



FACULTY OF HEALTH AND OCCUPATIONAL STUDIES  
Department of Health and Caring Sciences



NURSING DEPARTMENT,  
MEDICINE AND HEALTH COLLEGE  
Lishui University, China

# Nursing interventions to glycemic control among patients with type 2 diabetes

A descriptive literature review

Nan Anjie (Hani)  
Zhang Lu (Nina)

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Supervisor: Jian Hua Chen (Grace)

Examiner: Britt-Marie Sjölund



## **Abstract**

**Background:** According to the World Health Organization report in 2016, about 422 million adults worldwide have diabetes, and the majority of them have type 2 diabetes. The number of people with diabetes nearly doubled from 1980 to 2014. The high mortality and serious complications of type 2 diabetes require nurses to provide nursing intervention for helping patients control their blood sugar.

**Aim:** To describe nurses' intervention in glycemic control among patients with type 2 diabetes.

**Methods:** After searching and screening eligible articles in PubMed and CINAHL databases, 10 articles were finally adopted.

**Results:** The interventions mentioned in the selected articles fall into four categories: education, monitoring, assessment and planning. Among them, 10 articles involved educational intervention, 6 articles involved monitoring, 5 articles involved assessment intervention, and 2 articles involved making plan intervention. The intervention effect was judged by the change of HbA1c before and after intervention.

**Conclusions:** Currently, nursing intervention for glucose control among patients with type 2 diabetes summarized as 4 aspects: education, monitoring, assessment and make plan, mostly involved multi-disciplinary and multi-team intervention. Therefore, nurses need to cooperate with other professionals so as to improve the treatment program in achieving better glycemic control among patients with type 2 diabetes.

**Keywords:** Glycemic control, HbA1c, Nursing intervention, Type 2 diabetes

## 摘要

**背景：**全球约 4.22 亿成年人患糖尿病，其中以二型糖尿病为主。由于二型糖尿病的高死亡率、严重并发症，护士需提供护理干预以控制血糖。

**目的：**描述护士对二型糖尿病患者血糖控制方面的护理干预。

**方法：**在 PubMed 和 CINAHL 数据库中选择合适的文章并分析。

**结果：**所有研究的干预可分为教育、监测、评估和制定计划。以干预前后糖化血红蛋白变化作为判断标准。

**结论：**二型糖尿病患者血糖控制的护理干预分为 4 类，大部分涉及到多学科、多团队干预。因此，护士需与其他专业人员合作，以完善治疗方案。

**关键词：**血糖控制，糖化血红蛋白，护理干预，二型糖尿病

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**Appendix 1 Table 2. Overview of the selected articles**

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# **1. Introduction**

## **1.1 Background**

According to the report from WHO in 2016, there were approximately 422 million adults with diabetes worldwide in 2014, compared with 108 million in 1980, the numbers of patients with diabetes became almost doubled and raised from 4.7% to 8.5% in the adult population (World Health Organization [WHO], 2016). And the majority of diabetes patients owns type 2 diabetes (WHO, 2016). Diabetes caused 1.5 million deaths in 2012 and high-level blood glucose (BG) could cause supererogatory 2.2 million deaths and the condition became worse and worse every year (WHO, 2016). Over time, diabetes can cause serious complications in heart, blood vessels, eyes, kidneys and nerves (WHO, 2016). So that it's nurses' great responsibilities to taking care of patients, educating and screening early complications (Rodger, 2000). As Tagliacozzo and his colleagues' showed that nurses' effects could be studied in improving patients' awareness of the disease, self-management skills, satisfaction with medical services or reducing medical management cost (Tagliacozzo, Luskin, Lashof & Ima, 1974). In this article, nursing interventions that can be used in clinic for patients with T2D will be summarized and discussed using Cox's Interaction Model of Client Health Behavior. The meaning of this review study is to change patients' cognition of nurses' role and let them understand the importance of nursing intervention for disease control.

## **1.2 Diabetes and Type 2 diabetes**

Diabetes (diabetes mellitus) is a serious chronic disease that happens when pancreas cannot generate enough insulin or when the body can't use insulin availably (WHO, 2016). Diabetes can be mainly divided in three type based on the causes: Type 1 diabetes, Type 2 diabetes (T2D) and Gestational diabetes (WHO, 2018). T2D is a kind of diabetes that caused by an increase in insulin resistance which means the body can't use insulin effectively (Gillibrand, Holdich & Covill, 2009). T2D accounts for

most of the world diabetes patients and mainly affect adults, common unobvious symptoms: thirst, frequent urination, increased appetite but unexplained weight loss (WHO, 2016). What's more, high blood sugar will lead to serious complications like heart disease, strokes, diabetic retinopathy (WHO, 2016; Madden, Loeb & Smith, 2008).

### **1.3 Blood glucose and HbA1c (Diagnose of diabetes)**

Diabetes can be diagnosed by testing BG or HbA1c (WHO, 2016). Blood glucose (blood sugar levels) is the amount of glucose in the blood of humans (Wasserman, 2009). The normal fasting plasma glucose range is 3.9-6.1mmol/l and the diagnostic criteria for diabetes are fasting plasma glucose  $\geq 7.0$  mmol/l or plasma glucose  $\geq 11.1$  mmol/l (200 mg/dl) 2 hours after taking 75g glucose (WHO & International Diabetes Federation [IDF], 2006). Hypoglycaemia is defined as the normal fasting plasma glucose is  $<4$  mmol/L (patient with T2D) or  $\leq 2.8$  mmol/L (general adults) (WHO, 2018). Deviant high BG can be a life-threatening factor, when it causes the conditions such as diabetic ketoacidosis (DKA) in both T1D and T2D, and hyperosmolar coma in T2D (WHO, 2016). All types of diabetes can cause low BG which may give rise to seizures or unconsciousness (WHO, 2016). It may happen after patients omit one meal or exercises more than usual or takes too much anti-diabetes medication (WHO, 2016). These highlight the importance of glycemic control. HbA1c (glycated haemoglobin) also called haemoglobin A1c reveals the general BG level (BGL) over the past few weeks, instead of the current BGL (such as fasting or 2-h after meals) and play an important role in diagnosing diabetes even though patient is not in the fasting state (WHO, 2016). It is also an approach to monitor the glucose control of patients with diabetes (WHO, 2016).

### **1.4 Nurse interventions**

Nursing interventions are defined as the use of short-term counseling to help patients respond to a crisis and return to a state that is comparable or better than before the

crisis (Marie, 2003). A comparison of existing studies suggests that nurses' effects can be studied according to different interests which may including improve patients' awareness of the disease, self-management skills, satisfaction with medical services or cost reduction of medical management (Tagliacozzo et al., 1974). Studies have shown that patients with diabetes had difficulty in applying professional and complex knowledge to daily life for lack of the understanding of self-management principles of diabetes (Whittemore et al., 2004). Thus, patients urgently need nursing interventions in improving knowledge so as to control disease. Besides Whittemore et al. (2014) mentioned that individuals with chronic disease like T2D would have more psycho-social difficulties which may emotional strategies or psycho-social interventions may be particularly important. Tagliacozzo et al. (2014) also mentioned that nurse intervention had great significance for patients with diffuse diseases.

### **1.5 Nurses' role**

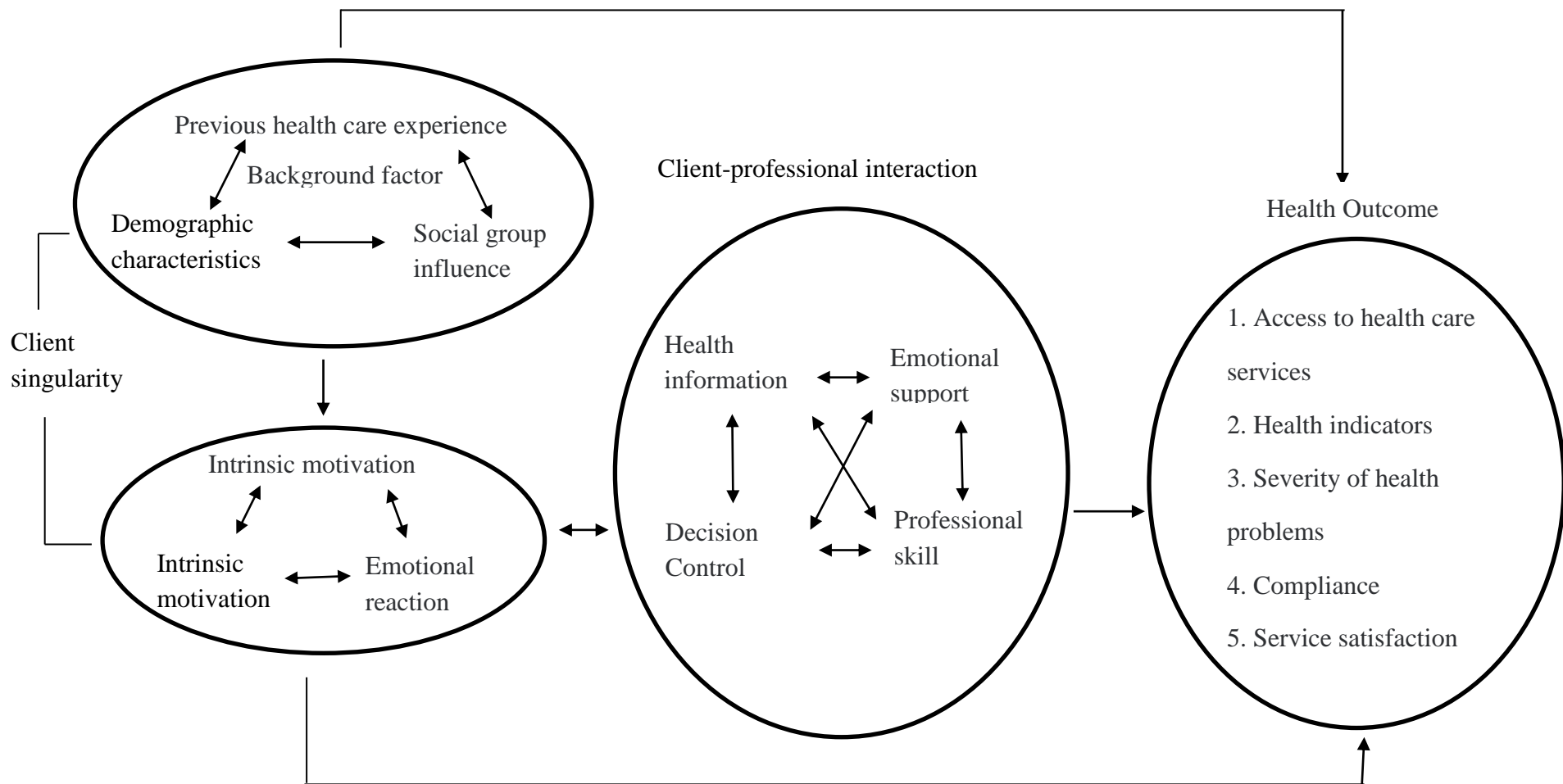
The nurse practitioner (NP) plays an important role in managing chronic disease patients (Dancer & Courtney, 2010). Nurses' role in nursing patient can be care giver. They also lead a leadership role in enhancing care and result of the patients with T2D (Dancer & Courtney, 2010). Nurses are also plan makers in nursing patient because the process of the nursing is a series of planed steps and measures to satisfy patients' needs (Li et al., 2015). In addition, nurses can be educators to educate patients with T2D what cause T2D and what managements can improve their quality of life (Li et al., 2015). For example, nurses can create an environment for individuals with T2D to enter decisions making and provide supports and encouragement for people with diabetes to help them change their behaviors (Rodgers, 2000). Rodger also mentioned that as a chronic disease diabetes needed nurse to continue follow-up and deterioration and right amount medication are supposed to be ensured by nurse.



## **1.6 Nursing theory- Interaction Model of Client Health Behavior (IMCHB)**

Cox's theory Interaction Model of Client Health Behavior (IMCHB) is used to support the research (**figure 1**). Cox pointed out that human had singularity and autonomy (Cox & Wachs, 1985). Back ground, intrinsic motivation, cognitive appraisal and affective response constituted client singularity (Li et al., 2015). There are three dynamic variables (intrinsic motivation, cognitive appraisal and affective response) that are controllable and susceptible to interventions (Cox & Wachs, 1985; Li et al., 2015). Cox described that nursing meant providing interventions based on client singularity and setting up a good interactive relationship with client to promote the optimal health outcome (Li et al., 2015).

In this study, human beings mean patients with T2D. According to Cox's theory, nurses can make nursing plans based on the characteristics of patients with T2D and control patients' HbA1c by intervening three dynamic variables, so as to achieve the purpose of controlling patients' condition (Cox & Wachs, 1985; Li et al., 2015).



**Figure 1 Theoretical framework of IMCHB.**

[Li, X., Zhu, J., Wang, A., Wan, Q., Wan, L., Ma, X., ... Guo, H. (2012). Cox's Interaction Model of Client Health Behavior. In X. Li (Ed.), *Introduction to Nursing* (3th ed., PP. 271-276). Beijing, China: People's Medical Publishing House.]

## **1.7 Earlier reviews**

A research group finished a systematic review of interventions by primary care or community professionals for the control of cardiovascular metabolic risk factors in diabetic patients (Seidu, Walker, Bodicoat, Davies & Khunti, 2016). Although no consistent association was found to improve cardiovascular risk and types of primary care, the results demonstrated that multifaceted interventions were more effective than single interventions (Seidu et al., 2016). One article reviewed the compliance of insulin treatment in diabetic patients, and there was some evidence that nurses' interventions could have an impact on patients' insulin treatment compliance (Doggrell & Chan, 2015). There was an review that focused on interventions for type 1 diabetes. It summarized how children and young people with type 1 diabetes achieve optimal self-care and management in a education environment (Edwards, Noyes, Lowes, Spencer & Gregory, 2014). And this study showed that most interventions had significant short-term effects, but the long-term effects of interventions needed to be demonstrated by post-studies (Edwards et al., 2014). And one article provided further evidence of a relationship between sleep quality and glucose control in type 2 diabetes (Zhu, Hershberger, Kapella & Fritschi, 2017).

## **1.8 Problem statement**

The number of people with T2D has skyrocketed in recently decades, its long duration and serious complications cause long-term suffering to patients and huge economic burden for the either patients and government. As patients with T2D, they need long-term self-management to control BG, while most patients have extremely poor self-control and knowledge deficiency. If the BG is not controlled for a long time, serious complications will be caused and both hyperglycemia and hypoglycemia will endanger the life of the patient. That is why people with T2D need long-term interventions to help them control their BG. It has been found that recent studies about nursing intervention to patients with T2D are focus on supporting quality of life,

diabetic foot management, cardiovascular disease, exercises and weight management aspects. The systematic review studies that summarized the existing nursing interventions to patients with T2D are mainly focus on complications. But articles that only focus on BG control are rarely. Therefore, it's necessary to sum up existing nursing interventions about BG control, so as to provide a direct way to learn new progress in nursing T2D.

## **1.9 Aim and research questions**

The aim of this review was to describe nurses' intervention to glycemic control among patients with type 2 diabetes, with the help of the following questions:

- Which kinds of nursing interventions among patients with type 2 diabetes were used during nurses' working environment?

## **2. Methods**

### **2.1 Design**

Descriptive literature review was used in this study (Polit & Beck, 2017).

### **2.2 Database and Search strategy**

Articles were searched both in PubMed and CINAHL with limits (see **table 1**). Search terms contain Type 2 diabetes, Nurse, Intervention, Patient, Glycemic control. Search terms were picked up from MeSH and CINAHL heading. But MeSH terms were only used in PubMed. And these search terms were searched in different combinations by using AND from Boolean operators (Polit & Beck, 2017). In the preliminary search, a total of 294 articles' abstracts were viewed (65 articles were repeated), 10 of these articles were considered to be in line with the research aim (see **table 1**).

**Table 1. Search strategies for the project.**

Database	Limits and search date	Search terms	Number of hits	Possible articles (excluding doubles)
PubMed	5 years, Full text, Human, Hogskolani Gavle 2018-6-14	Type 2 diabetes (MeSH)	24521	
PubMed	5 years, Full text, Humans, Hogskolani Gavle 2018-6-14	type 2 diabetes (MeSH) AND nurse	361	
PubMed	5 years, Full text, Humans, Hogskolani Gavle 2018-6-14	type 2 diabetes (MeSH) AND nurse AND intervention	272	
PubMed	5 years, Full text, Human, Hogskolani Gavle 2018-6-14	type 2 diabetes (MeSH) AND nurse AND intervention AND patient	199	8
PubMed	5 years, Full text, Human, Hogskolani Gavle 2018-6-14	type 2 diabetes (MeSH) AND nurse AND intervention AND glycemic control	29	2
CINAHL	5 years, Full text, Humans, English 2018-06-14	Type 2 diabetes	5270	
CINAHL	5 years, Full text, Humans, English 2018-06-14	Type 2 diabetes AND nurse	187	

CINAHL	5 years, Full text, Humans, English 2018-06-14	Type 2 diabetes AND nurse AND intervention	61	
CINAHL	5 years, Full text, Humans, English 2018-06-14	type 2 diabetes AND nurse AND intervention AND patient	48	0
CINAHL	5 years, Full text, Humans, English 2018-06-14	type 2 diabetes AND nurse AND intervention AND glycemic control	18	0
				Total:10

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### 2.3 Selection criteria

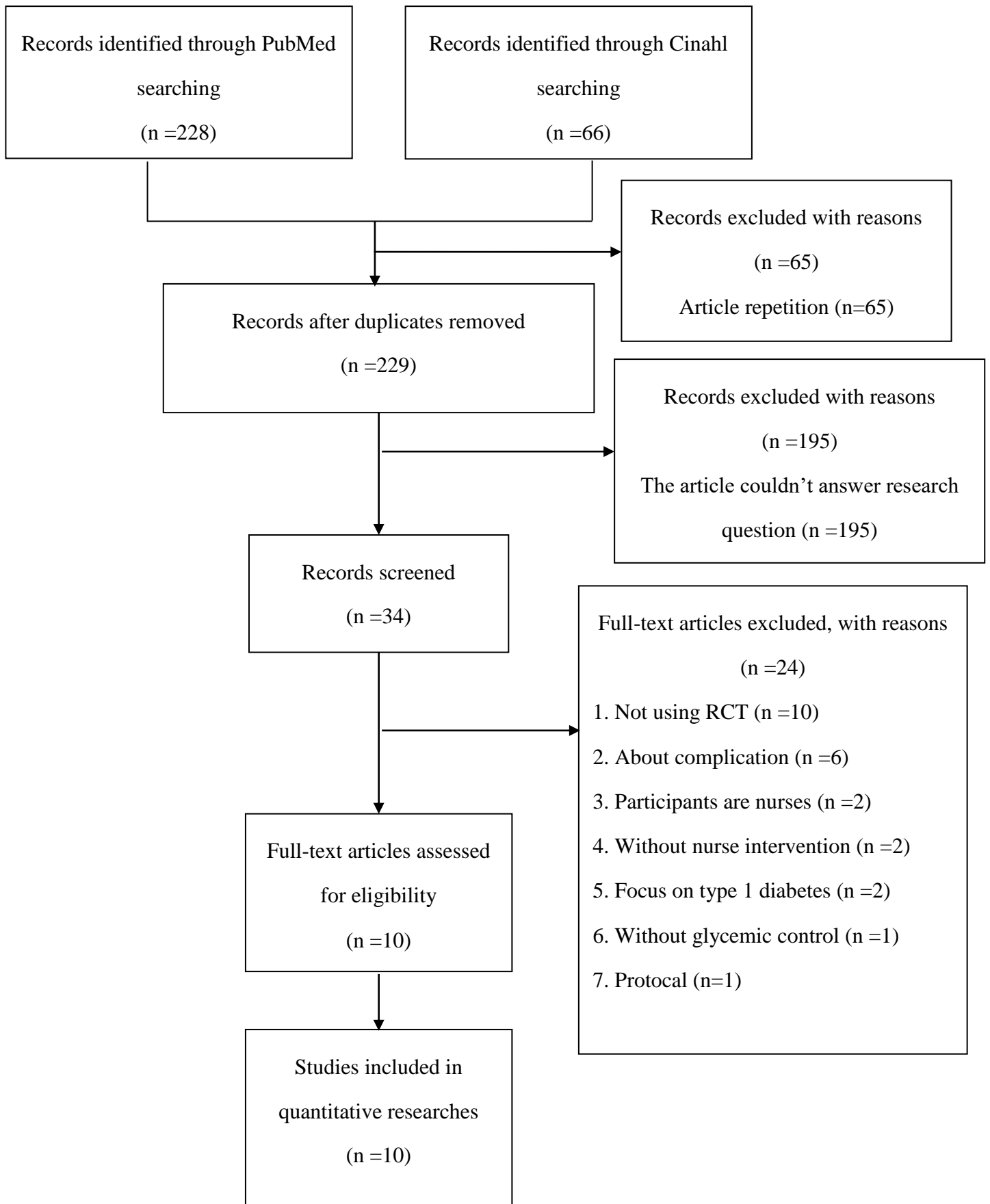
The inclusion criteria were contained: the articles that answer the research question and the articles were quantitative research.

The exclusion criteria in the study were involved: 1. The articles could not answer the research question. 2. The articles were not quantitative studies. 3. The articles that were research patients' social support, complications and psychological problems. 4. The articles that not designed as randomized controlled trials (RCT).

### 2.4 Selection process

The titles and abstracts of the articles were viewed firstly by two researchers. Articles that were related to the research aim and could be used to solve research problem were marked. Articles that were not consistent with included criteria were eliminated. Likewise, articles which conformed to excluded criteria were precluded. Then, these selected articles were read carefully to judge whether relevant to this literature review aim by two researchers and account for every step of the selection process.

After a quick reading, those articles that were matching the excluded criteria were shut out. 10 articles which fully consistent with the aim of this review study were selected. The details of the screening process for these 10 articles were presented in



**Figure 2 Flow chart of the systematic literature search**

## **2.5 Data analysis**

Polit and Beck pointed out that “It's better to use two-dimensional matrices to organize information for traditional narrative reviews of the literature.” because matrices directly support a thematic analysis of the retrieved evidence (Polit & Beck, 2017). Thus, this study was decided to use two matrices to analysis these articles. One table extracted the information about authors, publication year, publication country, title, design, participants, data collection methods and data analysis methods from the articles and another summarized the aim and result of these articles.

Two reviewers read these articles carefully, coded them from A to J, and allocated tasks to completed two matrices averagely. After finished matrices, reviewers exchanged the matrices to check if there were any mistakes.

The description of this review contained details of the selected articles. This included the study characteristics, sample characteristics, interventions and outcomes (Joanna Briggs Institute, 2014). The results that involved nurse intervention of patients with T2D would be presented in a logical, structured way (Joanna Briggs Institute, 2014). The interventions of each article were learned carefully and were divided into broad categories based on similarities and differences in their intervention content and the findings were presented in different categories.

## **2.6 Ethical considerations**

In the process of research, ethical norms were often violated due to insufficient attention to ethical considerations or had ethical dilemma because of the conflict with the research aim (Polit & Beck, 2017). Therefore, compliance with ethics was particularly important. Each selected article had been read carefully and fully understood. The viewpoints of the selected articles were described objectively and accurately. And not tampered with the results of selected articles according to subjective judgment and attitudes. The results would be submitted fully, without changing the author's wishes. At the same time, research misconducts such as



plagiarism, falsification of results or falsification of data were supposed to avoided (Polit & Beck, 2017). Thus, selected articles would be objective, neutral, not plagiarism, not forgery.

### **3 Result**

The result section would be divided into four aspects: intervention, outcomes, study characteristics and sample characteristics. The intervention section described the nursing interventions that articles had used. Finally, the outcomes section focused the variation of HbA1c outcomes cause the impacts of glycemic control are embodied in HbA1c. The study characteristics section briefly introduced the distinctions and traits of 10 selected articles and the sample characteristics section briefly described the samples that these 10 articles chose. Overview of the selected articles was shown in **table 2** (Appendix 1), and the aims and results from the selected articles was shown in **table 3** (Appendix 2).

#### **3.1 Interventions**

Interventions in the selected articles were divided into 4 categories: education, monitoring, assessment and make plan, detailed information can be seen in **table 4**.

##### **3.1.1 Education**

In the aggregate ten selected articles involved education intervention (Anzaldo-Campos et al, 2016; Depue et al, 2013; Furler et al, 2017; Hansen, Perrild, Koefoed, & Zander, 2017; Jutterström, Hörnsten, Sandström, Stenlund & Isaksson, 2016; Mons et al., 2013; Odnoletkova et al., 2016; Tang et al, 2018; Whitehead et al, 2017; Wild et al, 2016). Seven articles (Depue et al, 2013; Furler et al, 2017; Hansen et al, 2017; Jutterström et al, 2016; Mons et al., 2013; Odnoletkova et al., 2016; Whitehead et al., 2017) used session or discussion education. In one article, the frequency of group session with nurse care manager (NCM) was depended by patients' condition, high-risk patients attended a group session once a week, moderate risk patients participated group session once a month, low-risk patients attended a group session every three

months (De Pue et al., 2013). And the patient who didn't attend the group session would meet with the community health workers (CHWs) alone (De Pue et al., 2013). Furler et al. (2017) showed that practice nurse (PN) discussed the advantages and disadvantages of insulin treatment with patients in the intervention group after the general practitioner (GP) examined the patient's diabetes management. In Hansen et al (2017), nurses at the health care center held video session with patients monthly via table. One research showed that diabetes specialist nurses (DSNs) held six group discussion or individual conversation with patients in two intervention groups which depending on the assigned arms (Jutterström et al., 2016). And every meeting had different topic such as opinions of the disease, significance of diagnosis, integration of disease over time, management of time and space for disease in everyday life, future life prospects of living with diseases (Jutterström et al., 2016). In Mons et al. (2013), PNs and GPs gave the patients in intervention group supportive telephone counseling sessions monthly. In Odnoletkova et al. (2016), a qualified diabetes care education worker (coach) held five telephone sessions to help patients identify strategies to narrow the treatment gap which including lifestyle changes and persisting in recommended medications usage. Whitehead et al. (2017) showed education meeting was carried out by two primary health care nurses trained by 2 researchers and the topics included: fundamental pathophysiology of diabetes, understanding of diabetes, glucose and diabetes-related risk factors and complications, food components, portions, diabetes self-management (through diet, activity and drugs) and stress management, and monitoring of diabetes (including hypoglycemia and hyperglycemia). Three articles didn't use session to educate patients (Anzaldo-Campos et al., 2016; Tang et al., 2013; Wild et al., 2016). In one article, nurse provided personal education cooperated with attending doctor (Anzaldo-Campos et al., 2016). Another article showed that the NCMs responds to patients' updated data by giving patients personalized education education nuggets (Tang et al., 2013). In final research, participants were provided recommendations for lifestyle changes, the lag

time for the effects of lifestyle and drug changes on BG and blood pressure (BP) and they were told how to use the monitors of BP, BG and weight (Wild et al., 2016).

### **3.1.2 Monitoring**

There were six articles mentioned monitor participants in intervention group (Anzaldo-Campos et al, 2016; Depue et al, 2013; Hansen et al, 2017; Odnoletkova et al., 2016; Tang et al, 2018; Wild et al, 2016). The monitoring intervention was divided into two types: patient self-monitoring and monitoring led by nurse. There were two articles about monitoring that carried out by nurse (Anzaldo-Campos et al, 2016; Depue et al, 2013). In one article nurse monitored the progress of patient specific clinical or behavioral outcomes by reviewing their clinical history with attending doctor (Anzaldo-Campos et al., 2016). In De Pue et al article, patients' BG and BP were monitored during each session with NCMs and CHWs, and if BG>400 or BP>200/120 mmHg, the emergency levels would immediately refer to the TC doctor at clinical time or in the hospital emergency department (De Pue et al., 2013). There were four articles asked patient to do self-monitoring (Hansen et al, 2017; Odnoletkova et al., 2016; Tang et al, 2018; Wild et al, 2016). In one article, patients uploaded measured value of their BG, BP and weight directly to the flat computer via Bluetooth or USB regularly (Hansen et al., 2017). In Odnoletkova et al. (2016), participants were told by how to self-monitor BG and interpret the results, and were given recommendations for measuring frequency by coach. Tang et al. (2013) showed that patients were able to record online information related to diabetes (like home BP, dietary intake, physical activity, insulin dose, and weight). In Wild et al. (2016), patients were told to monitor their fasting and non-fasting BG at least twice a week, and their BP and weight at least once a week.

### **3.1.3 Assessment**

There were five articles used assessment intervention (De Pue et al., 2013; Mons et al., 2013; Odnoletkova et al., 2016; Tang et al, 2018; Wild et al, 2016). In De Pue et al.

(2013), NCMs and a CHW assessed patient risk profiles which including HbA1c, BP, smoking condition, alcohol consumption, and (phq-9) depression score. Mons et al. (2013) mentioned that GPs and PNs assessed patients' physical and mental condition, medication compliance, medical symptoms (cardiovascular symptoms, lower limb problems and visual impairment), lifestyle (body movement, weight, nutrition) through questionnaires. In Odnoletkova et al article, the coaches analyzed the patient's risk profile based on baseline assessment data (Odnoletkova et al., 2016). In one research NCMs analyzed patients' clinical variables (such as BG, food intake, and drug dose) that participants fed back regularly and timely, and NCMs independently adjusted drugs dose to maintain patients' A1c <7%, blood pressure <130/80 and LDL cholesterol <100 mg/dl (Tang et al., 2013). In the final article, patients in intervention group were assessed their Hba1c, mean daytime BP, weight, smoking history, height, weight, exhaled carbon monoxide, anxiety or depression (by using hospital anxiety and depression scale), quality of life (eq-5d), self-efficacy, drug compliance, body movement, knowledge of diabetes management by research nurse as baseline measurement (Wild et al., 2016). During research, the primary care nurse checked patients' outcomes of BG, BP and weight weekly, and organized the change of treatments according to national guidelines for the management of diabetes and hypertension (Wild et al., 2016).

#### **3.1.4 Make plan**

There were two articles mentioned making plan. In one article the coach prepared a written guidance report that contained a comparison of recommendations and actual outcomes for diabetes risk factors, as well as an agreed action plan to eliminate any arising gap (Odnoletkova et al., 2016). And in another article, the customized action plans for patients that NCM developed with the researchers were at the top of patients' diabetes status report (Tang et al., 2013).

**Table 4. Interventions of the selected articles.**

<b>Authors</b>	<b>Introduction</b>	<b>Education</b>	<b>Monitoring</b>	<b>Assessment</b>	<b>Make plan</b>
Anzaldo-Campos et al., 2016		√	√		
De Pue et al., 2013		√	√	√	
Furler et al., 2017		√			
Hansen et al., 2017		√	√		
Jutterström et al., 2016		√			
Mons et al., 2013		√		√	
Odnoletkova et al., 2016		√	√	√	√
Tang et al., 2013		√	√	√	√
Whitehead et al., 2017		√			
Wild et al., 2016		√	√	√	
total		10	6	5	2

### 3.2 Outcomes

In this review, the effects of glycemic control were limited to HbA1c. Thus, this review only focused outcomes on HbA1c. The articles' aim and results were presented in **table 3**.

#### 3.2.1HbA1c

After compared with baseline and HbA1c data after intervention, there were 9 articles found that HbA1c decreased significantly in the intervention group (IG) after intervention (Anzaldo-Campos et al., 2016, De Pue et al., 2013, Furler et al., 2017, Hansen et al., 2017, Jutterström et al., 2016, Odnoletkova et al., 2016, Tang et al., 2013, Whitehead et al., 2017).

Among them, one article found that at the sixth month, HbA1c in both groups were decreased, and the decrease in the IG was more significant (Tang et al., 2013).

However, when measured again at the 12th month, there was no significant imparities between two groups in HbA1c.

One of the articles set up two IGs. In these two groups, the HbA1c decreased significantly in the education group but there was no significant difference between the education plus ACT group and the control group (Whitehead et al., 2017). And one article was found that HbA1c both in the IG and the control group decreased significantly, but the difference between two groups was not statistically significant (Mons et al., 2013).

### **3.3 Study characteristics**

The detail information of selected studies such as design, participants, data collection methods and data analysis methods were presented in the **table 2**. These 10 selected articles are from 9 different countries. Two studies were carried out in America (Depue et al, 2013; Tang et al, 2018), the other studies were conducted respectively in Mexico (Anzaldo-Campos et al, 2016), Australia (Furler et al, 2017), Denmark (Hansen et al, 2017), Sweden (Jutterström et al, 2016), German (Mons et al., 2013), Belgium (Odnoletkova et al., 2016), New Zealand (Whitehead et al., 2017) and The United Kingdom (Wild et al., 2016). All articles were quantitative studies and designed as randomized controlled trials (RCTs). These studies were published among 2013 to 2017. And the involved participants ranged from 118 (Whitehead et al., 2017) to 574 (Odnoletkova et al., 2016), in the aggregate 2772 participants attended in 10 studies.

### **3.4 Sample characteristics**

All participants of 10 articles received researchers' explains about the content of the intervention, and gave the researchers written informed consent. Most of researchers initially screened eligible patients by using information from medical unit, health center, healthcare organization, hospital clinic department, the practice medical record database or primary care research networks (Anzaldo-Campos et al, 2016; Depue et al, 2013; Furler et al, 2017; Hansen et al, 2017; Jutterström et al, 2016; Tang et al, 2018; Whitehead et al., 2017; Wild et al., 2016). Some participants were recruited during

regular practice visits (Mons et al., 2013). Some researchers were selected patients based on their glucose-lowering medication consumption (Odnoletkova et al., 2016). There were 7 articles limited HbA1c concentration in inclusion criteria (Anzaldo-Campos et al, 2016; Furler et al, 2017; Hansen et al, 2017; Mons et al., 2013; Tang et al., 2013; Whitehead et al., 2017; Wild et al., 2016). In one article limited HbA1c > 8% (Anzaldo-Campos et al, 2016), 2 articles limited HbA1c  $\geq$  7.5% (Fuler et al, 2017; Tang et al, 2018), three articles limited HbA1c  $\geq$  7.5% (Hansen et al, 2017; Mons et al., 2013; Wild et al., 2016), and one article limited HbA1c > 7% (Whitehead et al., 2017). Participants who were suffering from cancer or serious medical conditions, had mental illness or pregnancy, planned pregnancy or breastfeeding would be excluded. In most of these studies, participants' language skills were required. In one article asked participants able to read (Anzaldo-Campos et al, 2016), five articles required participants have a certain level of reading and understanding of the local language (Hansen et al, 2017; Jutterström et al, 2016; Mons et al., 2013; Odnoletkova et al., 2016; Tang et al, 2018), one article exclude non-native English speakers (Whitehead et al., 2017). The gender distribution of each study was different, the proportion of male in the overall sample ranged from 33.2% to 64.2% (Anzaldo-Campos et al, 2016; Hansen et al, 2017).

## **4 Discussion**

### **4.1 Main results**

The review sums up recently 5 years articles about nursing interventions in glucose control among patients with T2D during nurses' working environment. The results section showed nurses' interventions could be divided into four aspects: education, monitoring, assessment and make plan. This review showed these nurses' interventions had remarkable impacts in BG control which could reflected in patients' reducing HbA1c. However, the further research still needed in glucose control among patients with T2D.

## **4.2 Results discussion**

### **4.2.1 Education**

A total of 10 studies involved education intervention (Anzaldo-Campos et al., 2016; De Pue et al., 2013; Furler et al., 2017; Hansen et al., 2017; Jutterström et al., 2016; Mons et al., 2013; Odnoletkova et al., 2016; Tang et al., 2013; Whitehead et al., 2017; Wild et al., 2016). It could be seen that education intervention was important for nurses to control patients' glycemic control. Education intervention was the core of glycemic control, many multidimensional or multidisciplinary interventions were based on education. There was a guideline shown that: in clinical care, educational intervention was the core content of glycemic control in patients with T2D which was structured, evidence-based and theory-driven (Sibal & Home, 2009). It was consistent with our result.

There were 9 articles' result showed that education intervention was effective for glycemic control in patients with T2D (Anzaldo-Campos et al., 2016; De Pue et al., 2013; Furler et al., 2017; Hansen et al., 2017; Jutterström et al., 2016; Odnoletkova et al., 2016; Tang et al., 2013; Whitehead et al., 2017; Wild et al., 2016). Education in various forms such as individual education, multidimensional education, DVD or video education showed that health education could be implemented in such different approaches, not just in traditional face-to-face education. As a way for nurses to interact with patients, health education not only provided patients with health-related information, but also built a trust relationship between nurses and patients, so as to promoted the development of healthy behaviors to a good health outcome. It was in the line with the Cox's theory. In some studies, such as Torres and his colleagues' diabetes educational program could effectively improve the glycemic control of participants in the intervention group (Torres et al, 2018). In Zhang and Chu's study, Systematic Health Education Model could improve HbA1c and was an effective intervention to treat T2D (Zhang & Chu, 2018). All of these researchers' studies support this review's results about education intervention.



In the meantime, Znan and Chu pointed out that due to the under-resourced of T2D health education, professionals should provide other resources to make education interventions more effective, such as face-to-face education, pamphlets and videos (Zhang & Chu, 2018). This is consistent with our opinions above.

The outcome of one article had no statistical significance (Mons et al., 2013). The reason might be that the main purpose of the session was to find out potential problems of patients through telephone communication; patients in the IG of this research only accepted a 10-minute teleconference consultation once a month, the session was not frequently enough, the time of each session was too short. Only when the patients were judged to have potential problems, nurses would report patients' condition to the doctors and patients themselves, then patients accepted treatments if necessary. Thus in IG, there were 7 patients never accept intervention. Also, the research didn't combine with other interventions other than assessment. Although patients were satisfied with teleconferencing and their quality of life improved, the improvement in HbA1c was not significantly different from that in the control group. Cox once pointed out that Professionals needed to provide health information to clients through appropriate channels to ensure that this information was fully understood and utilized by clients (Li et al, 2015). One research also found that only use mobile interventions couldn't significantly reduce HbA1c levels (Toma, Athanasiou, Harling, Darzi & Ashrafian, 2014). But it was not enough to deny the innovation and future potential of telephone intervention. Although there was one study showed that mobile intervention had no effect on glycemic control (Mons et al., 2013), mobile devices still have great potential for education intervention because of their convenience and flexibility (Zhang & Chu, 2018; Shen et al., 2018).

#### **4.2.2 Monitoring**

Six studies which related with monitoring all showed that the monitoring was helpful to control the BG of patients with T2D (Anzaldo-Campos et al., 2016; De Pue et al., 2013; Hansen et al., 2017; Odnoletkova et al., 2016; Tang et al., 2013; Wild et al.,

2016). In addition to requiring patients to measure their own BG, some researchers also provided testing equipment and required patients to upload data (Anzaldo-Campos et al., 2016; Hansen et al., 2017; Tang et al., 2013; Wild et al., 2016). The data could reflect the effect of glycemic control in the most intuitive way. The changes of data could help nurses to observe the treatment effect, and also could hasten patients to in cooperation with the treatment actively. These interventions enhanced patients' compliance, helped nurses and patients to know about glycemic control timely through self-monitoring of BG, thus promoting the realization of optimal health outcomes.

Monitoring intervention could help nurses to monitor patients' glycemic control, increased the interaction between nurses and patients, which was conducive to improving patients' compliance, so as to prompted patients to give feedback on time and developed towards a health outcome. This was similar to Lee, Greenfield and Pappas' research. which also proved that telehealth remoted patient monitoring was effective on glycemic control in T2D (Lee, Greenfield & Pappas, 2018). Havele and his colleagues' research showed the importance of monitoring from a doctor's point of view: although some doctors object to self-monitoring of BG, most doctors still recommend regular monitoring because they believed it drived lifestyle changes that improved glycemic control (Havele et al., 2018).

Research by Cameron and his colleagues showed that monitoring was not an independent process, but took place in a series of complex external and internal structures (Cameron, Harris & Evans, 2018). Also, according to cox's nursing theory, patients might on account of intrinsic motivation (e.g. thought glucometers are too expensive), affective response (e.g., resistance to self-monitoring of BG due to pain) to affected patients' health behavior such as ignoring the importance of self-testing BG (Li et al, 2015). Therefore, monitoring could not only observe the effect of intervention directly, but also helped patients to change their lifestyle and took the initiative to control blood glucose.

#### **4.2.3 Assessment**

Of the five articles which involved in the assessment (De Pue et al., 2013; Mons et al., 2013; Odnoletkova et al., 2016; Tang et al., 2013; Wild et al., 2016), four articles had statistically significant results (De Pue et al., 2013; Odnoletkova et al., 2016; Tang et al., 2013; Wild et al., 2016). One article had no statistically significant (Mons et al., 2013) which focused on potential problems that might compromise the success of diabetes therapy. Only when nurses found problems, doctors would get report from nurses.

It could be seen that the intervention of nursing assessment was effective to some extent, but the assessment results should be reported to the patient or doctor timely, so as to facilitate the adjustment of the glycemic control therapy, or combined assessment with other interventions to achieve the goal of glycemic control.

Health indicator was one of the 5 factors of health outcome (Li et al, 2015). Nurse could understand the patient's BG control situation in stages by assessment. In order to achieve better control of BG, nurses could feedback the assessment results to doctors and other professionals and modified the treatment project. Thus, assessment played a supplementary role in the entire treatment program, so it couldn't be considered ineffective if the study results were not statistically significant.

In Zhang and Chu's study, similar intervention was used to assessment the effectiveness of the treatment program, and the program was modified according to the evaluation effect to improve the dietary habits of the patients. The results showed that their intervention could effectively control blood glucose (Zhang & Chu, 2018).

#### **4.2.4 Make plan**

Two articles related with making plan (Odnoletkova et al., 2016; Tang et al., 2013). Although making plan was only one part of interventions, but the plan was based on patients' personally situation, which was an indispensable part of the program. It was necessary for nurses to make personalized plans according to patients' own conditions. Cox pointed out that interventions based on the client singularity were effective in

promoting healthy outcomes (Li et al, 2015). And Odnoletkova et al. (2016) showed that rational planning and efficient monitoring could be useful to control patients' BG effectively and promote the health education of T2D. Chiu and his colleagues also pointed out that only by following a well-structured care plan could BG be strictly controlled to improve the prognosis of diabetics (Chiu et al., 2009).

### **4.3 Methods discussion**

This study was a review study, as Polit and Beck indicated that a research review showed readers impersonal, organized and comprehensive evidence on a subject and its core task was revelation present state of knowledge from summarizing and critically evaluating the whole evidence (Polit & Beck, 2017). And Polit and Beck mentioned that literature review had no bias, that was one saving grace of literature review (Polit & Beck, 2017). Articles searching came from PubMed and CINAHL via the library of University of Gävle. It was an advantage of this review study cause PubMed and CINAHL have wide and abundant articles. As Polit and Beck mentioned, CINAHL and MEDLINE covered almost all English articles in nursing and health related journals, and MEDLINE database could be freely browsed through PubMed (Polit & Beck, 2017).

Articles were searched by combining different search terms with AND. And for search terms, MeSH was used to avoid any article omission since Polit and Beck said that MeSH offered a coincident way to search same concept using different words (Polit & Beck, 2017).

In article selection process, the limitations of articles' language and publishing years could result in articles omission. Because some significant articles that published earlier or published in other languages would be missed. Therefore, some nursing interventions would be missed and the number of articles this study selected also led to the inadequate of nursing intervention coverage in this review study. But in other side, limiting publishing year in 5 years could make sure that all interventions in

selected articles were up to date. Another strength of this study was all articles using randomized controlled trials (RCTs) design which aim to reduce bias when testing a new treatment and often considered the gold standard for a clinical trial (Polit & Beck, 2017). And RCTs were well adapted to arrive at conclusions about the effectiveness of health care interventions (Polit & Beck, 2017). Based on evidence sources, RCTs provide compelling evidences for the reason that the RCTs can minimize allocation bias, balancing known and unknown prognostic factors in treatment allocation which made it near the top of the evidence hierarchies rank (Polit & Beck, 2017; Schulz & Grimes, 2002). And due to the use of randomly assigned samples, the basic conditions of two or more groups were relatively consistent, so there was good comparability. However, the results of RCT researches were all from qualified research objects, as a result there was a certain limitation when extrapolating to the general population and only selected RCT designed quantitative articles could lead to articles omission and insufficient coverage of this review study. Furthermore, the selected articles only came from 9 countries, as a result this study couldn't represent the general population.

#### **4.4 Clinical implications**

This review study inspired clinical practice that the chronic care model should be continue adopted in low-resource settings. And the results of selected articles showed that Nurse-led telecoaching, supportive telephone counseling and telemonitoring can effectively help patients with type 2 diabetes enhance their glucose control. There was lots of strength evidence supported that HbA1c can be improved among patients with T2D through remotely monitoring BG and some more intensive telephone interventions (Hanlon et al., 2017). Smart phones sales started to grow rapidly by the late 2000s. Statista reported that about 60 percent of mobile phone user were smart phone user in 2018 and the number of smart phone users in China reached 482.7 million, and it would increase to about 690 million in 2019 (Statista, 2017). Thus, it could be seen the usage of applications in smart phones to educate and supervise

patients to manage their BG. For example, regular morning notifications from mobile phone software could remind patients to measure their fasting BG and record it which would be checked by their charge doctors and nurses. Nurse could make personalized plan both diet and activities for each patient to control their BG according to the outcomes from phone application. What's more, nurses could use application to inform patients the exact time of each session which was designed to educate patients and give patients chances to share their own experience of glucose control. If these interventions could be coordinated in clinical practice, glucose control would be more convenient and easier.

#### **4.5 Suggestions for future research**

One suggestion for future studies is to take long term intervention which may last for several years even decades on account of the effectiveness of nursing interventions in this review didn't last long. Besides this review study showed that 12 months after interventions there were no significant difference between IGs and CGs in glucose control. Another suggestion for future studies is that emphasis can be put on nursing interventions for patient who have poor glucose control and cardiovascular disease which is one serious complication of diabetes. As WHO had reported that cardiovascular disease caused about 31% deaths worldwide much more than other disease (WHO, 2017). what's more, the methods and frequency of education intervention in each article was different, as well as the standards for training that the nurses carried out in the intervention. Therefore, it still needs to be discussed which education intervention method is most suitable for blood glucose control among patients with type 2 diabetes. Just as one research said that the most suitable frequency and duration of telephone sessions for achieving T2D treatment goals still not clear (Suwita, Friska, Widjaja & Srisawitri, 2017). Furthermore, future studies are supposed to verify whether these interventions that selected in this review can get same result in larger sized sample and whether these interventions are applicable to

different income countries. As Polit & Beck (2017) mentioned that if the sample size is small, the risk of unequal population will be high, and with the increase of the sample size, the possibility of unequal population will be decreased.

## **5 Conclusion**

Glucose control plays an important role in T2D disease control. And for glucose control, nursing intervention plays a significant part to help patients with T2D to maintain their BG. This review study summarized 4 aspects nursing intervention (education, monitoring, assessment and make plan) from the selected articles that impact patients with type 2 diabetes in glycemic control. Currently, intervention for glucose control among patients with T2D is mostly multi-disciplinary and multi-team. Therefore, nurses need to cooperate with other professionals so as to improve the treatment program in achieving better control of patients' BG.

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## Appendix 1

**Table 2. Overview of the selected articles.**

Author(s) (Name, year and country)	Title	Design (possibly approach)	Participants (sampling method, No., age, gender, inclusion/exclusion criteria)	Data collection method(s)	Data analysis method(s)	Code
Anzaldo- Campos, M. C. Contreras, S. Vargas- Ojeda, A. Menchaca- Díaz, R. Fortmann, A. Philis- Tsimikas, A. Year of publication: 2016 Country: Mexico	Dulce Wireless Tijuana: A Randomized Control Trial Evaluating the Impact of Project Dulce and Short- Term Mobile Technology on Glycemic Control in a Family Medicine Clinic in Northern Mexico	Open-label randomized controlled trial	Sampling method: purposive sampling Number: 301 Age: 18-75 years Gender: Male: 100 (33.2%) Female: 201 (66.8%) Inclusion criteria: Diagnosis of type 2 diabetes, HbA1c $\geq$ 8% ( $\geq$ 64mmol/mol), no current insulin use, active IMSS health coverage, able to read. Exclusion criteria: Patients with severe medical or psychiatric conditions and who were unable to visit the clinic.	1) Laboratory assays were processed by the regional laboratory of the IMSS at Hospital #1 in Tijuana, according to standardized procedures HbA1c concentration was measured by a turbidimetric immunoinhibition method 2) Spanish Diabetes Self- Efficacy Patient Health Questionnaire (PHQ-9) Instrument to Measure Lifestyle of Type 2 Diabetes Mellitus Patients (IMEVID) Diabetes 39 Diabetes Knowledge Questionnaire 24 (DKQ24) 3) Age, gender, education, marital status, hypertension	1) Descriptive and graphical analyses, 2) Multilevel model, 3) Multilevel analysis, 4) analyses of covariance, 5) linear regression, 6) hierarchical linear modeling.	A

De Pue, J. D. Dunsiger, S. Seiden, A. D. Blume, P. Rosen, R. K. Goldstein, M. G. Nu'Usolia, O. Tuitele, J. Mcgarvey, S. T. Year of publication: 2013 Country: America	Nurse– Community Health Worker Team Improves Diabetes Care in American Samoa	Randomized controlled trial	Sampling method: purposive sampling Number: 268 Age: $\geq 18$ years ( $55 \pm 12.7$ ) years Gender: Male: 102 (38.0%) Female: 166 (62.0%) Inclusion criteria: Resident in service area; self-identify as Samoan; physician diagnosis of type 2 diabetes; mentally competent and able to consent; unlikely to leave AS for 4 months; and no serious comorbid conditions (e.g., end- stage renal disease, cancer). Exclusion criteria: This article has no clear exclusion criteria.	diagnosis, and previous hospitalizations 1) Glycemic control was measured as HbA1c to reflect BG over a 3-month period, using DCA 2000+ analyzer. 2) Three measurements of sitting systolic BP and diastolic BP were taken using standard American Heart Association protocol and they were averaged. Height, weight, and waist circumference were measured following standard methods. 3) Self-reports of previous doctor visits and presence of comorbid conditions during the year before baseline. 4) Samoan food frequency questionnaire Hill-Bone High Blood Pressure Therapy Scale Adapted measure of diabetes beliefs (subscales: perceived diabetes control, benefits of diabetes control) Patient Activation Measure 5) Physical activity was measured using the World	1) graphical methods, 2) descriptive analyses 3) nonparametric tests, and parametric tests (e.g., Wilcoxon rank-sum test, $t$ tests, $\chi^2$ tests), 4) mixed-effects longitudinal regression model 5) likelihood-based approach	B
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Furler, J. O'Neal, D. Speight, J. Manski- Nankervis, J. A. Gorelik, A. Holmes- Truscott, E. Ginnivan, L. Young, D. Best, J. Patterson, E. Liew, D. Segal, L. May, C. Blackberry, I. Year of publication: 2017 Country: Australia	Supporting insulin initiation in type 2 diabetes in primary care: results of the Stepping Up pragmatic cluster randomized controlled clinical trial	Two arm, non-blinded cluster randomized controlled trial	Sampling method: purposive sampling Number: 266 Age:18-80 years Gender: Male:121(61.3%) Female:103(38.7%) Inclusion criteria Adults with type 2 diabetes with above target HbA1c ( $\geq 7.5\%$ (58 mmol/mol)) in the past six months who were already prescribed maximum oral treatment (at least two oral hypoglycemia agents at maximum doses) or if their GP judged that insulin would be clinically appropriate. Exclusion criteria: patients were aged more than 80 years, were already using insulin, had an estimated glomerular	Health Organization STEPS interview items.	1) Descriptive statistics, 2) marginal logistic modelling, 3) Mixed effects linear regression, 4) <i>t</i> test, 5) Wilcoxon ranked sum test	C
				1) Researchers retrieved data of HbA1C from medical records or directly from pathology laboratories. 2) Nine item patient health questionnaires (PHQ-9) 3) Problem areas in diabetes scale (PAID) 4) Assessment of quality of life instrument (AQoL-8D) 5) Data on healthcare utilizations and costs		



			<p>filtration rate&lt;30 mL/min/1.73m<sup>2</sup>, were unable to give informed consent, or had a complex debilitating medical condition, such as severe mental illness, end stage cancer, or unstable cardiovascular disease.</p>			
<p>Hansen, C. R. Perrild, H. Koefoed, B. G. Zander, M. Year of publication: 2017 Country: Denmark</p>	<p>Video consultations as add-on to standard care among patients with type 2 diabetes not responding to standard regimens: A randomized controlled trial</p>	<p>Randomized controlled trial</p>	<p>Sampling method: purposive sampling Number: 165 Age: 30-75 years Gender: Male:106(64.2%) Female:59(35.8%) Inclusion criteria: Danish speaking inhabitants of the City of Copenhagen with T2D and a history of participation in a diabetes management program at least six months prior to inclusion HbA1c &gt;7.5% (59 mmol/mol), body</p>	<p>1) Assessed changes between HbA1c from baseline to 8 months. 2) Blood pressure, lipid levels, BMI, waist/hip ratio 3) Modified version of the Short Form 36, version 1 (SF-36) questionnaire 4) Diabetes-related hospital admissions. 5) Assessed changes in insulin doses and the fraction of patients treated with insulin.</p>	<p>1) Descriptive statistics, 2) ANOVA, 3) normality tests, 4) paired <i>T</i>-tests, 5) unpaired <i>T</i>-test, 6) QQ test, 7) mixed models, 8) Chi-square test 9) two-way ANOVA</p>	<p>D</p>

			mass index (BMI) >25 kg/m <sup>2</sup> Exclusion criteria: terminal disease with an expected lifespan of <6 months or need of an interpreter.		
Jutterström, L. Hörnsten Sandström, H. Stenlund, H. Isaksson, U. Year of publication: 2016 Country: Sweden	Nurse-led patient-centered self-management support improves HbA1c in patients with type 2 diabetes—A randomized study	Randomized controlled trial	Sampling method: purposive sampling Number: 182 Age: 40-80 years Gender: Male:114(62.6%) Female:68(37.4%) Inclusion criteria: Diagnosed with T2D within three years, Swedish speaking, and no diagnosed cognitive impairment or other severe illnesses. They had not received patient education other than information given to newly diagnosed T2D patients. Exclusion criteria: This article has no clear exclusion	1) HbA1c was measured with a standardized method by two local laboratories. 2) Standard clinical laboratory methods were used for total serum cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides. 3) Height, weight, blood pressure and waist circumference. 4) The medical records for laboratory data were annually reviewed in order to document the participants' laboratory data.	1) descriptive statistics, 2) one-way ANOVA, 3) Chi-square test, (4) Fisher's exact test, 5) random intercept mixed model, 6) ANCOVA, 7) <i>t</i> -test, 8) Eta-square test

E

Mons, U. Raum, E. Krämer, H. U. Rüter, G. Rothenbacher, D. Rosemann, T. Szecsenyi, J. Brenner, H. Year of publication: 2013 Country: German	Effectiveness of a Supportive Telephone Counseling Intervention in Type 2 Diabetes Patients: Randomized Controlled Study	Randomized controlled trial	criteria. Sampling method: purposive sampling Number: 204 Age: over 18 years Gender: Male:125(61.3%) Female:79(38.7%) Inclusion criteria: Adult patients with diagnosed type 2 diabetes mellitus. Have knowledge of the German language HbA1C>7.5% (equating 58.47 mmol/l) Exclusion criteria: patients were living in a nursing home, insufficient knowledge of the German language, and visiting the GP for palliative or emergency care only.	1) Participants' blood samples were sent to the contracted central laboratory which determined HbA1c-concentrations using ion exchange high pressure liquid chromatography (G8, Tosoh Biosciences). 2) Patient's age of first clinical diagnosis of type 2 diabetes mellitus, Lipid levels and blood pressure 3) Short Form General Health Survey (SF-12). 4) Geriatric Depression Scale (GDS) in the 15-item version. 5) Information on the sociodemographic background	1)Descriptive statistics, 2) Chi-square tests, 3)Shapiro-Wilk-test, 4)t-test, 5)Mann-Whitney U-test, 6)multivariate analysis, 7)hierarchical linear models, 8) Separate models	F
Odnoletkova, I. Goderis, G.	Optimizing diabetes control in people with Type	Parallel-group, randomized	Sampling method: purposive sampling Number: 574	1) The primary outcome was change in HbA1c level from baseline to 6 months after	1) Descriptivestatistics, 2) general linear model with an	G

Nobels, F. Fieuws, S. Aertgeerts, B. Annemans, L. Ramaekers, D. Year of publication: 2016 Country: Belgium	2 diabetes through nurse-led telecoaching	controlled trial	Age: 18-75 years Gender: Male:353(61.5%) Female:221(38.5%) Inclusion criteria: Adults with type 2 diabetes, who were receiving glucose lowering oral and/or injectable therapy. Exclusion criteria: patients who were receiving corticoid therapy and/or a debilitating coexisting medical condition, such as dialysis, mental illness or cancer; residence in long-term care facilities; pregnancy; and insufficient proficiency in Dutch.	randomization. 2) The secondary outcomes were: change in HbA1c from baseline to 18 months; change in total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, blood pressure, BMI and smoking status; change in proportion of people on target for the composite of the following four risk factors HbA1c, LDL cholesterol, systolic and diastolic blood pressure, and for selfperceived health status; diabetes-specific emotional distress; and satisfaction with diabetes care 3) Change in the annual healthcare utilisation compared with the year preceding the date of the randomization was explored, in particular the number of visits to the doctor. 4) The trial data were collected during the home assessment visits by nurses. 5) The blood samples were analyzed in a single laboratory. 6) Information on the annual healthcare utilization was	unstructured covariance matrix, 3) sensitivity analysis, 4) logistic regression model, 5) Mann-Whitney <i>U</i> -tests, 6) Fishers' exact tests
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Tang, P. C. Overhage, J. M. Chan, A. S. Brown, N. L. Aghighi, B. Entwistle, M. P. Hui, S. L. Hyde, S. M. Klieman, L. H. Mitchell, C. J. Perkins, A. J. Qureshi, L. S. Walimyer, T. A. Winters, L. J. Young, C. Y. Year of publication: 2013	Online disease management of diabetes: Engaging and motivating patients online with enhanced resources-diabetes (EMPOWER-D), a randomized controlled trial	Two-arm randomized controlled trial	Sampling method: purposive sampling Number: 415 Age: $\geq 18$ years Gender: Male: 249(60.0%) Female: 166(40.0%) Inclusion criteria: Diagnosis of T2D HbA1C $\geq 7.5\%$ Patient seen from March 2008 through December 2009 Exclusion criteria: (1) Initial diagnosis of type 2 diabetes mellitus within the last 12 months (2) Inability to speak or read English (3) Lack of regular internet access with email capabilities (4) Unwillingness to perform any self-monitoring at home, including blood glucose	extracted from the health insurance fund database. 1) Glucose control was reflected by A1C measurement. 2) Through clinical measurements to collect data about blood pressure, LDL cholesterol, 10-year Framingham cardiovascular risk, satisfaction, psychosocial well-being. 3) Healthcare utilization of all participants 4) Diabetes Knowledge Test 5) Problem Areas in Diabetes—measures diabetes-related stress in response to 20 common situations 6) Patient Health Questionnaire (PHQ-9) 7) Diabetes Treatment Satisfaction Questionnaire (DTSQ) 8) CAHPS Clinician and Group Survey assessed patient experience in access to care, clinician communication, shared decision making, and cost of care.	1) Descriptive statistics, 2) sensitivity analysis, 3) t tests, 4) $\chi^2$ tests, 5) mixed-effects regression models, 6) analysis of variance, 7) Kruskal-Wallis test 8) intention-to-treat analysis	H
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Country:  
America

(5) Diagnosis of a terminal illness and/or entry into hospice care

(6) Pregnancy, planning a pregnancy, or currently lactating

(7) Current enrollment in a care management program at PAMF or elsewhere

(8) Family household member enrolled in EMPOWER-D study

(9) Resident of a long-term care facility

(10) Plans to discontinue primary care at PAMF during the study period

(11) Uninsured

Whitehead, L. C.  
Crowe, M. T.  
Carter, J. D.  
Maskill, V. R.  
Carlyle, D.

A nurse-led education and cognitive behavior therapy-based intervention among adults with uncontrolled type 2 diabetes: A

Three-arm parallel group, randomized controlled trial

Sampling method: purposive sampling  
Number: 118  
Age:  $\geq 18$  years  
Gender:  
Male: 63(53.4%)  
Female: 55(46.6%)  
Inclusion criteria:

1) HbA1c was analyzed by a local medical laboratory.  
2) Acceptance and Action Diabetes Questionnaire (AADQ)  
3) Hospital Anxiety and Depression Scale (HADS).  
4) A subscale of the Diabetes

1) Standard descriptive statistics,  
2) analysis of covariance (ANCOVA)

I

Bugge, C. Frampton, C. M.A. Year of publication: 2017 Country: New Zealand	randomized controlled trial		<p>Clinical diagnosis of type 2 diabetes for 12 months or more and persistent, suboptimal glycemic control. This was defined as HbA1c &gt;7%, 53 mmol/mol in the past 12 18 months, with at least 2 records of HbA1c &gt;7%, 53 mmol/mol, during this period and HbA1c &gt;7%, 53 mmol/mol on recruitment.</p> <p>Exclusion criteria: Patients were non-English speaking, pregnancy, short-term or serious medical conditions, and currently in psychotherapy or participation in a diabetes education programme in the past 12 months.</p>	<p>Care Profile</p> <p>5) Diabetes Treatment Satisfaction Questionnaire (DTSQ)</p> <p>6) Summary of diabetes self-care activities measure</p>		
Wild, S. H. Hanley, J. Lewis, S. C. McKnight, J.	Supported Telemonitoring and Glycemic Control in People	Randomized, parallel, investigator- blind,	<p>Sampling method: purposive sampling</p> <p>Number: 321</p> <p>Age: &gt; 17 years</p>	<p>1) Baseline measurements included HbA1c, blood pressure (BP), smoking history, height and weight, exhaled</p>	<p>1)Descriptive statistics 2) complete case analysis, 3) linear</p>	J

<p>A. McCloughan, L. B. Padfield, P. L. Parker, R. A. Paterson, M. Pinnock, H. Sheikh, A. McKinstry, B.</p> <p>Year of publication: 2016</p> <p>Country: The United Kingdom</p>	<p>with Type 2 Diabetes: The Telescot Diabetes Pragmatic Multicenter Randomized Controlled Trial</p>	<p>controlled trial</p>	<p>Gender:</p> <p>Male: 214(66.7%)</p> <p>Female: 107(33.3%)</p> <p>Inclusion criteria:</p> <p>Diagnosis of type 2 diabetes managed in family practice, availability of a mobile telephone signal at home, and poor glycemic control, defined as HbA1c &gt;58 mmol/mol.</p> <p>Exclusion criteria:</p> <p>Blood pressure &gt;210/135 mmHg, hypertension or renal disease managed in secondary care, treatment for a cardiac event or other life-threatening illness within the previous 6 mo, major surgery within the last 3 mo, atrial fibrillation unless successfully treated or cardioverted, inability to use self-monitoring</p>	<p>carbon monoxide, questionnaire data on anxiety/depression, quality of life (EQ-5D), self-efficacy, medication adherence, physical activity, knowledge of managing diabetes, and ethnic group based on categories included in the 2011 UK Census.</p> <p>2) The follow-up appointment included similar measurements and questionnaires to those performed at baseline.</p> <p>3) Number of telephone/email contacts with practice nurses and GPs were also compared between groups as pre-specified additional outcome measures.</p> <p>4) Use of health care resources and adverse events were extracted from participants electronic family practice records by research nurses.</p>	<p>regression, 4) analysis of covariance, 5) correlation analysis, 6) sensitivity analyses, 7) multiple imputation analysis, 8) similar linear regression methods 9) subgroup analyses, 10) logistic regression 11) intention-to-treat analysis</p>
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equipment, and  
pregnancy.

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## Appendix 2

**Table 3. The aims and results from the selected articles.**

<b>Authors (Name, year and country)</b>	<b>aims</b>	<b>Results</b>	<b>Code</b>
Anzaldo-Campos, M. C. Contreras, S. Vargas-Ojeda, A. Menchaca-Díaz, R. Fortmann, A. Philis-Tsimikas, A. Year of publication: 2016 Country: Mexico	This study proposed to adapt and evaluate the Project Dulce program, with and without mobile technology, for patients with type 2 diabetes mellitus from a medical family unit in the United States Mexican border region of Tijuana, Mexico.	The decrease of HbA1c in PD- TE and PD from baseline to the 10th month was significantly higher than CG ( $p = 0.009$ and $p = 0.001$ ). There was no statistically significant difference between PD and pd-te on these indicators ( $p = 0.54$ and $p = 0.86$ ).	A
De Pue, J. D. Dunsiger, S. Seiden, A. D. Blume, P. Rosen, R. K. Goldstein, M. G. Nu'Usolia, O. Tuitele, J. Mcgarvey, S. T. Year of publication: 2013 Country: America	To evaluate the effectiveness of a culturally adapted, primary care-based nurse-community health worker (CHW) team intervention to support diabetes self-management on diabetes control and other biologic measures.	At 12 months, CHW team have more significant decrease in participants' mean HbA1c than the CG ( $p = 0.03$ ). After controlling for confound factors, there are at least 0.5% of HbA1c clinically significantly improved in the CHW group which was twice as much as the CG ( $p = 0.05$ ).	B

<p>Furler, J. O’Neal, D. Speight, J. Manski-Nankervis, J. A. Gorelik, A. Holmes-Truscott, E. Ginnivan, L. Young, D. Best, J. Patterson, E. Liew, D. Segal, L. May, C. Blackberry, I. Year of publication: 2017 Country: Australia</p>	<p>To compare the effectiveness of a novel model of care (“Stepping Up”) with usual primary care in normalising insulin initiation for T2D, leading to improved glycated haemoglobin (HbA1c) levels</p>	<p>HbA1c was improved in both the intervention group and the CG, and the effect of the intervention group was better. (<math>p = 0.02</math>) There were no severe hypoglycemia events were reported.</p>	C
<p>Hansen, C. R. Perrild, H. Koefoed, B. G. Zander, M. Year of publication: 2017 Country: Denmark</p>	<p>To determine whether monthly video consultations with a nurse preceded by regular measurements of blood sugar, blood pressure and weight uploaded to a common database in addition to clinic-based care could improve the glycemic regulation of patients with poorly regulated T2D, who had previously attended a disease management program. Moreover, to determine if a given effect would last after intervention.</p>	<p>At 8 months, HbA1c decreased in both the intervention group and the CG, and the intervention group decreased significantly (<math>p &lt; 0.000001, p = 0.022</math>). At 6-month follow-up, there was no statistically significant change in HbA1c in the intervention group.</p>	D
<p>Jutterström, L. Hörnsten</p>	<p>To evaluate the effect of a patient-centered self-management support, in T2D with</p>	<p>At 12-month follow-up, HbA1c was decreased significantly both in the group</p>	E

Sandström, H.  
 Stenlund, H.  
 Isaksson, U.  
 Year of publication:  
 2016  
 Country: Sweden

regard to metabolic changes.

intervention and individual intervention ( $p < 0.001$ ,  $p = 0.004$ ). HbA1c was close to baseline in the internal control group and it was increased in the external control (EC) group without clinical significance. After adjusted the HbA1c difference at baseline, there were significant differences between the intervention group and EC-group.

Mons, U.  
 Raum, E.  
 Krämer, H. U.  
 Rüter, G.  
 Rothenbacher, D.  
 Rosemann, T.  
 Szecsenyi, J.  
 Brenner, H.  
 Year of publication:  
 2013

To investigate whether a patient-centered intervention comprising monthly supportive telephone-based counseling sessions by practice nurses in a general practice setting improves diabetes-related medical and psycho-social outcomes above usual care in type 2 diabetes mellitus patients with poor glycemic control at baseline, who are at increased risk for many diabetes-associated complications.

During the 12-month follow-up measurement, HbA1c in both the intervention group and the usual care group decreased from baseline significantly, but it was not significant between two group.

F

Country: German  
 Odnoletkova, I.  
 Goderis, G.  
 Nobels, F.  
 Fieuws, S.  
 Aertgeerts, B.  
 Annemans, L.  
 Ramaekers, D.  
 Year of publication:  
 2016  
 Country: Belgium

To investigate the effect of the COACH programme on HbA1c and other modifiable diabetes risk factors in people with Type 2 diabetes in a primary care setting in Belgium compared with usual care.

At 6 months, the mean (SD) HbA1c level in the intervention group decreased, while the control group remained unchanged. Intergroup differences on HbA1c was -2 mmol/mol ( $p = 0.003$ ), supporting the intervention.  
 At 18 months, the difference between groups in HbA1c level was: -2 mmol/mol ( $p = 0.046$ ).

G

<p>Tang, P. C. Overhage, J. M. Chan, A. S. Brown, N. L. Aghighi, B. Entwistle, M. P. Hui, S. L. Hyde, S. M. Klieman, L. H. Mitchell, C. J. Perkins, A. J. Qureshi, L. S. Waltimyer, T. A. Winters, L. J. Young, C. Y. Year of publication: 2013 Country: America</p>	<p>To evaluate an online disease management system supporting patients with uncontrolled T2D.</p>	<p>At 6 months, HbA1c was reduced significantly in the intervention group compared with usual care group (<math>p &lt; 0.001</math>). At 12 months, there was no significant difference between the two groups (<math>p = 0.133</math>). In post hoc analysis, at 12 month more patients in intervention group had improved diabetes control (<math>&gt;0.5\%</math> reduction in A1C) than patients in usual care group (<math>p = 0.006</math>).</p>	H
<p>Whitehead, L. C. Crowe, M. T. Carter, J. D. Maskill, V. R. Carlyle, D. Bugge, C. Frampton, C. M.A. Year of publication: 2017 Country: New Zealand</p>	<p>To determine whether a nurse-led educational intervention alone or a nurse-led intervention using education and acceptance and commitment therapy (ACT) was effective in reducing hemoglobin A1c (HbA1c) in people living with uncontrolled T2D compared to usual care.</p>	<p>HbA1c decreased both in the intervention group after 6 months but education group had more decrease in HbA1c than education and ACT group. HbA1c increased in the control group after 6 months. There was a greater reduction in nurse - led education intervention. Positive changes in HbA1c (reduced HbA1c) were found in 50 participants.</p>	I
<p>Wild, S. H. Hanley, J.</p>	<p>To investigate the effect of supervised, self-monitoring of glycemic control, blood</p>	<p>At follow-up the mean HbA1c of intervention group decrease more than the</p>	J

Lewis, S. C.  
McKnight, J. A.  
McCloughan, L. B.  
Padfield, P. L.  
Parker, R. A.  
Paterson, M.  
Pinnock, H.  
Sheikh, A.  
McKinstry, B.  
Year of publication:  
2016  
Country: The United Kingdom

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pressure, and weight with telemetric transmission of measurements (hereafter described as supported telemonitoring) among people with poorly controlled diabetes compared with a control group receiving usual care.

usual care group. Compare to the baseline the intervention group decrease 11.1 mmol/mol, 1% HbA1c, the control group decrease 5.2 mmol/mol, 0.4% HbA1c ( $p = 00007$ ).