Original Article

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Effect of Telemonitoring Intervention on Glycemic Control in Diabetes Patients: A systemic Review of Randomized Controlled Trials

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Abstract

Diabetes is a metabolic disease and the number of diabetes is increasing worldwide. Regular follow-up treatment and self-care management are important to control blood glucose level. The aim of this study was to assess the effect of telephone contact intervention on glycemic control compared with the usual care in diabetes. The literatures were electronically searched up until January 2013. We also searched from the references of relevant studies. All randomized control trials which evaluated the telephonic intervention in diabetes patients and measured glycated hemoglobin (HbA1c) as an outcome were included. Data were extracted for year of publication, country, intervention and clinical outcome. Twenty studies were included in this systematic review. The intervention components consisted of education related to diabetes and monitoring of self-care activities such as medication, lifestyle, diet and self-monitoring glucose measuring. Among the included studies, eight studies showed significant improvement in HbA1c compared with the control group. From the results of all included studies, telesupport may improve glycemic control in diabetes.

Key word: Telephone intervention, Diabetes, Telemonitoring, Systematic review, Glycemic control

INTRODUCTION

Diabetes is one of the chronic diseases and it is characterized by hyperglycemia resulting from insulin deficiency, insulin resistance or both. There are three main types namely: type 1, type 2 and gestational diabetes. Type 1 diabetes results from lacking of insulin production and type 2 diabetes is diagnosed when the body cannot use insulin effectively. Gestational diabetes is hyperglycemia which is firstly diagnosed during pregnancy[1]. Among them, type 2 is the most common and is occurred in more than 80% of all diabetes. Type 1 and gestational diabetes account for approximately 10% and 5% respectively. The number of diabetes patient is more than 180 million people worldwide and it is likely to be increased to more than double by 2030. WHO estimated that there were 1.1 million people died from diabetes in 2005[2]. For diabetes, there are many effective ways such as pharmacological and non-pharmacological treatments to control blood sugar level that are related with serious complications[3]. The management of diabetes is complicated and regular follow-up assessment in self-care activities is the key to achieve the target blood glucose level[4-5].

To improve the glycemic control in diabetes, health care providers offer telemonitoring service to the patient[6]. The term "telemonitoring" is defined as the use of audio, video, and other telecommunication and electronic information processing technologies to monitor patient status at a distance[7]. Telephone is widely used by all age groups

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and in almost every country. The healthcare provider and patient can easily connect at any time, in any place and any setting. The healthcare provider can provide education and assessment of self-management activities to the patients over the telephone. Self-management contains many behaviors such as lifestyle modification, medication adherence and blood glucose measuring. For diabetes, the self-management activities are important and it can decrease the rate of serious complication[8-9].

In this study, we performed a systemic review of phone call intervention in glycemic control for diabetes self-management.

METHODS

Data sources

The electronic databases were searched by using Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science (ISI), Ovid SP, the Cochrane Central Register of Controlled Trials, Medline (Pubmed), Scopus and ScienceDirect. The search was conducted from inception to January 2013. We also manually searched the reference lists of potentially relevant studies and review articles reporting the telemonitoring intervention to improve outcomes in diabetes patients. The search strategies were performed combining the medical subject headings (MeSH) and other keywords. The MeSH terms were diabetes mellitus, telemonitoring, telehealth and randomized controlled trials. Other keywords were telephone intervention, diabetes, systematic review and glycemic control. Only articles published in English were included.

Inclusion/exclusion criteria

Articles were selected if they reported randomized controlled trials of phone contact interventions in diabetes patients and the endpoint result was HbA1c. There was no limitation for age of patients. We excluded studies that contained (1) electronic transmission of outcomes data from the patients to the health care providers, (2) gestational diabetes, or (3) hospitalized patients.

Data extraction

The data from individual study were abstracted. The data recorded were the year of publication, country, the age group, the study population, duration of the intervention period, sample sizes, frequency of calls, duration of each session, intervention components, and baseline and post-intervention HbA1c data.

RESULTS

Characteristics of the included studies

A total number of 122 studies were searched and we included 20 randomized control trials which met the inclusion criteria (Figure 1). All studies evaluated the effect of phone calls intervention, not other forms of phone services (eg. SMS and internet) in diabetes patients compared with control group (Table 1). One study[9] used automated phone calls which send the voice message from the computer-based center to the patients via the telephone. The control group was defined as usual care which slightly differed among the studies. Studies were conducted in USA[9,11-14,16-17,23,26-28], UK[21,24,25], South Korea[10,20], Iran[15], Australia[18], Japan[19] and Jordan[22]. The numbers of patients ranged from 36 to 554. There were 12 studies[9,11,13-14,16-18,21-23,25-26] that contained ≥ 100 patients. Both type 1 and type 2 patients were included and the patients in most studies were type 2 [9,10,13-17,19-22, 25-26,28]. Type 1 patients were examined in 3 studies[18, 24, 27] and both patients with type 1 and 2 were in three studies[11, 12, 23]. There were broad variations in the number of calls and the duration of each session among the included studies. The length of intervention in the included studies varied from 3 to 18 months. Most of the included studies provided education

related to diabetes and monitored self-care management activities, such as blood glucose measurement, physical activities, diet and medication. Phone interventions together with in-person contact were implemented in eight studies[14,16,19,22-23,26-28]. The face-to-face intervention components were education, lifestyle management, medication adherence, review of blood sugar testing and treatment goal setting. In one study, healthcare provider mailed to the patients about the outcome data and recommendation related to the diet[20].

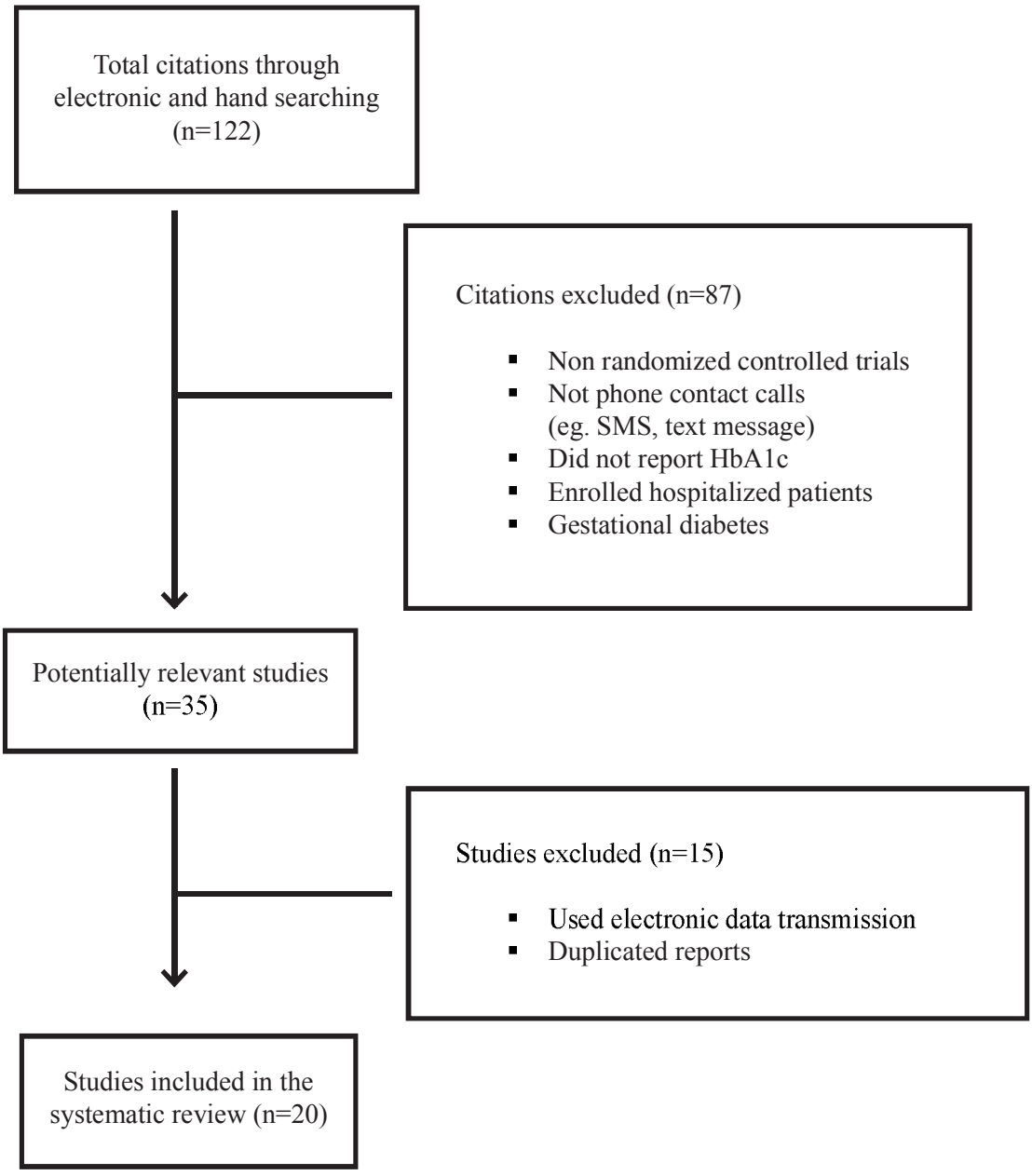

Figure 1. Study selection in the review

Table 1. Characteristics of the included studies

Study [Ref]	Country	Age (years)	Type	Duration (months)	Intervention	Frequency of calls	Call duration (minutes)	Intervention component
Kim (2003) [10]	South Korea	Intervention=59.7±7.3 Control=60.9±5.8	Type 2	3	Telephone	16 calls (average) [once or twice weekly]	25 (average)	Education, reinforcement of diet, exercise and medication adjustment recommendations, self-monitoring of blood glucose levels
Maljanian† (2005) [11]	USA	Intervention=56.9±12.0 Control=59.2±13.4	Type 1 and 2	3	Telephone	12 calls	5-20 (range)	Education, adherence with self-management activities, and attendance at scheduled physician office visits
Thompson (1999) [12]	USA	Intervention=47.5±11.8 Control=50.0±14.8	Type 1 and 2	6	Telephone	8 calls (average)	15 (average)	Insulin adjustment
Walker† (2011) [13]	USA	Intervention=55.7±7.4 Control=55.4±7.2	Type 2	12	Telephone	10 calls [once 4-6 weekly]	NI	Tailored to the participant reported needs, medication adherence, diet, physical activity, problem solving, goal setting, communication skills, and preplanning for medical visits
Bogner (2012) [14]	USA	Intervention=57.8±9.4 Control=57.1±9.6	Type 2	3	Telephone + in-person	2 calls	15	Education about depression and type 2 diabetes, antidepressant and oral hypoglycemic agent use, assessment for side-effects and assistance in their management
Nesari (2010) [15]	Iran	Intervention=51.9±7.6 Control=51.0±8.2	Type 2	3	Telephone	16 phone calls [once or twice weekly]	20 (average)	Diet, exercise, medication-taking, foot care, blood glucose monitoring and education and the participants' questions were answered
Krein† (2004) [16]	USA	Intervention=61.0±10.0 Control=61.0±11.0	Type 2	18	Telephone + in-person	NI	NI	Encourage self-management including diet and exercise, provide reminders for recommended screenings/tests, help with appointment scheduling; monitor home glucose and blood pressure levels; and identify and initiate medication and dose changes as needed

Table 1. Characteristics of the included studies (cont.)

Study [Ref]	Country	Age (years)	Type	Duration (months)	Intervention	Frequency of calls	Call duration (minutes)	Intervention component
Piette (2011) [17]	USA	Intervention=55.1±9.4 Control=56.0±10.9	Type 2	12	Telephone	21 calls (average=13.5) [12 weekly + 9 monthly]	NI	Depression management and a pedometer-based walking program
Nunn (2006) [18]	Australia	Intervention=11.9±3.7 Control=11.9±3.0	Type 1	7	Telephone	Bimonthly	15–30 (range)	Current insulin, carbohydrate intake, blood glucose values, education, diabetes management
Graziano (2009) [9]	USA	Intervention=60.1±7.4 Control=63.0 ±9.3	Type 2	3	Automated telephone	1-3 calls daily	Less than 1	Serious nature of type 2 DM and its complications (severity), the relationship of hyperglycemia to complications (susceptibility), and benefits of self-management in controlling blood glucose levels
Moriyama (2009) [19]	Japan	Intervention=66.4±9.2 Control=65.2±8.5	Type 2	12	Telephone + in- person	24 calls [Biweekly]	NI	Check goal-setting behaviors
Oh† (2003) [20]	South Korea	Intervention=59.2±7.2 Control=62.0±5.7	Type 2	3	Telephone + mail	16 calls (average)	25 (average)	Continuous education and reinforcement of diet, exercise and medication adjustment and frequent self-monitoring of blood glucose level
Young (2005) [21]	UK	67.0*	Type 2	12	Telephone	Once every 3 months or 7 weeks or monthly	20	Knowledge about diabetes and provided educational advice about lifestyle improvements, readiness to change related to social behavior medication adherence, blood glucose control
Jarab (2012) [22]	Jordan	Intervention=63.4±10.1 Control=65.3±9.2	Type 2	6 [4(in-person)+2 (phone)]	Telephone + in- person	8 calls	20 (average)	Discuss and review the prescribed therapy, emphasize the importance of adherence to treatment plan and answer patient questions or address patient concerns.

Table 1. Characteristics of the included studies (cont.)

Study [Ref]	Country	Age (years)	Type	Duration (months)	Intervention	Frequency of calls	Call duration (minutes)	Intervention component
Aubert† (1998) [23]	USA	Intervention=54.0† Control=53.0† (median)	Type 1 and 2	12	Telephone + in- person (initial assessment)	Weekly or biweekly	NI	Review the blood glucose log and discuss glucose values with the patient, medication regimens adjusted as needed and meal planning and exercise reinforced
Howells (2002) [24]	UK	16.5* (Intervention, Control)	Type 1	12	Telephone	16 calls (average) [range 5-19]	9 (mean) 2-30 (range)	Provide support and assistance in using problem-solving steps
Dale (2009) [25]	UK	NI	Type 2	6	Telephone	average 4.5 [range 1–6 calls]	9.5(average) 1–37(range)	Motivate adherence
Skelly (2009) [26]	USA	Intervention=65.0† Control=68.0†	Type 2	9	Telephone + in- person	4 calls	15 (average)	Reinforce the strategies developed during home visits, engage in problem solving, provide motivation and encouragement, and encourage reframing and adjustment as needed
Howe (2005) [27]	USA	Intervention=12.1±4.0 Control=12.2±3.7	Type 1	6	Telephone + In-person	18 calls [weekly calls followed by bimonthly calls]	5–15 (range)	Review blood sugars, safety issues related to hypoglycemia and hyperglycemia, problem-solving skills, diet and meal planning, and changing insulin dose. The study coordinator also discussed parenting and behavior management skills with parents as needed.
Whittemore (2004) [28]	USA	57.6 ±10.9*	Type 2	6	Telephone + In-person	2 call	NI	Education, behavioral and affective strategies

*Data are mean ± SD, *reported as a whole group, † median, NI= no information

Glycated hemoglobin outcome

For diabetes, hemoglobin A1c (HbA1c) is currently recommended as a diagnosis test and a tool to monitor the blood sugar level[29]. The American Diabetes Association (ADA) recommends the target level of HbA1c 7.0% which can decrease the diabetes related complications[30]. In our study, we used HbA1c as an outcome measure to assess glycemic level and the HbA1c results of the included studies are shown in Table 2. Most of the included studies showed better glycemic control in the intervention group compared with the control group. Among them, eight studies[12-15,20-23] revealed significant difference in HbA1c between the intervention and the control groups ($p < 0.05$), and the number of calls for each patient ranged from 2 calls within 3 months and weekly or biweekly for 12 months. Three[13,21,23]

Table 2. Mean changes from baseline in glycated hemoglobin outcomes

Study	Reference	Subject	Duration (months)	Intervention HbA1c (%) (SD)	Control HbA1c (%) (SD)	P value
Kim (2003)	10	36 (C=16, I=20)	3	-1.2	0.6	0.252
Maljanian (2005)	11	274 (C=126, I=148)	3	-1.23	-1.05	NS
Thompson (1999)	12	46 (C=23, I=23)	6	-0.018	-0.005	<0.01
Walker (2011)	13	444 (C=216, I=228)	12	-0.23 (1.66)	0.13 (1.91)	0.04
Bogner (2012)	14	180 (C=88, I=92)	3	-0.70(1.32)	0.5(1.11)	<0.001
Nesari (2010)	15	60 (C=30, I=30)	3	-1.87	-0.4	<0.001
Krein (2004)	16	209 (C=103, I=106)	18	-0.02	-0.16	0.61
Piette (2011)	17	291 (C=146, I=145)	12	0.2	0.0	0.7
Nunn (2006)	18	123 (C=63, I=60)	7	0.7	0.5	0.24
Graziano (2009)	9	119 (C=58, I=61)	3	-0.834 (1.09)	-0.767 (1.14)	0.84
Moriyama (2009)	19	65 (C=23, I=42)	12	-0.59	-0.03	0.705
Oh (2003)	20	38 (C=18, I=20)	3	-1.2 (1.5)	0.6 (0.9)	0.000
Young (2005)	21	554 (C=180, I=374)	12	NI	NI	0.003
Jarab (2012)	22	156 (C=79, I=77)	6	-0.8	0.1	0.019
Aubert (1998)	23	100 (C=NI, I=NI)	12	-1.7	-0.6	<0.001
Howells (2002)	24	54 (C=28, I=26)	12	0.28 (1.03)	0.62 (1.13)	NS
Dale (2009)	25	211 (C=86, I=115)	6	-0.56	-0.8	0.87
Skelly (2009)	26	114 (C=59, I=55)	9	-0.76	NI	NS
Howe (2005)	27	54 (C=28, I=26)	6	-0.5	-0.3	0.97
Whittemore (2004)	28	49 (C=23, I=26)	6	-0.2	-0.1	0.64

NS = not significant, NI = no information, C = Control, I = Intervention

of eight studies took 12 months of duration. Six studies[12,14-15,20-22] used an average of ≥15 minutes for each call, but two studies[13,23] did not report the time taken for each call. Among eight studies that contained mixed intervention of phone call and in-person contact[14,16,19,22-23,26-28], three studies[14,22-23] showed significant improvement in glycemic control in the intervention group compared with the control group.

DISCUSSION

We conducted the systematic review of randomized controlled trials that assessed the effect of phone intervention in glycemic control. We excluded the phone intervention with electronic data transmission from patients to healthcare providers. There are many forms of phone-based data transmission, for example, internet, bluetooth and text message. To send data to the healthcare providers, patients need to have technological knowledge and able to use modern devices (eg. glucometer) to measure clinical outcomes. Phone-based intervention with data transmission cannot be used by all diabetes patients because of technical barriers and cost compared with phone calls. The previous systematic review and meta-analysis of home telehealth in diabetes evaluating phone call and other forms of communication technologies including email and internet reported that home telemonitoring improved glycemic control compared with usual care (mean difference in HbA1c -0.22%, 95%CI -0.08 to -0.35%)[6]. Our study focused specifically on phone call and had the advantages of evaluating larger number of RCTs, most of which enrolled large number of patients[9,11,13-14,16-18,21-23,25-26] and with long intervention period[13,16-17,19,21,23-24]. Our systematic review demonstrated varied treatment effect among the included studies. This may partly be due to the differences in usual care utilized in individual trials. In one study[11], the usual care consisted of three 4-hour education classes, individual visits with the healthcare provider and collaborative care management between healthcare givers and primary care providers or regular clinical visits and supplies as needed in other study[12]. Significant effect on HbA1c was observed in eight studies[12-15,20-23]. Participants' factors (eg, state of disease, education background and age), geographic location (urban and rural area) and intervention components may also play a role. The intervention component of most studies was diabetes education[9,10,11,14,15,18,20,21,28], reinforcement of diet[10,13,15-16,18,20-21,23,28] and physical exercise[10,13,15-16,20-21,23,28]. The length of intervention, the frequency of phone call and time taken for each call also affected the outcome of the studies. Three studies[11,16,28] reported the patient satisfaction outcomes. Among these, one study[11] showed no difference between groups, while other two studies[16,28] described more satisfaction among patients in the intervention group compared with usual care. None of the included studies discussed about serious adverse effect of the intervention. One study[31] reported that phone intervention can cost moderately to get moderate improvement in glycemic control.

From the results of our systematic review, telesupport may improve glycemic control in diabetes. It may be a convenient intervention for patients who are of old age, have difficulty for clinical visits, especially in rural area, and those with poor adherence to control their diabetes and its related complications. Further studies should examinethe effectiveness of phone contact intervention in patient with various disease status, age, and with different number of calls taken.

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