic backgrounds.

No significant delayed effects were detected in drug and blood glucose self-monitoring behaviors. This may have been because of patients not willing to pay the out-of-pocket cost for blood glucose test paper at the stage of post-post-test,

Telehomecare for self-care behaviors in diabetic patients

which may have resulted in decreased usage. We therefore recommend that the Bureau of National Health Insurance should consider including blood glucose test paper among consumable materials eligible for health insurance payments, which may enhance the delayed effect of intervention on blood glucose self-monitoring.

CONCLUSIONS

In the present observational study, early intervention model, the telehomecare might strengthen self-care behaviors of the participants. The outcome of telehomecare group is superior to the control group both in posttest. Future research may focus on promoting healthy behaviors for foot care and exercise among diabetes patients and employ different forms of intervention to improve patients' self-care performance and behaviors.

Acknowledgment

This study could not have been carried out without the cooperation and support of all participants.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Davis RM, Hitch AD, Salaam MM, Herman WH, Zimmer-Galler IE, Mayer-Davis EJ. TeleHealth improves diabetes self-management in an underserved community: Diabetes TeleCare. *Diabetes Care* 2010;33:1712-7.
2. Demiris G, Doorenbos AZ, Towle C. Ethical considerations regarding the use of technology for older adults. The case of telehealth. *Res Gerontol Nurs* 2009;2:128-36.
3. Huang Z, Tao H, Meng Q, Jing L. Management of endocrine disease. Effects of telecare intervention on glycemic control in type 2 diabetes: A systematic review and meta-analysis of randomized controlled trials. *Eur J Endocrinol* 2015;172:R93-101.
4. Istepanian RS, Zitouni K, Harry D, Moutosammy N, Sungoor A, Tang B, *et al.* Evaluation of a mobile phone telemonitoring system for glycaemic control in patients with diabetes. *J Telemed Telecare* 2009;15:125-8.
5. Dale J, Caramlau I, Docherty A, Sturt J, Hearnshaw H. Telecare motivational interviewing for diabetes patient education and support: A randomised controlled trial based in primary care comparing nurse and peer supporter delivery. *Trials* 2007;8:18.
6. Dale J, Caramlau I, Sturt J, Friede T, Walker R. Telephone peer-delivered intervention for diabetes motivation and support: The telecare exploratory RCT. *Patient Educ Couns* 2009;75:91-8.
7. Knight KM, Dornan T, Bundy C. The diabetes educator: Trying hard, but must concentrate more on behaviour. *Diabet Med* 2006;23:485-501.
8. Wang JS, Wang RH, Lin CC. Self-care behaviors and related factors in outpatients newly diagnosed with non-insulin-dependent diabetes mellitus. *J Nurs* 1998;45:60-74.
9. Sood A, Watts SA, Johnson JK, Hirth S, Aron DC. Telemedicine consultation for patients with diabetes mellitus: A cluster randomised controlled trial. *J Telemed Telecare* 2017;1357633X17704346.
10. Joiner KL, Nam S, Whittemore R. Lifestyle interventions based on the diabetes prevention program delivered via eHealth: A systematic review and meta-analysis. *Prev Med* 2017;100:194-207.
11. Wang G, Zhang Z, Feng Y, Sun L, Xiao X, Wang G, *et al.* Telemedicine in the management of type 2 diabetes mellitus. *Am J Med Sci* 2017;353:1-5.

