USE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN DIABETES MANAGEMENT

A Descriptive Literature Review

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Abstract

Living with chronic conditions like diabetes requires a lot of changes in one´s daily life from modifications in nutrition, medication and many more. The new emerging information and communication technologies have contributed in many ways to the management of diabetes among patients and health care providers. The aim of this study is to examine the use of ICT in diabetes self-care and management. The purpose of this thesis was to improve knowledge among diabetic patients and health professionals on ICTs interventions in the care process.

The method selected to conduct this thesis was a descriptive literature review. Different articles were gathered by performing an electronic database search in PubMed, CINAHL and Google Scholar, using inclusion and exclusion criteria. The data analysis used was qualitative analysis and it was done by using thematic analysis. The codes obtained from the articles were noted, organized and developed into themes. One of the main themes that were identified after analyzing the articles was " Benefits of ICT in diabetes management" that was further sub-categorized into "emotional and psychological benefits", co-ordination of care" and convenient access to healthcare services". In addition, another main theme identified was "Limitations of ICT in diabetes management" that was sub-themed into " lack of knowledge and technical skills", "inability to continue care" and "privacy concern".

In conclusion, it was discovered that involving the diabetic patient in self-management of their condition improves their quality of life and prevents many acute complications. The education and skills developed using various communication and technologically advanced devices in care management enhance the knowledge regarding their disease condition and measures to prevent complications. The number of increasing ICT and digital platforms in healthcare is evident to enhance health and diminish the undeniable burden of diabetes.

Keywords

ICT, self-management, diabetes, nursing

Julkaisun nimi		
Tieto- ja viestintätekniikan käyttö diabeetikoiden keskuudessa		
kuvaileva kirjallisuuskatsaus		

Tutkinto		
Sairaanhoitaja		

Abstrakti

Kroonisten sairauksien, kuten diabeteksen, kanssa eläminen vaatii paljon muutoksia jokapäiväisessä elämässä muutoksista ravitsemukseen, lääkkeisiin ja moniin muihin. Uudet syntyvät tieto- ja viestintätekniikat ovat vaikuttaneet monin tavoin diabeteksen hallintaan potilaiden ja terveydenhuollon tarjoajien keskuudessa. Tämän tutkimuksen tavoitteena on selvittää ICT: n käyttöä diabeteksen omahoidossa ja hoidossa. Opinnäytetyön tarkoituksena oli parantaa diabeetikkojen ja terveydenhuollon ammattilaisten tietämystä hoitoprosessin ICT-interventioista.

Opinnäytetyön suorittamiseen valittu menetelmä oli kuvaava kirjallisuuskatsaus. Eri artikkeleita koottiin suorittamalla elektroninen tietokantahaku PubMedissä, CINAHL: ssä ja Google Scholarissa käyttämällä sisällyttämis- ja poissulkemisperusteita. Käytetty data-analyysi oli laadullinen analyysi ja se tehtiin käyttämällä temaattista analyysiä. Artikkeleista saadut koodit merkittiin, järjestettiin ja kehitettiin aiheiksi. Yksi pääteemoista, jotka tunnistettiin artikkeleiden analysoinnin jälkeen, oli "ICT: n edut diabeteksen hoidossa", joka jaoteltiin edelleen "tunne- ja psykologisiin hyötyihin", hoidon koordinointiin "ja terveyspalvelujen helppoon saatavuuteen". . Lisäksi toinen tunnistettu pääteema oli "TVT: n rajoitukset diabeteksen hoidossa", jonka alateema oli "tietämättömyys ja tekniset taidot", "kyvyttömyys jatkaa hoitoa" ja yksityinen huolenaihe ".

Yhteenvetona todettiin, että diabeetikon osallistuminen tilansa itsehallintoon parantaa heidän elämänlaatuaan ja estää monia akuutteja komplikaatioita. Erilaisilla viestinnän ja teknologisesti parannetuilla laitteilla hoidon hoidossa kehitetty koulutus ja taidot parantavat tietoa heidän sairaustilastaan ja toimenpiteistä komplikaatioiden estämiseksi. Lisääntyvien tieto- ja viestintätekniikan ja digi-alustojen lukumäärä terveydenhoidossa on ilmeistä terveyden parantamisessa ja diabeteksen kiistattoman taantuman vähentämisessä.

CONTENTS

Abbreviations

ADA: American Diabetes Association

CDS: Clinical Decision Support

CGM: Continuous Glucose Monitoring

CPOE: Computerized Physician Order Entry

CSII: Subcutaneous Insulin Infusion

EMR/HER: Electronic Medical/ Health Records

E-prescribing: Electronic Prescribing

EU: European Union

ICT: Information and Communication Technology

ICN: International Council of Nursing

IGF: Impaired Glucose Tolerance

IFG: Imapaired Fasting Glycaemia

LADA: Latent Autoimmune Diabetes in Adult

MODY: Maturity Onset Diabetes of the Young

TENK: Finnish Advisory Board on Research Integrity

WHO: World Health Organization

1   INTRODUCTION

Diabetes is a condition which results from the body's inability to regulate blood glucose level. Two major types of diabetes are type 1 and type 2. Type 1 is insulin-dependent, as it occurs when the body is unable to produce enough insulin. Type 2 occurs when the body is not able to effectively use insulin even when enough insulin is produced. (American Diabetes Association 2019.)

Diabetes can cause severe medical complications including cardiovascular, ocular, and renal disorders. It can lead to serious damage to vital organs in the body, resulting in disabilities and sometimes even death. Diabetes was reportedly the 7th leading case of death worldwide, affecting 463 million people worldwide in 2019 by the International Diabetes Federation. (International Diabetes Federation 2019.) Diabetes poses an enormous financial burden on patients and their families. The direct costs mainly include hospital-inpatient care, medical supplies and physician appointment visits. The indirect costs related to increased absenteeism, decreased productivity at work, and low productive capacity due to diabetes-related disability.

Type 1 diabetes currently has no safe and effective preventive measures. Insulin is the only main treatment for this type of diabetes. On the other hand, many risk factors for type 2 diabetes are controllable. Most prevention strategies include lifestyle changes such as improved diet, increased physical activity, and weight loss. These self-management aspects require knowledge and awareness among diabetic patients. Innovative mobile health apps, telemedicine, and web-based systems are used to educate and motivate diabetic patients during self-management practice. In addition to educating and motivating diabetic patients, recent technologies have simplified and automated much of the work that goes into diabetic care. Wearable tracking technologies, for example, monitor blood glucose levels continuously, which significantly reduces the burden of managing the condition. Furthermore, ICT based intervention facilitates a network of care among healthcare providers to achieve therapeutic objectives. It helps to minimize medical errors and provide competent care and treatment to diabetic patients. However, it is worth noting that the use of ICTs in diabetes care and management is limited by technical challenges, familiarity with the system, subject to malfunction, and security and privacy concerns.

This study aims to examine the use of ICT in diabetes self-care and management. It targets to provide a comprehensive review of ICT mediated approaches in diabetes care and management. The purpose of this study is to improve knowledge among diabetic patients and

health professionals on ICTs interventions in the care process. The method used is a descriptive literature review, and the analysis method is qualitative thematic analysis. In this regards, the study attempts to answer this question: How has ICT contributed to self-care and management of diabetes?

2   INFORMATION AND COMMUNICATION TECHNOLOLGY IN HEALTHCARE

Information and Communication Technology (ICT) refers to digital technologies that facilitate remote care, integrative clinical support and the exchange of information and knowledge in the healthcare sector. (Gagnon, Breton, Paré, Courcy, Côté , Trépanier & Fortin 2013, 22-34). The use of ICTs has facilitated patient-centred healthcare, which promotes a shared partnership among patients and health professionals at a reduced cost and time. It has also improved the quality of care and exchange of information and knowledge between health professionals and patients. It has thus become an essential tool to improve and enhance health care service delivery worldwide. (Rouleau, Gagnon & Côté 2015, 75.)

Recently, there has been rapid development and implementation of health technology to effectively and efficiently process, access, and retrieve data and information Most European countries now use ICT in healthcare. Many have almost entirely introduced the full use of computers in the health sector. Furthermore, in many EU countries, e-health plans and programs are implemented, including computerized medical reports and e-prescriptions. (Rosis & Seghieri 2015.)

In addition to its vital role in clinical practice and research, ICT has become an essential feature for health professionals, especially nurses. They are at the forefront of providing and coordinating health service delivery. It is imperative that they incorporate the current technological shift including communication and decision-making process in their services. (Page 2004; Rowe 2008.) The broad categories of ICT tools used in health care as suggested by Gulavani Sampada & Kulkarni, Raja and Professor, Asst & Bharati (2002) are listed below:

· Electronic Medical/ Health Records (EMR/HER)

· Clinical Decision Support (CDS)

· Computerized Physician Order Entry (CPOE)

· Electronic Prescribing (E-prescribing)

· Health Information Exchange

· Personal Health Record

· Remote Monitoring

· Telehealth/ Telemedicine

- · Home Monitoring of patients

- · Clinical Data Processing

The International Council of Nursing (ICN) has motivated the use of digital technology to provide medical knowledge and education to families and communities. ICN strives to promote eHealth practice, be recognised as an eHealth authority and be strategically placed in the eHealth sector. The ICN eHealth initiative aims to create awareness and increase participation of nurses in eHealth worldwide through ICN policies and programs relevant to research and international partnerships. (International Council of Nurses 2019.) Not only does this improve the quality of care but it also increases patient's health and service performance in their entirety (Rouleau et al. 2015).

They are several factors that can promote or constrain the application of ICTs in clinical settings. The most enabling factors are increased patient care and safety, reduced medical cost, the convenience of usage, far-reaching capabilities, easier communication, quick transfer of information, and improved access to data. Whereas, the frequent limiting factors are issues relating to technical challenges, familiarity with the system, subject to malfunction, the security of information and privacy concerns. (Giuseppe,Valerio & Antoio 2018.) As suggested by While & Dewsbury (2011), the following Table 1 displays the pros and cons of ICT in the healthcare sector:

Table 1 Advantages and Disadvantages of ICT (While & Dewsbury 2011)

Advantages	Disadvantages
Nurse can involve with patients indirectly	Degrade of the healthcare system
Nurse will be able to handle more massive workload	Inappropriate to eliminate conventional practices
Enhanced exchange of information	Challenge of digital data management
Minimized cross-infection	The predictable approach may limit practice and hinder professional accountability
Reduce medical expenses	Need for substantial expenditure

Remote joint consultations among patients, their families and health care team	Patients expectations may be unpractical and unacknowledged
Improvements in self-care among patients	Strengthening of "digital" divide
Titration of drugs and digital prescription shifts	Problems of usability across multiple ICT systems
Optimal assistance to optimize healthcare resources	ICT malfunction can threaten the healthcare system

ICT implementation in clinical practice can offer significant benefits by substituting conventional nursing methods related to evaluation, health education and service. New technology will promote virtual health sessions with care providers individually or with a group of people together. Patients can make virtual visits, discuss and coordinate their self-practice activities with their health providers through secure connections online. Patients will be able to store and access information about their conditions and personalized medical advice. (While & Dewsbury 2011.) Nurses have recognized the importance of technology in improving the working conditions minimizing irregular working habits, delays and interruptions, lack of supplies ad insufficient information. Nevertheless, the technological structures used by nursing staffs during treatment are not always convenient to use. (Cipriano & Hamer 2013.) The implementation of new technologies has beneficial impacts on most nursing workers with efficient patients care conduct (Veer, Fleuren, Bekkema & Francke 2011).

Usability considerations for electronic health records were explored for nurses. It stated that the usability of HER is highly influenced due to less reliability and poor ease of use. Likewise, low e-care skills were correlated with time pressure and high psychological distress. It is also an opportunity for nurses to learn continuously from rapid technical development. Additionally, the use of technology as an obstacle has also been established in some instances.. For example, the audio-visual interaction between patients and nurses was viewed as a complicated part of home telecare. It discourages nurses from using technology during patient care. (Vehko, Hyppönen, Puttonen, Kujala, Ketola, Tuukkanen, Aalto & Heponiemi 2019.) Nursing workers benefit from multiple ICT advantages to ease their everyday activities while contributing factors seem a burden (Meißner & Schnepp 2014). The ability to access a wide range of information sources is a significant benefit of ICT. ICT consumers have noted dramatic changes in the treatment of quality and satisfaction among Canadian nurses. ICT is a significant facilitator in evidence-based nursing. The research

nurses documented that ICT provides an improved understanding of ad usability over time for effective patient care results. (Rouleau, Gagnon & Côté 2015.)

Despite the apparent drawbacks, the role of technology in healthcare outweighs the limitations with benefits. The study also concluded that the use of health information technology improved patient's safety by eliminating prescription mistakes, minimizing allergic drug effects, and enhancing compliance with practice protocols. We can thus contend that health information technology is a crucial factor for improving the quality and safety of health care. (Alotaibi & Federico 2017, 1173.)

3 DIABETES

3.1 Types of diabetes

Diabetes is a debilitating insulin-related metabolic disease. It usually occurs when the pancreas can not generate sufficient insulin, or the body can not use the insulin produced effectively. It leads to a variety of fatal and life-threatening complications and disabilities. Diabetes has become a severe cause of death around the globe. Diabetes was reported as the 7th leading cause of death, with 1.6 million deaths worldwide. (World Health Organization 2018.) It is one of the most common diseases, even in countries like Finland with the highest quality of health service. Finnish Diabetes Association reported that one in ten Finns had diabetes. The report also suggested that almost 50,000 Finns have type 1 diabetes and 350,000 have type 2 diabetes. (Finnish Diabetes Association 2019.)

Type 1 diabetes is often defined as juvenile diabetes. It is common among children and young adults. It is a result of autoimmune beta-cells destructions in the pancreas characterized by absence of insulin production. Thus, it also called insulin-dependent diabetes. Of all diabetes cases, 5 per cent to 10 per cent are type one. Insulin therapy is used to manage this condition. (Deshpande, Harris-Hayes & Schootman 2008.) In type 2 diabetes, the body is not able to use pancreatic insulin (World Health Organization 2018). It occurs when the body increases its resistance to the action of insulin and released insulin is not sufficient to overcome it. Type 2 diabetes includes 90 to 95 per cent of all reported cases of diabetes. (Deshpande et al. 2008,1255.)

Gestational diabetes is increased in blood glucose level that occurs during pregnancy. There is risk of complications during pregnancy and at delivery to women with gestational diabetes. It is usually diagnosed during prenatal screening as it remains asymptomatic. After pregnancy, there is still risk of type 2 diabetes among these women and their children. (World Health Organization, 2018)

Impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) are the mid-phase disorders that arise between average blood glucose levels and type 2 diabetes. While this transition can be prevented, patients with IGT or IFG face an increased risk of cardiovascular conditions, including heart attacks and strokes. (World Health Organization 2016.) Gestational diabetes is increased in blood glucose level that occurs during pregnancy. It often results in complications during pregnancy and delivery. As it remains asymptomatic, it is usually diagnosed during prenatal screening. Even after pregnancy, such women and their children are at threat of type 2 diabetes. (World Health Organization 2018.)

LADA (Latent Autoimmune Diabetes in Adult) is a type of diabetes similar to type 2 diabetes in which there is insulin deficiency, but it develops faster in LADA compared to type 2 diabetes. LADA is also known as type 1.5 diabetes. (Terveyskylä.fi 2018.) According to Hoito (2018), LADA usually onsets during adulthood and does not need insulin therapy in the initial stage. About 10% of diabetes patient over the age of 35 develop GAD (Glutamic Acid Decarboxylase) antibodies. It might be related to the autoimmune process, but there is no evidence of this. In LADA, there are symptoms and characteristics of both type 1 and type 2 diabetes; therefore, this should be taken into account during its treatment. (Hoito 2018.)

Secondary Diabetes Mellitus is caused as a result of other medical conditions such as cystic fibrosis, hemochromatosis, chronic pancreatitis, polycystic ovary syndrome (PCOS), Cushing's syndrome, pancreatic cancer, glucagonoma, and pancreatectomy. Treatment of secondary diabetes mellitus depends upon the cause due to which it has been caused. (Diabetes.co.uk 2019.)

Maturity Onset Diabetes of the Young (MODY) is a type of diabetes that is inherited and caused due to changes in one of the eleven genes. Patients with MODY have problems regulating their blood sugar levels, just like other diabetic patients. It is most likely to affect young adults; however, it can occur in any age group. (Harvard Health Publishing 2019.) There are less than 2% of cases of MODY among people with diabetes in Finland (Hoito 2018).

Mitochondrial diabetes is a rare type of diabetes which is caused due to defect in a gene called MELAS gene and is inherited from mother to children. This may result in hearing loss, cardiovascular diseases and neurological disorders. (Terveyskylä.fi 2018.)

Neonatal diabetes is a type of diabetes which is diagnosed in children before the age of 6 months. Neonatal diabetes is also defined to be a monogenic form of diabetes (Diabetes.co.uk 2019). This type of diabetes can be both for a short period or can last permanently (Hoito 2018).

3.2   Impacts of diabetes

The primary symptoms of diabetes include excessive urination, elevated thirst, impaired vision, and twitching pain in extremities. The most prevalent complications are related to cardiovascular, ocular and renal diseases. Also, the risk of foot ulcers and infection requiring amputation of the limbs is prevalent among diabetic patients. (Diabetes.co.uk 2019.) About 90% of diabetic patients suffer from neuropathy, commonly referred to as nerve damage. Another common complication among diabetic patients is diabetic nephropathy, which is a chronic renal disorder. (Helve, Sund, Arffman, Harjutsalo, Groop, Grönhagen-Riska & Finne

2018.) Similarly, diabetic retinopathy is a retinal microvascular disease which causes total blindness in patients (Sharma, Oliver-Fernandez, Liu, Buchholz & Walt 2005; Frank 2004). Diabetes also leads to silent myocardial infarction, increasing the risk of heart attacks and strokes that could lead to death (Sarwar, Gao, Seshasai, Gobin, Kaptoge, Angelantonio, Ingelsson, Lawlor, Selvin, Stampfer, Stehouwer, Lewington, Pennells, Thompson, Sattar, White, Ray & Danesh 2010).

Diabetic patients face a higher possibility of single or multiple depression (Petrak, Herpertz, Albus, Hermanns, Hiemake, Hiller, Kronfeld, Kruse, Kulzer, Ruckes & Müller 2013). Diabetes depression usually leads to an impaired glycaemic level, increased obesity, decreased physical activity and possibly more complications of the end-organs with impaired functions. (Von Korff 1999).

Diabetes and its consequences put tremendous financial pressure on patients with diabetes and their families. The impacts vary from the direct medical cost to loss of productivity or earnings. (Bommer, Heesemann, Sagalova, Manne-Goehler, Atun, Bärnighausen & Vollmer 2017; Seuring, Archangelidi & Suhrcke 2015.) Outpatient, emergency care, hospital care, and medical supplies are primarily direct costs. While the effect on employment and work productivity due to amputations, loss of vision, and other physical disabilities are indirect costs. (American Diabetes Association 2003.)

3.3   Diabetes management

There is currently no safe and effective prevention of type 1 diabetes (Atkinson, Eisenbarth & Michels 2014). Research, however, shows that type 2 diabetes mellitus is generally preventable. This type of diabetes can be prevented by altering mainly lifestyle aspects such as for overweight, lack of physical exercise, and poor nutrition. (Kolb & Martin 2017.)

Adequate dietary intake of macronutrient, including high fibre and low saturated fat, is crucial in lessening the risk of type 2 diabetes. The quality is than diet quantity. Numerous strategies based on portion control and balanced food choices are available to minimize calorie intake. Many personalized and cultural diets, such as the Mediterranean and vegetarian diet, have low glycemic and carbohydrate content. (Rolls & Bell 2000, 401-418.) Increasing the intake of whole grains, fruits, leafy greens, and nuts can reduce calorie intake while maintaining nutrient composition. Improving portion control by replacing meal products and adopting proper nutrition plans enhance dietary calorie compliances. (Mohammad 2014.)

For diabetic patients, diets lower in refined grains, reeds, saturated fats, and sweetened drinks have shown to enhance glycemic control and blood lipids. Non-nutritive sweeteners

are appropriate replacements for natural sweeteners when consumed in moderation. It significantly brings down overall calorie and carbohydrate intake. (Rovner, Nansel & Gellar 2009, 3003-3007.) Similarly, daily supplementation of vitamin D also lowers the chance of type 1 diabetes (Aljabri, Bokhari & Khan 2010, 454-458). Although moderate alcohol consumption has no significant effect on long-term blood glucose regulation, it has the risk of hypo-and hyperglycemia and weight gain in diabetic patients (American Diabetes Association 2019).

In addition to dietary change, physical activity is a crucial factor in the reduction and maintenance of weight to mitigate the predicted risk of diabetes. In lifestyle modification aimed at reducing the risk of diabetes, even 30 minutes of walk per day is essential as physical exercises. (Sénéchal, Slaght, Bharti, Bouchard & Danielle 2014.) International Diabetes Federation (2019) recommends at least 60 minutes of light to intense physical exercises for at least three days a week. Aerobic activity, flexibility training and balance training are highly recommended for diabetic patients (Colberg, Sigal, Yardley, Riddell & Dunstan 2016). Besides weight maintenance, physical exercises provide cardiovascular benefits and psychological well-being. Furthermore, it increases glycemic control, enhances insulin sensitivity and improves blood pressure. American Diabetes Association (2019) proposes that long term physical activity also prevents and manages metabolic anomalies, including hyperlipidemia, and fibrinolysis.

Diabetes management is primarily a team-based care and treatment process. It, therefore, encourages the patient's involvement through knowledge and awareness, functional skills and capacity building. An interactive and collaborative treatment process develops the awareness and abilities among patients to alter their habits and better handle the disease effectively. It can further minimize the risk of complications and thus reduce morbidity and mortality from the disease. (Burke, Sherr & Lipman 2014, 45-53.)

Lack of self-empowerment can result in a workload for health professionals. It can also become an economic burden for the patients and their families. Empowering strategies include increased positive beliefs, optimistic attitudes, and self-confidence in patients. While empowering the patients, the diabetes care system also requires the patients to effectively self-manage the care and facilitate decision making. (American Diabetes Association 2019.)

Diabetes depression is a very typical psychological response while coping with a serious, complicated and challenging chronic disease like diabetes. High levels of diabetes distress significantly impact the care and treatment process. Depression, anxiety, eating disorders and cognitive dysfunction are among some issues directly related to diabetes distress. It is

therefore preferred to incorporate psychological assessment of the patient to avoid deterioration in metabolic or mental status during the care process. Thus, collaborative and patient-focused psychosocial support is considered an essential component in the clinical care of diabetic patients. (American Diabetes Association 2019.)

Diabetes care process requires the collaboration of many health professionals, including nurses, dieticians, primary care providers, endocrinologists, and other specialists. Nurses, however, are usually the initial representatives of the health care team to connect with patients. As many studies have shown, nurses' function is pivotal in educating patients on care of diabetes. They also employ their expertise, skills and training to provide and ensure high-quality care for patients. (Peimani, Tabatabaei-Malazy & Pajouhi 2010, 1-2.)

Diabetic patients spend the most time interacting and discussing their condition with the nurses. As a result, nurses can positively contribute to the patient's diabetes management process. They can assist patients from early diagnosis to identifying and implementing corrective treatment regimes. They further support patients to establish their clinical goals and manage complications associated with diabetes as they occur. (Siminerio, Funnell M, Peyrot & Rubin 2007,152-153.)

In diabetic care process, nurses are typically divided according to their responsibilities such as nurse practitioners, diabetes nurse, clinical nurse specialists, and generalist nurses. In this network of care, specialist nurses are engaged with the patients to achieve therapeutic objectives including insulin use. Nurses specialized in clinical settings are involved in administrative works, management, leadership and collaboration with other nurses. Such trained nurses provide diabetic patients and their families with emotional and social support and help them overcome the condition through primary, secondary and tertiary care. Besides recognizing therapeutic and educational needs, they also assist patients in lifestyle modification, health promotion, and prevention of complications. (Peimani et al. 2010, 1-2.)

Empowering patients in self-care is a key factor in achieving efficient diabetes care. Fonseca (2010) defines the roles of health care providers to enhance patient motivation as listed below:

- Helping patients find meaningful and individual insights on diabetes management with simple reflective questions

- Assessing the patient's knowledge and understanding of treatment and self-care practices

- Assessing the patient's financial and emotional factors

- Evaluation of exercise and dietary plan schedules for patients

- Promoting patient's positive efforts

3.4 ICT in diabetic care

There has been significant progress from discovery of insulin to continuous subcutaneous insulin infusion (CSII) along with continuous glucose monitoring (CGM) to manage diabetes (Ratheau, Jeandidier, Moreau, Sigrist & Pinget 2011, 57). It has become one of the fields in which telemedicine, e-health and consumer health solutions are practised widely. Among many ICTs systems under clinical trials, only a few are part of the diabetes management system. (Bellazzi 2008, 98-99.)

Innovative mobile health applications, telemedicine, and web-based systems have simplified and automated much of the work that goes into diabetic care. Monitoring of blood sugar level was usually done from the blood sample taken from the finger. However, diabetes patients can now monitor their blood glucose levels wirelessly with a micro sensor under the skin. This device sends data electronically to a connected digital system. This data is then converted into glucose reading in the interstitial fluid just beneath the skin. Some advanced CGMs can detect blood sugar levels by simply waving the reader over the sensor. The sensor produces a light signal which is tracked to monitor the blood sugar level. (Watson 2020.)

Diabetes medication is intended to reduce excess blood sugar but consuming too much insulin can cause a serious life-threatening plunge. Fortunately, some emerging technology can predict drop-in blood sugar levels and immediately interrupt insulin transmission. Automated insulin delivery pumps are programmed to release a continuous dose of insulin which can also be manually adjusted to level with food intake such as carbohydrates. More advanced automated insulin pumps use a closed-loop system that uses an algorithm to constantly monitor blood sugar level to assess insulin intake. Given the difficulty of finding a form of glucagon which is stable enough to function in the pump, completely accurate closed-loop systems to deliver both insulin and glucagon are under development. (Spanakis, Chiarugi, Kouroubali, Spat, Beck, Asanin, Rosengren, Gergely & Thestrup 2012.)

Although the pumps can track the blood sugar level and deliver insulin, they must be attached to patients. The alternative is a smartpen, offering all of a pump's memory capability without tethering a patient to a device. It keeps track of insulin dose and timing via Bluetooth

to a smartphone app. The data can further be shared with several diabetes monitoring systems. (Wearable-Technologies 2018.)

3.5   Self-management of diabetes using ICT

A proper self-management of diabetes requires adequate knowledge and skills to address four key factors including blood glucose monitoring, compliance to medication, nutrition, and physical activity (Finnish Diabetes Association 2019). Several advances in ICTs have addressed the issues relating to knowledge and understanding of the disease to more efficient ways to self-manage the condition (Takenga, Musongya, Kitero, Katoke, Molo, Kazingfu, Meni & Vikandy 2014, 6).

The most common technological devices used during self-management practice are personal computers, laptops and mobile phones. These devices are used to access multiple websites that provide adequate information through audio, video, or written content on diabetes. This, therefore, facilitates more efficient self-management of diabetes. (Courtney, Spearson & Mistry 2016, 4-5.)

Similarly, mobile phone applications have become useful tools to enhance self-management practice by monitoring blood glucose level away from clinical settings. (Jeffery, Bagala, Creighton, Leavey, Nicholls, Wood, Longman, Barker & Pit 2019, 2.) Recently wearable tracking technologies have become one of the most popular CGM devices to monitor blood glucose level continuously. These wearable devices come in various forms such as bracelets, smartwatches, skin patches, and even eye lenses. Although these devices cannot completely cure the disease, they help to lower the daily burdens of managing the conditions. (Wearable-Technologies 2018.)

Movement-based video games can promote exercises among diabetic patients. Many video games such as the Nintendo Wii Fit Plus have been developed and found effective among kids and young children with type 1 diabetes (Rollo, Aguiar, Williams, Wynne, Kriss, Callister & Collins 2016, 382-387). Virtual and augmented reality can be used to figure out the exact point of insulin administration making it easy for self-management care. It can help people to determine the glycaemic index of food they are eating and its effects on the blood sugar. (Augmented Reality In medicine 2017.)

Self-care is critical for type 2 diabetes patients as it can reduce complications. Self-care needs specific and appropriate details and guidance from health care providers. Theory of self-care from Dorothea Orem has been taken as a reference in this context of our study. Dorothea E. Orem's self-care model provides a good practice framework for preparing an implementing good self-care. Orem defined self-care theory as the capacity of a person to

sustain and engage by nursing guidance. A self-care program aims at educating patients through different self-handling skills and strategies. (Renpenning & Taylor 2003.)

Orem's self-care theory notes that each person requires self-care to maintain maximum health and wellbeing. Every person has the ability and obligation to care for themselves. Individuals should initiate and emphasize on performing self-care activities exploring the individual capacity to engage themselves in self-care. The theory is conditioned by life experiences, social, cultural orientation and available resources. The expertise, understanding and strategic actions influence self-care attitudes. (Borji, Otaghi & Kazembeigi 2017.) The main factors influencing self-care are social, age, family background and economic situations. Self-care needs to be balanced in terms of capacity and demand. Orem assumes that individuals can take care of themselves and nurses can help people re-establish their strength through direct care and compensatory academic support. Moreover, Orem recommends that nurses should encourage and assist patients to pursue independent self-care through reliable and effective nursing planning. Many health institutions and practitioners recommend encouraging self-care as a method to reduce the increased medical expenses. (Orem,Taylor & Renpenning 2001.)

Due to the chronic nature of diabetes, diabetes individuals should collaborate in all stages of diabetes and its treatment. They should be capable to conduct self-care activities on their own. Patients and relatives perform the vast majority of routine diabetes care. Patients must learn knowledge and skills to self-manage diabetes. (Shrivastava, Shrivastava & Ramasamy Jegadeesh 2013.) The integral self-care activities include monitoring of sugar level, consumption of balanced diet, maintaining insulin dosage, and general exercises. Good problem-solving skills, coping strategies skills and risk reduction habits are also important factors affecting the self-handling behaviours. (American Association of Diabetes Educators 2008, 445-449.) Patients are urged to take good care of their health independently following healthy and productive lifestyles. The theory aims to motivate the patients to take an active part in regular self-care. (Meleis 2011.)

4   PURPOSE, AIM AND THESIS QUESTION

The primary aim of this study is to examine the use of ICT in diabetes self-care and management. This will be achieved through descriptive literature review. The focus is on the use of ICT mediated tools in diabetic care. The thesis will analyse the benefits and limitations of ICT in diabetes management.

The purpose of this study is to improve knowledge among diabetic patients and health professionals on ICTs interventions in the care process. In doing so, we aim to promote awareness of the quality of care for diabetic patients. This study, therefore, attempts to answer the following question: How has ICT contributed to self-care and management of diabetes?

5   METHODOLOGY

5.1   Method and search process

The method used in this study is a descriptive literature review. A literature review critically summarizes and analyses relevant available research on the selected topic or subject. The literature review aims to bring updated and relevant information to the reader regarding the topic. It provides a deep understanding and knowledge of the selected topic. The literature review identifies patterns and helps to narrow the research question which contributes to the determination of evidence-based practice and generates foundation for future researches. (Lau & Kuziemsky 2016; Coughlan, Cronin & Ryan 2008, 38.)

According to Cronin (2008), the process of conducting a literature review includes identifying a topic of interest, searching and obtaining meaningful literature, analysing findings of the articles appropriately using different analysis methods and finally writing the review. The main purpose of a descriptive literature review is to recognize the depth of knowledge in a particular research subject that interprets what kind of patterns or trends are present in that specific topic including the methods and findings (King & He 2005; Paré, Trudel, Jaana & Kitsiou 2015). A descriptive literature review was considered suitable in the context of our thesis. It was considered suitable in the context of our thesis as it aims to summarize existing studies about the use of ICTs in self-care and the management of diabetes.

While conducting a descriptive literature review, a topic was selected to review, and research questions were formed after building a theoretical framework. After forming research questions, different search strategies were developed such as the use of electronic databases with outlined inclusive and exclusive criteria for data search. The next step was to carry out a literature search based on inclusion and exclusion criteria and select relevant articles. The process of the literature search is presented in Figure 1.

Total 10 articles were selected, read, and analysed by using thematic analysis process. Findings, recommendations and conclusion were written as a part of the report of the literature review. The selected articles are in Appendix 1.
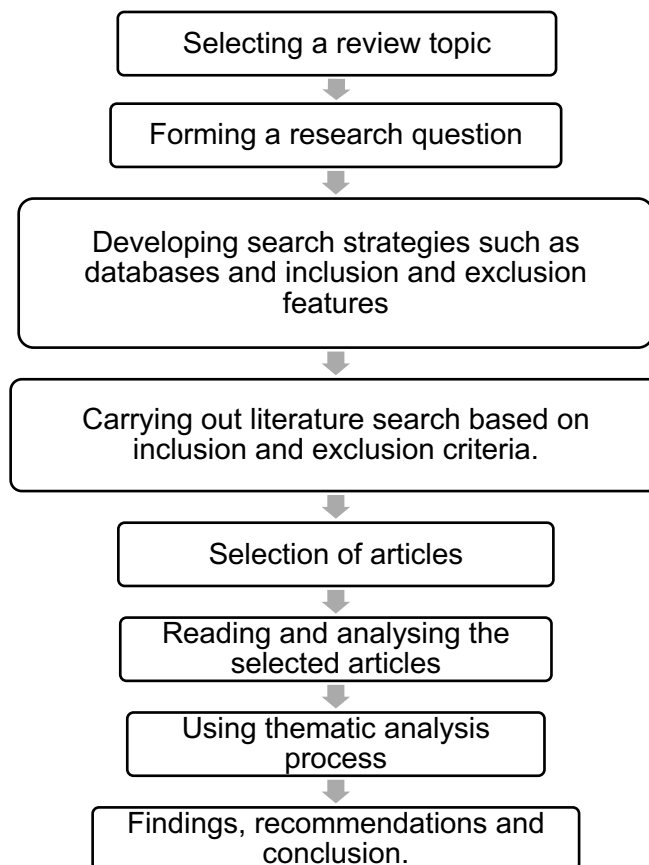
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│   Findings, recommendations and │
│            conclusion.          │
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Figure 1 summary of literature review

5.2   Inclusion and exclusion criteria

Inclusion criteria are the characteristics that the potential articles must-have for inclusion in the study. While exclusion criteria are features that absolve the articles from inclusion in the study. The inclusion and exclusion criteria were set during this review to limit the validity of the review and serve as guidance. (Parahoo 2014.) It is important to set inclusion and exclusion criteria for a study since they affect the validity of the study results. It also leads to designing high-quality research. (Patino & Ferreira 2018, 84.)

The selection of appropriate inclusion and exclusion criteria was important to meet the objective of our study. It filtered the search results to only those articles that were published in the last 5-10 years and written in the English language. Furthermore, only full text and peer-reviewed articles were selected for the study. Inclusion and exclusion criteria as presented in Table 2 were chosen based on our study goals.

Table 2 Inclusion and Exclusion criteria

Inclusion Criteria	Exclusion Criteria
Reviews published in the last 5-10 years	Studies published more than 10 years ago
Studies published in English language only	Studies published in languages other than English
Studies addressing our research questions	Studies that does not address our research question
Original studies	Literature review
Full-text articles and academic articles	Abstract, non-academic articles or discussion
Peer-reviewed articles	Articles not peer-reviewed

5.3 Literature Search

The literature search was conducted using electronic databases after identifying the aims and purpose of the thesis. The search terms used during the literature search were 'diabetes', 'information and communication technologies (ICTs)', and 'self-management' and 'nursing'. The main aim of using these keywords was to narrow the search results and obtain articles that would be used in this literature.

Electronic databases used to conduct the literature search were CINAHL, PUBMED and Google Scholar. Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases are the most commonly used and trusted research resources for nurses, students and health professionals worldwide.CINAHL covers fifty nursing specialities, speech and language therapy, nutrition, general wellness, pharmacy and more (EBSCO Health 2020). PubMed is a free tool for searching and retrieving literature from biomedical and related fields reviewed by experts to improve the health (National Library of Medicine 2020). Google Scholar is a simple method to search scholarly literature through multiple outlets namely academic articles, theses, books, websites, publishers and many more (Google Scholar 2020).

The databases chosen were in relevance to our study. The title of the articles was first thoroughly scanned to find out if the articles were reliable to the study. After scanning the

papers, duplicates were removed, and the articles search was narrowed by using inclusion and exclusion criteria. After the final search, only the relevant articles were selected for this descriptive literature review. Table 3 presents the search summary.

Table 3 Database search summary

Research Database	Initial articles	Final articles (duplicates removed)
CINAHL	66	4
PUBMED	225	4
Google Scholar	14,800	2
Total	15,091	10

5.4   Thematic analysis

The thematic analysis aims to understand patterns of meaning from the selected data and develop them into themes. While conducting a thematic analysis, it is vital to understand the implications hidden in the experiences that are obtained from the collected data. (Sundler 2018.) Thematic analysis is an independent qualitative explanatory model. It is described as a mechanism for data pattern identification, analysis and reporting. (Braun & Clarke 2006.) In the thematic analysis, data obtained can be in any form such as interviews, notes, any document, or videos. Different concepts and meanings are extracted from the selected data by open-minded reading. Using thematic analysis process, based on a descriptive approach starts from text and being familiar with the chosen data, identifying meanings and eventually organizing those meanings into patterns. Once the patterns are converted and themes are identified, the results are written based on the aim of the study and context. The thematic analysis approach is considered suitable as this form of analysis enables the writer to create and decide our themes from the collected data which are strictly related to the research question. (Javadi 2016.)

The selected papers have been read carefully and reviewed many times after performing the literature search for detailed information. Any set of data that were relevant and corresponded to the objectives of our thesis were noted and highlighted. Related data on the use

of ICT in diabetes management were considered in codings into words, phrases or sentences. Once all the necessary information was noted, initial codes were categorized into groups. The primary purpose of our study was to improve knowledge among diabetic patients and health professionals on ICTs interventions in the care process. Consequently, the codes were divided into categories to find out any similarity or differences with each other. Those categories were then developed into sub-themes and checked to see if they justified the sub-themes. Some generated sub-themes were later eliminated as they did not seem to contribute to the research.

Different data from the study showed that diabetic patients were interested in using various types of ICTs to manage their condition and avoid acute complications. Their feedback was collected from different kinds of methods and survey. In total, six sub-themes were identified from the codes which were relevant to answer the research question of our study. Decisively, these sub-themes were further divided into two main themes. Several data from the selected studies showed that ICTs benefit the diabetes management process, including prevention of acute complications. This central theme on the benefits of ICTs in diabetes management was derived from 3 sub-themes, namely "emotional and psychological benefit", "coordination of care", and "convenient access to healthcare services". These sub-themes were derived after reviewing and examining the relevant codes from the articles several times. In like manner, identified the links between the sub-themes and combined them into our central theme. The diabetic patient showed interest and concerned regarding their self-management using different kinds of information and communication technologies that would not only prevent acute complications but also contributes to their physical well-being. For instance, factors that would facilitate care coordination among diabetic patients were self-management education, nutritional management, physical exercises, regular medication and customized care.

Consequently, the study also concluded in a few limitations in the utilization of ICTs for self-care of diabetes. For instance, distrust on technological efficiency discouraged to adopt new lifestyles, preference to direct visit and low economic condition. The limitations were categorized into three sub-themes "lack of knowledge and technical skills", "inability to continue care" and "privacy concern" which was further derived into one of the main themes "Limitations of ICT in diabetes management".

The result of our thematic analysis is presented in appendix 2. The appendix includes one of the sub-themes "Co-ordination of care" from our one of our main themes "Benefits of ICT in diabetes management" that partly answer our research questions on how ICT contribute in self-care and management of diabetes. The results of the thematic analysis are presented

in Table number 4 and 5. The results are categorized into the benefits and limitations of ICT in diabetes management. Table 4 displays the " Benefits of ICT in diabetes management", and the results are detailed in chapter 6.1. In likewise manner, Table 5 illustrates our next main themes "Limitations of ICT in diabetes management". The results for the limitations are discussed in chapter 6.2.

6 RESULTS

6.1 Benefits of ICT in management of diabetes

Patients diagnosed with diabetes undergo immense emotional and psychological stress. ICTs play a significant role in counselling and educating newly diagnosed patients on disease condition, treatment, and self-management practices. According to the literature, psychological aspects and self-care practices are essential in improving self-management of diabetes. Therefore. the sub-themes and themes identified in the literature are listed in table 4 below:

Table 4 Benefits of ICT in diabetes management

Codes	Sub-themes	Theme
- Acceptance of the diagnosis - Adaptation to emotional and behavioural change - Clinical relationship between patient and healthcare professionals - Taking shared decision - Quick access to information - Prevention of complications - Increased autonomy in self-care process	**Emotional and psychological benefits**	**Benefits of ICT in diabetes management**
- Self-management education - Nutritional management - Blood glucose monitoring - Physical activities/ exercise - Personalized information - Customized medication and care	**Coordination of care**	
- Direct access to health providers - Easy and frequent communication - Share of documents with families and care-givers - Feedbacks - Continous care - Coordinated care - Exchange of information via SMS, text messaging, email, and social media - Webcam appointments via video calls or skype - Equity in care - Access to education	**Convenient access to healthcare services**	

Emotional and psychological benefits

Based on the findings from the articles psychological aspect is one of the most important parts in the management of diabetes among patients. The study suggests the diagnosis of diabetes can be shocking and unexpected for some patients which makes it difficult for them to accept it. Such type of patients may take a longer time to cope with the treatment and adapt to their changing life situation. According to Gardsten (2017), acceptance of diagnosis is the very first step in recognizing the disease condition. Only then can this lead to individualized treatment under the guidance of healthcare professionals (Gardsten, Mörtberg & Blomqvist 2017, 197-2006).

Use of ICT in diabetic care has proven to have psychological benefits with high treatment satisfaction. The study found that ICT tools such as CGM provides quick access to information to patients, family members and caregivers motivating them to make better decisions on their diabetes management and care. It also permits individuals and families to be alert of the possible complications such as hypo- and hyperglycaemia. (Lawton, Blackburn, Allen, Campbell, Ellen, Leelarathna, Rankin, Tauschmann, Thabit & Hovorka 2018.)

The findings from Graffigna, Barello, Bonanomi & Menichetti (2016) suggest that encouraging the participation of patients in ICT based care management has a huge positive impact on their cognitive process and behaviours. This helps in educating the patients on illness condition and medical requirements needed for treatment. The study further points out that patients seeking knowledge and information on health and treatment via ICT can be seen as a psychological expression of their acceptance of the diagnosis.

Clinicians regarded remote monitoring of self-tracked data as a chance to enhance the patient's self-care skills and monitor their compliance with medication. This self-tracking and data sharing also enabled early intervention by caregivers with timely counselling and treatment process. The study also found that clinical self-tracking system increased the patient's autonomy in decision making while allowing medical interventions at the same time. (Piras & Miele 2017, 38-53.)

It is suggested that incorporation of ICT mediated tools in patient care improved the patient-provider relationship. This clinical partnership is crucial as the data is used by the patients for self-management as well as shared with care providers for the treatment process. It further enhances shared decision making between patient and healthcare professional on

treatment, managing the condition, and addressing social, physical and emotional challenges. (Wildevuur,Simonse,Groenewegen & Klink 2019,1-9.

Care coordination

Gardsten, Mörtberg & Blomqvist (2017) points out that self-management of diabetes requires many decision-making skills that can be supported by ICTs. It implies that patients lacking self-management skills have high possibility to suffer from complications. (Gardsten et al. 2017, 197-206.) Self-management of diabetes can be categorized into nutritional management, exercise, blood glucose monitoring, utilization of medication, reducing risk, problem-solving and healthy coping. (Ojeda-Cherrez, Vanegas, Calero, Plaza, Cano, Calderon Carlos, Valdano, Gutierrez Oswaldo & Guevara 2018,1-8.)

Self-management is more complex than just attitudes, services and interactions with health professionals. It involves many challenges related to nutrition, exercise, and medication. As suggested by Lawton et al. (2018), ICT is an interactive and inspiring source in the self-management of diabetes. It allows the patients to approach and manage their condition through more informed decisions.

Individualization of information and awareness made it easier for patients to understand how blood glucose levels are influenced by food, diet, physical activity and insulin dosage. Patients noted the convenience of with which they could achieve their data on insulin levels using technology. It enabled them to make effective changes in life to achieve more stable glucose levels. (Lawton et al. 2018.)

ICT has a positive impact on patient-health professional relationships. This relationship promotes the patient's involvement in self-management of disease. It enables patients to gain knowledge and understand their disease condition to make effective changes in life. This psychodynamic intervention can further mitigate some of the negative effects of treatment procedure such as hypo-glycaemia and hyperglycaemia. (Wildevuur E et al. 2019.)

Convenient access to healthcare service

Patients with diabetes require frequent communication with their health care providers. The ICT enabled applications functions as a method to receive information from the patients. It enables caregivers to make the assessment of the disease condition and provide clinical treatment accordingly.

Among many ICT tools, the patient portal texting system provides patients with continuous communication and coordination of care with their health care providers. Due to its ease of use and speed, it allows patients with direct access to a physician without calling or visiting

the office. These features positively enhance the treatment process. Hefner also found that using the patient portal technique helped multiple providers to coordinate and manage patient's care and treatment. In return, it benefitted the patient with easy and frequent communication with multiple care providers. Although it required efforts from both care providers and patients, it significantly improved the quality of communication and positively impacted health outcome. (Hefner, MacEwan, Biltz & Sieck 2019.)

The findings from Ojeda-Cherrez et al. (2018) suggests that SMS, text messaging, email, and social media like Facebook, Twitter and WhatsApp are the most preferred means of communication tools to obtain and exchange information between diabetic patients and their caregivers. These are the most used ICT tools to obtain information and resolve queries with health providers. The survey highlighted that these services allowed patients to easily share information with family members and caregivers. The survey mainly emphasized on the usability of such technologies due to their ease of use.

The findings by Morris, Campbell- Richards, Wherton, Vijayaraghvan, Greenhalgh, Collard, Byrne & O'shea (2017) believes that webcam consultations reduced patients' time and expense, and improved efficiency and possible virtual interaction and communication with their care providers. The study further indicated that these distant telemonitoring services like video calls and skype resulted in shorter waiting time, more connection to the service and equity in care.

Telehealth is a valuable ICT tool for diabetic patients. It provided e-learning service platform where individuals can retrieve education from both the system and health workers. Moreover, it was easy to run and even an untrained person would find it relatively simple to operate. In addition to ease of use, this device had alarms, alerts and questionnaires for continuous self-tracking of care. This further facilitated care providers in making decisions for patients, for example, pregnant women and children, who had limited autonomous decision-making capability. (Piras & Miele 2017, 38-53.)

6.2   Limitations of ICT in diabetes management

The most frequent limiting factors are issues relating to technical challenges, familiarity with the system, subject to malfunction, security of information and privacy concerns. The codes and sub-themes for limitations of ICT in diabetes management are tabulated below in Table 5.

Table 5 Limitations of ICT in diabetes management

Codes	Sub-themes	Theme
• No basic technology skills • Lack of computer acess • Limited experience and education	**Lack of knowledge and technical skills**	
• Distrust on technological efficiency • Discouraged to adopt new lifestyles • Prefer direct visit to physician • Low economic conditio	**Inability to continue care**	**Limitations of ICT in diabetes management**
• Data self limit • Value of privacy	**Privacy concern**	

Lack of knowledge and technical skills

Basic technical training is necessary to use information and communication tools to control diabetes. The findings from the articles highlighted the difficulty in preventing issues related to diabetes due to lack of basic technological skills. Besides, it is noted that there are constant diabetes management issues due to limited experience and education. (Piras & Miele, 2017.) Similarly, health professionals also held the same view. Low technical expertise and lack of computer access were key obstacles to ICTs in diabetes management. Electronic health information sources have been widely debated for its unreliability and inefficiency. It contributes to ineffective self-care management of diabetes. (Graffigna et al. 2016.)

Unability to continue care

The analysed articles suggested that self-care of diabetes using technological advances is a continuous process. The study by Lee, Greenfield & Pappas (2018) reported patients' distrust on persistent quality care and effective conversation with the health professionals using the technology. The studies also showed that patients use technology to reassert their control in the management of diabetes. Patients expressed a desire for face-to-face meetings with the healthcare team to address serious health concerns and advice rather than using ICT. In some situations, patients did not prefer interventions from their providers in the technological platform. It resulted in the avoidance of calls and texts from health professionals. Hence, patients demonstrated an unwillingness to adapt to the new lifestyle behaviours obligatory to diabetes management. (Piras & Miele 2017; Lee et al. 2018.) Patients

were worried about abuse of their provider's time and demonstrated trouble understanding how long and detailed their text should be (Hefner et al. 2019).

The results of our studies show that not every diabetic patient has the same economic condition and can afford management through technologies. Some of them have no access to the internet and thus cannot make use of different applications that are available through the internet for the management of diabetes. People living in the countryside might not have access to smartphones and could not get services through text or phone calls directly to health professionals. In addition to this, the level of education might also affect the use of ICT. Patient with diabetes who have received self-management education is seemed to be more aware of their health condition and management of daily life as they know the future complications of diabetes compared to those who lack education regarding diabetes and its management. (Ojeda-Cherrez et al. 2018.)

Privacy concerns

The findings of the articles add insight to the confidentiality concerns about the data sharing and monitoring among patients. It was evident from the studied articles that patients valued their data privacy. They did not prefer sharing their detail information in a technological setting with the healthcare team and, even with family members. It hinders interpretation and therapeutic action resulting in poor quality care. (Piras & Miele 2017; Lee et al. 2018; Hefner et al. 2019.)

7 DISCUSSION

7.1 Findings

The aim of the study to examine the use of ICT in diabetes self-care and management. Therefore, our study attempts to answer the thesis question: " How has ICT contributed to self-care and management of diabetes?"

Based on the analysis, different advantages and disadvantages of using ICTs in diabetes management from the patient's perception has been highlighted. Diabetes is a devastating disease that involves a variety of improvement in behaviours, including physical exercise, diet, medication, and glucose surveillance. The results indicate that living with diabetes requires a lot of management in behavioural changes from the meal plan, exercise, and managing blood glucose level. The findings from Gardsten (2017) states that different ICT applications can support the management of chronic diseases like diabetes. Patients and families need to have a strong commitment to live along with diabetes due to its complexity and persistent nature. It is equally important to be knowledgable on nutritional management, physical activity, insulin usage and other coping strategies. (Ojeda-Cherrez et al. 2018.)

Different communication channels enable patients to interact with health professionals that help to build trust between patient and care provider relationships. Communication tools and channels provide easy access to patients' information with caregivers and family members. (Ojeda-Cherrez et al. 2018.) As discussed in the articles, ICT devices are extensively used for communication through text messaging, data storage, tracking and electronic health records. Patients who are well-known and informed about their condition will make the necessary regular improvements to cope with diabetes. In the same way, ICT offered the flexibility among the health professionals in terms of obtaining patient information, interaction and counselling to address more individual-centred care. The results support the concept that the introduction of e-health tools and applications has assisted patients, families health care providers and health system significantly. (Hefner et al. 2019.)

We might argue that besides having several benefits of ICTs, we cannot ignore the drawbacks that come along with it. The impact of diabetes among patients is numerous. It requires enormous effort from patients to prevent and manage acute and chronic complications from diabetes. Lack of knowledge and technical skills, confidentiality issue doubt in regular follow-ups and level of education were some of the highlighted limitations. Some of the patients faced technical challenges due to inadequate information and training to operate available technological appliances. (Piras & Miele 2017.) Nurses' role in educating the patients and families on the management of diabetes is significant. The findings would

appear that many patients were concerned about their privacy. They seemed hesitant sharing all their information with their care providers. It appeared to hamper the continuity of care as sometimes, patients limit their data sharing and lessen their interaction with health practitioners. The findings of our studies show that not every diabetic patient has the same economic condition. Everyone cannot afford to use technological appliances and platform. Also, the unavailability of internet access has restricted individuals from using different applications.

Self-care is critical for diabetes patients. It reduces the possible complications. Self-care needs consistent and appropriate details, and guidance from health care provides. After the diagnosis of diabetes, it is evident that health practitioners make numerous suggestions on food, exercise, medicine and blood glucose regulation. The involvement and awareness of patients on their diabetic condition is the most priority in self-care activities. We have realized the self-management strategies presented in our study agree with theoretical guidelines outlined by Dorothea Orem's theory of self-care. So, we have highlighted the relevance of involvement and interest of an individual in own diabetes care. Orem's self-care theory not only emphasize the patient's commitment but also of family members and relatives equally in care management. We have discussed the myriads of benefits and restrictions faced by diabetic patients while using ICTs applications. In most of the cases, patients are solely responsible for their lifestyles, medication and sugar level controls. To support our viewpoint, Orem's theory of self-care claims that each individual with diabetes requires to keep their health and well-being optimum. It has also been evident from the articles analyzed that patients are aware of their diabetes condition. Every individual can act in order to maintain their health and treat themselves.

7.2 Reliability and Validity

The review is based on the methodological review of the academic articles on information and technologies used in diabetes management. A systematic literature review includes using previously available publications for data analysis, formulating concepts and findings that share common ground with applicable evidence-based and accurate policy and practice information. (Neale & Osborne 2009.) Validity is the appropriateness of the tools, processes and data. Validity in a qualitative research question, appropriate data analysis process and valid results and conclusions based on the context of the research study. (Leung 2015, 324-327.)

The quality and reliability of the study are one of the key factors in the conduct of research in each stage. Several efforts were made at each stage of this work to avoid any mistakes.

Articles were searched from recognized and valid academic databases, for instances, CI-NAHL, PUBMED, and Google Scholar. All of these databases are well established in the nursing profession and research. Sufficient works of literature have been reviewed based on inclusion criteria. It is assumed that the purpose of the selected articles is in relevance to the objective of the study.

We have considered for areas in determining the trustworthiness of a qualitative study: credibility, transferability, dependability and confirmability (Shenton 2004). Research trustworthiness can be presented through a trustable assessment process. For effective content analysis, articles must be categorized and interpreted and the categories must consistently represent the study topic. (Elo & Kyngäs 2008.) It is essential to incorporate credible operational measures to meet the concepts of the study. The research material published only over the last decade is selected. For a literature search, only databases that are closely linked to nursing, ICT and health have been used.

The thesis is based on reviewing and extracting new themes with the existing articles by using thematic analysis process. The steps of the thematic analysis process. The steps of thematic analysis were followed. The selected articles were read by both writers. While reading the articles several times, coding was done in between to note important data that might be beneficial in answering our research question. The articles were re-read and checked if codes have been recorded correctly. Codes were rearranged multiple times to make sure they fit in similar categories. The main aim of the process is to obtain a new theme from the selected data. The codes were then developed into sub-themes and eventually main themes were derived from the set of sub-themes. Any kind of individual opinions and judgement from both the writers were avoided and conclusions were based on the articles without any bias.

We acknowledged a few limitations during the study. The initial downside is the fact that only three online sources were used for data extraction. It has influenced the total number of articles chosen for the analysis. We could have extracted more information on the subject topic if we could utilize more databases for literature search. However, we also know that the databases that we used are credible and reliable sources for our field of study. Along with it, the restricted use of terminologies has limited to find articles to locate articles appropriate to the research question. The third drawback impacts selecting articles that are written only in English. This could have caused the omission of relevant research papers published in any other language. Furthermore, articles without full text were excluded from the research. Moreover, the rapid development of technological advancements, we admit that we have not been able to include myriads of ICTs applications and their usability in diabetes

care as our study. It is so because the sample size of this research is comparatively small with just ten articles being analyzed. Likewise, we cannot deny that it would be possible to narrow the study results if we had specified the type of diabetes instead of all types of diabetes altogether. We think the results would be more coherent, specific and effective comparing to the number of articles and time frame available.

7.3   Ethical Consideration

Ethics refers to doing what's morally and legally right during the research conduct. The researcher needs to be knowledgeable, rational and truthful in their approach, reporting and decision making. Similarly, they are accountable for their actions and consequences. It ensures that the results of the research outweigh any potential negative effects. Ethical decisions are much easier to make with this approach. As authors, we have considered the legal and ethical implications of the study to comply with the basic human rights standards. (Neale 2008.) Research misconduct includes data manufacturing, and falsification, misunderstanding, forgery and copyright issues. These ethical misconducts should be avoided throughout the research process. This literature review has maintained principles illustrated by The European Code of Conduct for Research Integrity (2017). The principles include reliability, sincerity, dignity and responsibility.

The study also ensured research quality by incorporating proper design, methodology, and analysis as per TENK guidelines. Research ethics is a concept that stresses the fairness and dignity of all researchers in their study. The important ethical aspects that need to have adhered to includes objectivity during analysis and interpretation of the data, avoidance of fabrication and misinterpretation, and maintaining the copyright and acknowledgements of previous studies. (Finnish Advisory Board on Research Integrity 2012.)

This study was conducted based on the principles of research including precision in reporting, presentation and evaluation of the results of the analysis. The literature review findings were presented transparently and responsibly. Any personal views, judgements and preferences did not influence the way the study data were obtained, analysed and evaluated. The inclusion and exclusion criteria have been carefully drawn to eliminate bias in the selection of research which would result in positive and negative outcomes.

In order to prevent any plagiarism, citations have been made accurately and referred to in the guidelines. Authors whose works have been cited specifically in this analysis are credited accordingly. The sources were evaluated in a way that did not impact the integrity of the review along with strict analysis of source credibility. All the associated authors have complied to these ethical principles throughout the study.

7.4   Conclusion

Based on the results of the articles analyzed, it is obvious that ICTs play a vital role in the management of diabetes. The findings from the literature highlight the contribution of ICT in emotional and psychological aspects as well as self-care practices among diabetic patients. Psychological aspects mainly include acceptance of the diagnosis among diabetic patients to understand their disease condition and follow the treatment process accordingly. The findings suggest that the use of ICT mediated system and services facilitate awareness, education, and counselling among patients. The research found that various ICT platforms provided accessible interactive health knowledge and information for both patients and health professionals. Additionally, ICTs can promote various self-care practices such as blood glucose control, nutrition, exercise, and medications to resolve complications during the treatment process.

The findings from the articles suggest that communication tools and technologies are widely used in diabetic care. Different means of communication enable patients to contact their care providers directly, thus making it easier to discuss issues and resolve queries without visiting the hospital. However, we might argue that ICT cannot be viewed as a complete alternative to face-to-face consultations. Here the concerned issues related to patient's privacy, confidentiality and willingness to share information online. The research also found various innovative developments in ICTs from insulin pens to artificial pancreas. We might reasonably argue here that many patients lack the technical expertise and ability to use the equipment correctly. It, therefore, points to the need for education and training so that the patients can make effective and independent use of the technologies.

The findings were indicative of the fact that the use of ICT in diabetic care was partly limited by technological illiteracy and lack of access to computers and the internet. Several results even show that some patients struggled to engage in as simple as a secure messaging system. Few patients were concerned about misuse of their care providers' time with message length, timing, and appropriateness of the message. The results also suggest that patients found annoyance and frustration with alerts and questionnaires from some ICT devices used in the care process.

From the future perspective, it is apparent that there is a massive potential for improving the quality, health and outcome of diabetes care with the tremendous progress in the management of diabetes using ICT applications and platform. ICT has the ability to improve how people use health care by obtaining information and other forms of remotes assistance to educate and engage users. People are recognizing their own health needs. ICT advancement allows for more accurate control of blood glucose values by improved administration

and distribution of insulin. More than ever, people are choosing to assess their health conditions through internet guidance, technical applications and better-personalized services from health care provides.

In order to overcome the burden of self-management of diabetes, ICT services and professions need to be integrated into the healthcare organization. The technological advances have been remarkably changing. The implementation of ICT in healthcare raises new standards for health practitioners and patients in support of self-management approaches aimed at improving efficiency while reducing the cost of diabetes treatment in the immediate future.

LIST OF REFERENCES

Abel, E. D. 2019. Mechanisms for Cardiovascular Complications of Diabetes - Implications for Personalized Therapy. Endocrine Abstracts, vol.63.

Abi Khalil, C., Roussel, K., Mohammedi, K., Danchin, N. & Maree, M. 2012. Cause-specifc mortality in diabetes: recent changes in trend mortality. European Journal of Preventive Cardiology, 19(3), 374-381.

Afkarian, M., Zelnick , L. & Hall, Y. 2016. Clinical manifestations of kidney disease among US adults with diabetes. Journal of the American Medical Association, 316(6), 602-610.

Aljabri, K. S., Bokhari , S. A. & Khan, M. J. 2010. Glycemic changes after vitamin D supplementation in patients with type 1 diabetes mellitus and vitamin D deficiency. Ann Saudi Med , 30(6), 454-458.

Alotaibi, Yasser K & Federico, F 2017. The impact of health information technology on patient safety. Saudi medical journal, 38(12), 1173.

American Association of Diabetes Educators 2008. AADE7 Self-Care Behaviors. Diabetes Educ, 34, 445-449.

American Diabetes Association 2003. Economic costs of diabetes in the U.S. in 2002. Diabetes Care, 16, 917-932.

American Diabetes Association 2004. Physical Activity/Exercise and Diabetes. Diabetes Care, 27(1), 58-62.

American Diabetes Association 2019. Standards of Medical Care in Diabetes 2019. Abridged for Primary Care Providers, 37(1).

Anderson, R., Freeland, K., Clouse, R. & Lustman, P. 2001. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. Diabetes Care, 24, 1069-1078.

Argoff, C., Cole, B., Fishbain , D. & Irving , G. 2006. Diabetic peripheral neuropathic pain: clinical and quality-of-life issues. Mayo Clin Proc, 14, 3-11.

Atkinson, M., Eisenbarth, G. & Michels , A. 2014. Type 1 diabetes . Lancet, 383(9911), 69-82.

Augmented Reality In medicine 2017, March 29. Augmented Reality and Diabetes Self-Management. Available at: http://arinmed.com/augmented-reality-and-diabetes-self-management/

Bailes, B. K. 2002. Diabetes Mellitus and its Chronic Complications. AORB Journal, 76(2), 265-274.

Bansal, V., Kalita, J. & Misra, U. 2006. Diabetic neuropathy. Postgrad Med J, 82(964), 95-100.

Bellazzi, R. 2008. Telemedicine and Diabetes Management: current challanges and future research directions. Journal of Daibetes Science and Technology, 98-99.

Bland, R. C.1992. Psychiatric Disorders in America. The Epidemiologic Catchment Area Study. J Psychiatry Neuroscience, 17(1), 34-36.

Bommer, C., Heesemann, E., Sagalova, V., Manne-Goehler, J., Atun, R., Bärnighausen , T. & Vollmer, S. 2017. The global economic burden of diabetes in adults aged 20-79 years: a cost-of-illness study. The Lancet Diabetes Endocrinology, 5(6), 423-430.

Borji, M., Otaghi, M. & Kazembeigi, S. 2017. The Impact of Orem's Self-Care Model on the Quality of Life In Patients With Type II Diabetes. Biomed Pharmacol J , 10(1).

Boulton, A., Kirsner, R. & Vileikyte, L. 2004. Clinical practice. Neuropathic diabetic foot ulcers. N Eng J Med, 351, 48-55.

Bourne, R., Stevens, G., White, R., Smith , J., Flaxman, S., Price , H., Jonas, JB., Keeffe, J., Leasher, J., Naidoo, K., Pseudovs, K. & Taylor HR. 2013. Causes of vision loss worldwide, 1990-2010: a systematic analysis. Lancet Glob Health, 1(6), 339-349.

Braun, V. & Clarke, V. 2006. Using thematic analysisi in psychology. Qualitative Research in Psychology, 3, 77-101.

Burden, M. 2003. Diabetes: treatment and complications--the nurse's role. Nurse Times, 99(2), 30-32.

Burke, S. D., Sherr, D. & Lipman, R. D. 2014. Partnering with diabetes educators to improve patient outcomes. Diabetes Metab Syndr Obes, 7, 45-53.

Burkoski, V., Yoon, J., Hutchinson, D., Solomon, S. & Collins, B. E. 2019, May 01. Experiences of Nurses Working in a Fully Digital Hospital: A Phenomenological Study. Nursing Leadership, 32, 72-85.

Calle-Bustos, M. J.-G. 2017. An augmented reality game to support therapeutic education for children with diabetes. Plos One, 4-5.

Cappozi, D. & Lanzola, G. 2011. Utilizing information technologies for lifelong monitoring in diabetes patients, 1(5(1)), 55-62.

Carney , C. 1998. Diabetes mellitus and major depressive disorder: an overview of prevalence, complications, and treatment. Depress Anxiety, 7, 149-157.

Ciechanowski, P., Katon, W. & Russo, J. 2000. Depression and diabetes: impact of depressive symptoms on adherence, function, and costs. Arch Intern Med ,160, 3278-3285.

Cipriano, P. F. & Hamer, S. 2013. Nursing, Technology and Information Systems. American Nurse Today.

Clarke, V. & Braun, V. 2013. Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. The Psychologist, 26(2), 120-123.

Colberg, S., Sigal, R., Yardley, J., Riddell , M. & Dunstan, D. 2016. Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. Diabetes Care, 39(11), 2065-2079.

Coulter, A. 2011. Engaging Patients In Health care. Open University Press.

Courtney L. S. & Anahita, M. 2016. Several Aspects of Internet and Web-Based Technology in Diabetes Management. Diabetes Spectrum, 4-5.

Coughlan, M., Cronin, P. & Ryan, F. 2008. Undertaking a literature review: a step-by-step approach. British Journal of Nursing ,38.

Decode Study Group 2003. Age- and sex-specific prevalences of diabetes and impaired glucose regulation in 13 European cohorts. Diabetes Care, 26, 61-69.

Deeb, L. C. 2008. Diabetes Technology During the Past 30 Years: A Lot of Changes and Mostly for the Better. DiabetesSpectrum, 21(2), 78-83.

Delone, W. H. & Mclean, E. R. 2003. The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. Journal of Management Information Systems, 19(4), 9-30.

Deshpande, A., Harris-Hayes,M. & Schootman,M. 2008. Epidemiology of Diabetes and diabetes-related complications . Physical Therapy, 1255.

Diabetes 2018, October 30. Retrieved from World Health Organization, Available at: https://www.who.int/news-room/fact-sheets/detail/diabetes

Diabetes. co. uk 2019. How Does Diabetes Affect The Body. Retrieved Dec 2020, Available at: https://www.diabetes.co.uk/how-does-diabetes-affect-t--he-body.html

Diabetes-World Health Organization 2019. Retrieved from World Health Organization, Available at: https://www.who.int/news-room/fact-sheets/detail/diabetes

Donnelly, R., Emslie-Smith, A. M., Gardner, I. D. & Morris, D. A. 2000. ABC of arterial and venous disease. BMJ, 320(1062).

Elo, S & Kyngäs, H. 2007. The Qualitative Content Analysis Process. Journal of Advanced Nursing. Available at https://www.ncbi.nlm.nih.gov/pubmed/19592803

EBSCO Health 2020. CINAHL Databases. Available at: https://www.ebscohost.com/nursing/products/cinahl-databases

Finnish advisory Board on Research Integrity 2012. Ethical principles of research in the humanities and social and behavioural sciences and proposals for ethical review. Retrieved November 14, 2019, Available at: https://www.tenk.fi/sites/tenk.fi/files/HTK_ohje_2012.pdf

Finnish Diabetes Association 2019. Diabetes in Finland. Retrieved 06 18, 2019, from Finnish Diabetes Association, Available at: https://www.diabetes.fi/en/finnish_diabetes_association/diabetes_in_finland

Fonseca, V. 2010. Diabetes: Improving Patient Care. Newyork: Oxford university Press Inc.

Frank, R. N. 2004. Diabetic Retinopathy. New England Journal of Medicine, 350(1), 48-58.

Fuller, H. & Alberti Hugh. 2017. Barriers to lifestyle changes in people with diabetes. British Journal of General Practice, 67(61).

Gagnon , M.-P., Breton, E., Paré, G., Courcy, F., Côté , J., Trépanier , A. & Fortin, J.-P. 2013. The Impact of Information and Communication Technologies (ICTs) on Nurse Retention. Sante Publique, 25(3), 305-313.

Gardsten, C. B. 2017. Designing and ICT self-managemnet service: suggestions from persons with type 2 diabetes . Health Technology , 197-206.

Giorgio, A. 1970. Psychology as a Human Science: A Phenomenologically Based Approach. Harper & Row Publishers.

Graffigna, G., Barello, S., Bonanomi, A. & Menichetti, J. 2016. The Motivating Function of Healthcare Professional in eHealth and mHealth Interventions for Type 2 Diabetes Patients and the Mediating Role of Patient Engagement. Journal of Diabetes Research.

Gray, N., Picone, G. & Yashkin, A. 2015. The relationship between BMI and onset of diabetes mellitus and its complications. Southern medical journal, 108(1), 29.

Guariguata, L., Whiting, D., Hambleton, I., Beagley, J., Linnenkamp, U. & Shaw, J. 2014. Global estimates of diabetes prevalence in adults for 2013 and projections for 2035. Diabetes Res Clin Pract, 103(2), 137-160.

Guest, G., Kathleen, M. K. & Namey, E. E. 2011. Applied thematic analysis. Sage Publications.

Guimarães Barbosa, J. A. 2018. Nursing Perspectives and the Advanced technologies in Diabetes Management. Journal of Nursing, 1112-1116.

Gulavani, S. S. & Kulkarni, R. V. 2010. Role of Information Technology in Health Care. Proceedings of the 4th National Conference.

Haffner, S. M., Lehto, S., Rönnemaa, T., Pyörälä, K. & Laakso, M. 1998. Mortality from coronary heart disease in subjects with type 2 diabetes and in nondiabetic subjects with and without prior myocardial infarction. The New England Journal of Medicine, 339(4), 229-234.

HeathConnect International 2014. ICT for Health.

Hefner, J. L., MacEwan, S. R., Biltz, A. & Sieck, J. C. 2019. Patient portal messaging for care coordination: a qulaitative study of perspectives of experienced users with chronic conditions. BMCFamily Practice, 20(57).

Helve, J., Sund , R., Arffman, M., Harjutsalo, V., Groop, P.-H., Grönhagen-Riska, C. & Finne, P. 2018. Incidence of End-Stage Renal Disease in Patients With Type 1 Diabetes. Diabetes Care, 41(3), 434-439.

Hollick, M. 2004. Vitamin D: Importance in theprevention of cancers, T1DM, heart disease and osteoporosis. Am J Clin Nutr, 79, 362-371.

Holloway, I. & Todres, L. 2005. The status of method: flexibility, consistency and coherence. Qualitative Research in Health Care, 1, 90-102.

How to conduct a literature review 2019. Available at: https://guides.library.vcu.edu/health-sciences-lit-review/selection-criteria

Hyppönen, H., Hämäläinen, P. & Reponen, J. 2015. E-health and e-welfare of Finland. Helsinki, Finland: Finn Telemedicum and National Institute for Health and Welfare.

International Council of Nurses 2019. eHealth and ICNP. Retrieved 09 02, 2019, Available at: https://www.icn.ch/what-we-do/projects/ehealth-icnp

International Diabetes Federation 2019. IDF DIABETES ATLAS. Available at: https://diabetesatlas.org/upload/resources/2019/IDF_Atlas_9th_Edition_2019.pdf

Javadi, M. & Zaera, K. 2016. Understanding Thematic Analysis and its Pitfall. Journal of Client Care, 34-40.

Jeffery,B.,Bagala,M.,Creighton,A.,Leavey,T.,Nicholls,S.,Wood,C.,Longman,J.,Barker,J. & Pit,S. 2019. Mobile phone applications and their use in the self management of type 2 diabetes mellitus: a qualitative study among app users and non app users. Diabetology & metabloic Syndrome, 2.

Jones, A., Olsen, M. Z., Perrild, H. J. & Willaing, I. 2015. The psychological impact of living with diabetes: Descriptive findings from the DAWN2 study in Denmark. ScienceDirect.

Kaufman, N. & Khurana, I. 2016. Using Digital Health Technology to Prevent and Treat Diabetes. Diabetes Technology Therapeutics, 1(18).

King, W. R. & He, J. 2005. Understanding the Role and Methods of MetaAnalysis in IS Research. Communications of the Association for information Systems, 16, 665-686.

Knowler, W., Barrett-Connor, E., Fowler, S., Hamman, R., Lachin , J., Walker, E. & Nathan, D. 2002. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med., 346(6), 393-403.

Kolb, H. & Martin, S. 2017. Studies show that lifestyle factors such as overweight, lack of exercise, and poor diet can be altered by behavioural and environmental changes. Lifestyle change primarily involves reduction in calorie intake and exercises (Knowler, et al., 2002). BMC Med, 15(131).

Krippendorff, K. 2004. Reliability in Content Analysis: Some Common Misconceptions and Recommendations. Human Communication Research, 30(3), 411-433.

Larry, C. 2008. Diabetes Technology During the Past 30 Years: A Lot of Changes and Mostly for the Better. Diabetes Spectrum , 78-80.

Lau, F. & Kuziemsky., C. (Eds.). 2016. Handbook of eHealth Evaluation: An Evidence-based Approach. Victoria (BC): University of Victoria.

Lau, F., Hagens, S. & Muttitt, S., 2007. A proposed benefits evaluation framework for health information systems in Canada. Healthcare quarterly, 10(1), p.112. ElectronicHealthCare, 5(3), 112-118.

Lawton, J., Blackburn, M., Allen, J., Campbell, F., Ellen, D., Leelarathna, L.,Rankin, D., Tauschmann, M., Thabit, H. & Hovorka, R. 2018. Patients' and caregivers' experiences of using continuous glucose monitoring to support diabetes self-management qualitative study. BMC Endocrine Disorders, 18(12).

Lee, P. A., Greenfield, G. & Pappas, Y. 2018. Patients' perception of using telehealth for type 2 diabetes management: a phenomenological study. BMC Health Services Research, 18(549).

Leung, L. 2015. Validity, reliability, and generalizability in qualitative research. Journal of Family Medicine and Primary Care, 4(3), 324-327.

Levich, B. 2011. Diabetes management: optimizing roles for nurses in insulin initiation. J Multidiscip Healthc, 4, 15-24.

Levitt, N., Stansberry, K., Wynchank, S. & Vinik, A.1996. The natural progression of autonomic neuropathy and autonomic function tests in a cohort of people with IDDM. Diabetes Care, 19(7), 751-754.

Ley, S. H. & Hu, F. B. 2014. Prevention and management of type 2 diabetes: dietary components and nutritional strategies. The Lancet, 383(9933), 1999-2007.

Lindström, J., Louheranta, A., Mannelin, M., Rastas, M., Salminen, V., Erikson, J., . . . Tuomilehto, J. 2003. The Finnish Diabetes Prevention Study (DPS). Diabetes Care, 26(12), 3230-3236.

Mair, F. S., May, C., Murray, E., Finch, T., Anderson, G., O'Donnell, C.,Wallace, P. & Sullivan, F. 2009. Understanding the Implementation and Integration of e-Health Services.

Mann, J., De Leeuw, K., Hermansen, B., Karamanos, B., Karlström, B., Katsilambros, N., Riccardi, G., Rivellese, A.A., Rizkalla, S., Slama, G., Toeller, M., Uusitupa, M. & Vessby, B. 2004. Evidence-based nutritional approaches to the treatment and prevention of diabetes mellitus. Nutrition, Metabolism and Cardiovascular Diseases, 14(6), 373-394.

Meißner, A. & Schnepp, W. 2014, June 20. Staff experiences within the implementation of computer-based nursing records in residential aged care facilities: a systematic review and synthesis of qualitative research. BMC Medical Informatics and Decision Making, 14(54).

Meleis, I. A. 2011. Theoretical nursing: Development and progress. Lippincott Williams & Wilkins.

Menachemi, N. & Collum, T. H. 2011. Benefits and drawbacks of electronic health record systems. Risk Management and Healthcare Policy, 4, 47-55.

Mensing, C. 2010. Comparing the processes: accreditation and recognition. The Diabetes Educator, 36(2), 219-243.

Mohammad, A. 2014. The prevention and control the type-2 diabetes by changing lifestyle and dietary pattern. Journal of Education and Health Promotion, 3(1).

Morris, J., Campbell- Richards, D., Wherton, J., Vijayaraghvan, S., Greenhalgh, T., Collard, A., O'shea, T. 2017. Webcam consultations for diabetes: findings from four years of experience in Newham. Practical Diabetes, 34(2).

Natioanal Library of Medicine 2020. PUBMED Overview. Available at: https://www.nlm.nih.gov/bsd/pubmed.html

NCD Risk Factor Collaboration 2016. Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4*4 million participants. Lancet.

Neale, J. 2008. Research Methods for Health and Social Care. Red Globe Press.

Neale, J. & Osborne, D. 2009. Research Methods for Health and Social Care. London: Palgrave Macmillan.

Norris, S., Lau, J., Smith, S., Schmid, C. & Engelgau, M. 2002. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. Diabetes Care, 25, 1159-1171.

Ojamo, M. 2017. The Finnish Register of visual impairment; annual statistics 2017. Finnish Federation of The Visually Impaired.

Ojeda-Cherrez, I., Vanegas, E., Calero, E., Plaza, A., Cano A, J., Calderon Carlos, J., . . . Guevara, J. 2018. What kind of Information and Communication Technologies Do patients with Type 2 Diabetes Mellitus Prefer?An Ecuadorian Cross-sectional Study. International Journal of Telemedicine and Applications, 1-8.

Orem, D. E., Taylor, S. G. & Renpenning, K. M. 2001. Nursing : concepts of practice (6th ed.). St. Louis: Mosby.

Page, A. 2004. Keeping Patients Safe: Transforming teh Work Environment of Nurses. (A. Page, Ed.) Wahington (DC): National Academies Press(US).

Parahoo, K. 1991. Politics and Ethics in Nursing Research. Nursing standard.

Parahoo, K. 2014. Nursing Research: Principles, Process and Issues. (3 ed.). Hamsphire.

Paré, G., Trudel, M.-C., Jaana, M. & Kitsiou, S. 2015. Synthesizing information systems knowledge: A typology of literature reviews. Information and Management, 52(2), 183-199.

Patino Maria, C. F. 2018. Inclusion and exclusion criteria in research studies: definitions and why they matter. JBP, 84.

Peimani, M., Tabatabaei-Malazy,O. & Pajouhi,M. 2010. Nurses role in Diabetes care; a review. Iranan Journal of Diabetes and Lipid disorders , 1-2.

Penninx, B., Rejeski, W., Pandya, J., Miller, M., Di Bari, M., Applegate , W. & Pahor, M. 2002. Exercise and depressive symptoms: a comparison of aerobic and resistance exercise effects on emotional and physical function in older persons with high and low depressive symptomatology. J Gerontol B Psychol Sci Soc Sci , 57, 124-132.

Petrak, F., Herpertz, S., Albus, C., Hermanns, N., Hiemake, C., Hiller, W., . . . Müller, M. J. 2013. Study protocol of the Diabetes and Depression Study (DAD): a multi-center randomized controlled trial to compare the efficacy of a diabetes-specific cognitive behavioral group therapy versus sertraline in patients with major depression and poorly controll. BMC Psychiatry, 13(206), 2013.

Piras, E. M. & Miele, F. 2017. Clinical self-tracking and monitoring technologies: negotiations in the ICT-mediated patient-provider relationship. Health Socialogy Review, 26(1), 38-53.

Polonsky, W., Earles, J., Smith, S., Pease , D., Macmillan, M., Christensen, R., . . . Jackson, R. 2003. Integrating medical management with diabetes self-management training: a randomized control trial of the Diabetes Outpatient Intensive Treatment program. Diabetes Care., 26(11), 3048-3053.

Rasoulzadeh, N., Abbaszadeh, A., Zaefarian, R. & Khounraz, F. 2017, May. Nurses views on accepting the creation of a nurses' health monitoring system. Electronic physician, 9(5), 4454.

Ratheau, L. P. 2011. How tchnology has changed diabetes management and what it has failed to achieve. Elsevier Massion, 57.

Rathmann, W., Ziegler, D., Jahnke, M., Haaster, B. & Gries, F. 1993. Mortality in diabetic patients with cardiovascular autonomic neuropathy. Diabet Med., 10(9), 820-824.

Renpenning, K. M. & Taylor, S. G. 2003. Self Care Theory in Nursing. NewYork: Springer Publishing Company.

Rollo, E,M., Aguiar,J,E., Williams,L,R., Wynne,K., Kriss,M., Callister,R. & Collins,E,C. 2016. eHealth technologies to support nutrition and physical activity behaviors in diabetes self-management. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 382-387.

Rolls, B. & Bell, E. 2000. Dietary approaches to the treatment of obesity. Med Clin North Am., 84(2), 401-418.

Rosis, S. D. & Seghieri, C. 2015. Basic ICT adoption and use by general practitioners: and analysis of primary care systems in 31 European countries. BMC Medical Infromatics and Decision Making.

Rouleau, G., Gagnon, M.-P. & Côté, J. 2015. Impacts of information and communication technologies on nursing care: an overview of systematic reviews (protocol). Systematic reviews, 4(1), 75.

Rovner, A. J., Nansel, T. R. & Gellar, L. 2009. The effect of a low glycemic diet versus a standard diet on blood glucose levels and macronutrient intake in children with type 1 diabetes. J Am Diet Assoc., 109(2), 303-307.

Rowe, M. 2008. Information and communication technology in health: a review of the literature. Journal of Community and Health Sciences.

Royal College of Nursing (RCN) 2020. eHealth. Retrieved 01 10, 2020, Available at: https://www.rcn.org.uk/clinical-topics/ehealth

Sadosky, A., Mardekian, J., Parson, B., Hopps, M., Bienen, E. & Markman, J. 2015. Healthcare utilization and costs in diabetes relative to the clinical spectrum of painful diabetic peripheral neuropathy. J Diabetes Complications., 29(2), 212-217.

Sandelowski, M. & Barroso, J. 2003. Writing the proposal for a qualitative research methodology project. . Qual. Health Res. , 13, 781-820.

Sarwar, N; Gao, P; Seshasai, R; Gobin, R; Kaptoge, S; Di Angelantonio, E; Ingelsson, E; Lawlor, DA; Selvin, E; Stampfer, M; Stehouwer, CD; Lewington, S; Pennells, L; Thompson , A; Sattar, N; White , IR; Ray , KK; Danesh, J Danesh, J. 2010. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. Lancet, 375(9733), 2215-2222.

Schreiber, A. K., Nones, C. F., Reis, R. C., Chichorro, J. G. & Cunha, J. M. 2015. Diabetic neuropathic pain: Physiopathology and treatment. World J Diabetes, 6(3), 432-444.

Sénéchal, M., Slaght, J., Bharti, N. & Bouchard, D. R. 2014. Independent and combined effect of diet and exercise in adults with prediabetes. Diabetes Metab Syndr Obes., 7.

Seuring, T., Archangelidi, O. & Suhrcke, M. 2015. The economic costs of type 2 diabetes: A global systematic review. . PharmacoEconomics, 33(8), 811-831.

Sharma, S., Oliver-Fernandez, A., Liu, W., Buchholz, P. & Walt, J. 2005. The impact of diabetic retinopathy on health-related quality of life. Current Opinion in Opthalmology, 16(3), 155-159.

Shibuta, T., Waki, K., Tomizawa, N., Igarashi, A., Yamamoto- Mitani, N., Yamaguchi, S., . . . Izumida , Y. 2017. Willingness of patients with diabetes to use an ICT- based self management tool: a cross sectional study. BMJ Open Diabetes Research Gate, 5(1).

Shrivastava, R. S., Shrivastava , S. P. & Ramasamy Jegadeesh 2013. Role of self-care in management of diabetes mellitus. J Diabetes Metab Disord.,12(14).

Siminerio M, L., Funnell M,M., Peyrot,M. & Rubin R,R 2007. US Nurses perceptions of their role in Diabetes care. The Diabetes EDUCATOR, 152-153.

Spanakis, E. G., Chiarugi, F., Kouroubali, A., Spat, S., Beck, P., Asanin, S., . . . Thestrup, J. 2012. Diabetes Management Using Modern Information and Communication Technologies and New Care Models. Interactive journal of medical research, 1(2).

Sundler, A. L. 2014. Qualitative thematic analysis based on descriptive phenomenology. Nursing Open, 4.

Takenga, C., Musongya, O., Kitero, J., Katoke, R., Molo, K., Kazingfu, B., . . . Takenga, H. 2014. An ICT-Based Diabetes Management System Tested for Health Care Delivery in the African Context. International Journal of telemedicine and applications, 6.

Tesfaye, S., Boulton, A. & Dickenson , A. 2013. Mechanisms and management of diabetic painful distal symmetrical polyneuropathy. Diabetes Care, 36, 2456-2465.

The European Code of Conduct for Research Integrity. (2017). The European Code of Conduct for Research Integrity. Retrieved 11 08, 2019, Available at: https://www.allea.org/wp-content/uploads/2017/05/ALLEA-European-Code-of-Conduct-for-Research-Integrity-2017.pdf

Thomas, D. R. 2006. A General Inductive Approach for Analyzing Qualitative Evaluation Data. American Journal of Evaluation,, 27(2), 237-246.

Tol, A., Sharifirad, G., Shojaezadeh, D., Tavasoli, E. & Azadbakht, L. 2013. Socio-economic factors and diabetes consequences among patients with type 2 diabetes. J Educ Health Promot, 2(12).

Tunceli, K., Bradley, C. J., Nerenz, D., Williams, K. L., Pladevall, M. & Lafata, J. E. 2005. The Impact of Diabetes on Employment and Work Productivity. Diabetes Care, 28, 2662-2667.

Tuomilehto, J., Lindström J, Eriksson , J., Valle, T., Hämäläinen , H., Ilanne-Parikka, P., . . . Uusitupa, M. 2001. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med, 344(18), 1345-50.

UNESCO, U. N. 2019. Information and Communication Technologies. Available at: http://uis.unesco.org/en/topic/information-and-communication-technologies-ict

VCU Libraries 2019, July 30. How to conduct a literature review . Retrieved from VCU (Virginia Commonwealth University), Available at: https://guides.library.vcu.edu/health-sciences-lit-review/selection-criteria

Veer, A. J., Fleuren, M. A., Bekkema, N. & Francke, A. L. 2011, October 27. Successful implementation of new technologies in nursing care: a questionnaire survey of nurse-users. BMC Medical Informatics and Decision Making, 67.

Vehko, T., Hyppönen , H., Puttonen, S., Kujala, S., Ketola, E., Tuukkanen, J., Aalto, Anna-M. & Heponiemi, T. 2019, August 14. Experienced time pressure and stress: electronic health records usability and information technology competence play a role. BMC Medical Informatics and Decision Making, 19(1), 1-9.

Von Korff, M. 1999. Disability and psychological illness in primary care. In Common Mental Disorders in Primary Care: Essays in Honour of Professor Sir David Goldberg. Tansella M, Thornicroft G, Eds., 52-63.

Watson, S. 2020. How Technology Is Changing Life With Diabetes. Retrieved 1 16, 2020, from WebMD, Available at: https://www.webmd.com/diabetes/features/technology-changing-life-with-diabetes#3

Wearable-Technologies 2018. The Diabetes Epidemic is Driving Med Tech Companies to Develop Wearable Devices to Manage the Condition. Retrieved from Wearable-Technologies, Available at: https://www.wearable-technologies.com/2018/10/the-diabetes-epidemic-is-driving-med-tech-companies-to-develop-wearable-devices-to-manage-the-condition/

While, A. & Dewsbury, G. 2011. Nursing and information and communication technology (ICT): A discussion of trends and future directions. International Journal of Nursing Studies, 48(10), 1302-1310.

WHO 2018. Diabetes. Retrieved Jan 10, 2020, Available at: https://www.who.int/news-room/fact-sheets/detail/diabetes

Wildevuur E, S., Simonse WL, L., Groenewegen, P. & Klink, A. 2019. Information and comminication technology enabling partnership in person-centred diabetes management: building a theoritical framewrok from an inductive case study in The Netherlands. BMJ Open, 1-9.

Williams, D., Tumomilehto, J. & Björk, S. 2000. The Economics of Diabetes Care: An international Perspective. Blackwell Science.

World Health Organization 2009. Telemedicine: Opportunities and developments in Member States.

World Health Organization 2016. GLOBAL REPORT ON DIABETES. WHO Press.

World Health Organization 2018. Diabetes. Retrieved 06,18, 2019, Available at: https://www.who.int/news-room/fact-sheets/detail/diabetes

World Health Organization 2019. eHealth .Available at: https://www.who.int/ehealth/about/en/

Zhang, P., Zhang, X., Brown, J., Vistisen, D., Sicree, R., Shaw, J. & Nicholas, G. 2010. Global healthcare expenditure on diabetes for 2010 and 2030. Diabetes Res Clin Pract, 87, 293-210.

APPENDICES

Appendix 1 Summary of the reviewed literature

Title 1: What kind of Information and Communication Technologies Do patients with Type 2 Diabetes Mellitus Prefer? An Ecuadorian Cross-Sectional Study.

Author/s and publication date: Ojeda-Cherrez, I., Venegas, E., Calero,E., Plaza,K., Cano A,J., Calderon,J., Valdano,J., Gutierrez Oswaldo,J., and Guevara,J. 2018

Purpose of the study: To assess the frequency of use of information and communication technologies and patterns of preference among Ecuadorian patients

Summary of Results and Conclusions: The outcome of this article shows that SMS was the most used ICT followed by Internet among the Ecuadorian patients with diabetes with mean sample age 57.7 years. However, this study concludes that there should be understanding of what kind of ICTs services do patient with diabetes prefer as it would help in development of different applications considering some specific requirements of patients.

Title 2: Nursing Perspectives and the advanced technologies in diabetes management.

Author/s and publication date: Guimaraes B., J., Ribeiro, S.D., Celly, M. 2018

Purpose of the study: To address the most relevant innovations currently available for the control and treatment of diabetes in a nursing perspective.

Summary of Results and Conclusions: The study states that nurses should be aware of the latest and recent resources available for diabetes care and should use these resources whenever necessary.

Title 3: Information and communication technology enabling partnership in person-centred diabetes management: building a theoretical framework from an inductive case study in The Netherlands

Author/s and publication date: Wildevuur E, S., Simonse WL, L., Groenewegen,P., and Klink, A.B. 2019

Purpose of the study: To construct a theoretical framework for information and communication technology (ICT)-enabled partnership towards diabetes management.

Summary of Results and Conclusions: This study suggests that management of diabetes by using ICTs requires partnership and adjustment between health professionals

and person living with diabetes. ICT provided an opportunity of sharing data and contributed in carefree living.

Title 4: Designing an ICT self-management service: suggestions from persons with type 2 diabetes

Author/s and publication date: Gardsten, C.,Mörtberg, C., Blomqvist, K. 2017

Purpose of the study: To report the wish and needs of people with type 2 diabetes for a future information and communication technology (ICT) self-management service to help manage their condition and their everyday life.

Summary of Results and Conclusions: This study showed that ICT self-management service need to offer few services such as different communication channels, possibilities for exchanging experiences and written and visualized information. It states that there might be different options for communication for supporting and facilitating self-management in future ICT self-management service.

Title 5: Patients' and caregivers' experiences of using continuous glucose monitoring to support diabetes self-management: qualitative study

Author/s and publication date: Lawton J.,Blackburn M.,Allen J.,Campbell F.,Elleri D.Leelarathna L.,Rankin D.,Tauschmann, M.,Thabit H.,Hovorka, R 2018

Purpose of the study: To explore participants' experiences of using CGM in order to provide recommendations for supporting individuals to make optimal use of this technology

Summary of Results and Conclusions: The results of this study noted that CGM as a technological tool is empowering due to easy access to informative blood glucose data .The information aids in dietary changes, physical activity and insulin doses and its impact on blood glucose levels.

Title 6: Patient portal messaging for care coordination: a qualitative study if perspectives of experienced users with chronic conditions.

Author/s and publication date: Hefner, J.L.,MacEwan, S.R.,Biltz, A.,Sieck, C.J. 2019

Purpose of the study: To better understand the ways patients with chronic condition utilize secure messaging within the patient portal

Summary of Results and Conclusions: The result of this study analysed that patient's motivation for using messaging included the speed and ease of such communication and direct access to a physician.

Title 7: Clinical self-tracking and monitoring technologies: negotiations in the ICT-mediated patient-provider relationship.

Author/s and publication date: Piras, E.M.,Miele, F. 2017

Purpose of the study: To quantify the effectiveness and the acceptability of a self-tracking/remote-monitoring platform for type 1 diabetes patients

Summary of Results and Conclusions: This study reaffirms the benefits of empirically grounded theorising as a way to grasp the rich and evolving phenomenology of self-trackpractices.

Title 8: Patient's perception of using telehealth for type 2 diabetes management: a phenomenological study

Author/s and publication date: Lee, P.A.,Greenfield, G.,Pappas, Y. 2018

Purpose of the study: To explore patient's perceptions of using telehealth for type 2 diabetes management

Summary of Results and Conclusions: The study results identified potential effect of telehealth in terms of improving their quality of life

Title 9: The Motivating Function of Healthcare Professional in eHealth and mHealth Interventions of Type 2 Diabetes Patients and the Mediating Role of Patient Engagement.

Author/s and publication date: Graffigna, G.,Barello, S.,Bonanomi, A.,Menichetti, J.

2017

Purpose of the study: To explore the introduction of new health technologies can be integrated in healthcare system for clinical success.

Summary of Results and Conclusions: The study confirms important role of healthcare professionals' ability to foster type 2 diabetes patients' autonomy in enhancing their activation and engagement towards self-management.

Title 10: Webcam con- sultations for diabetes: findings from four years of experience in Newham

Author/s and publication date: Morris, J.,Richards, D.C.,Wherton, J.,Sudra, J.,Vijayaraghvan, S.,Halgh, T.G.,Collard, A.,Byrne E.,O'Shea, T 2017

Purpose of the study: To provide more accessible and cost-effective care by replacing selected follow-up outpatient appointments with webcam consultations

Summary of Results and Conclusions: The results indicated that patients found the service convenient and empowering with some limitations.

Appendix 2 Grouping Initial codes, subthemes and theme

Codes	Subtheme	Theme
- Self-management education - Nutritional management - Blood glucose monitoring - Physical activities/ exercise - Personalized information - Customized medication and care	Co-ordination of care	Contribution of ICT in diabetes self management