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SOCIAL SCIENCES, BUSINESS AND ADMINISTRATION

DIGITAL TREATMENT TECHNOLOGIES AND REMOTE PATIENT MONITORING IN DIABETES NURSE'S WORK

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THESIS
Abstract

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Abstract

Diabetes is a long-term illness which requires continuous self-care and monitoring from the diabetic person, and regular check-up visits to a healthcare professional. It can cause various side effects from stress and self-care burnout to uncomfortable symptoms of too low or too high blood glucose to additional diseases like kidney, neurological and vascular ailments. While diabetes is a worldwide health issue, Finland has one of the highest occurrences of the disease in the world, and the cost of it has been shown to heavily affect the national economy in many ways. Diabetes treatment in public healthcare varies in quality and availability despite of efforts to create a uniform national treatment path and guidelines for diabetics. Specialized nurses called diabetes nurses are among the frontline professionals caring for diabetic outpatient visits and developing diabetes treatment.

The aim of the study was to produce information on how diabetes nurses view digital treatment technologies of diabetes in Finland and identify the challenges they face in their work when using these technologies. There were no previous studies in Finland or internationally focusing specifically on the relationship of diabetes nurses to digital treatment technology devices and applications. The study was performed as a qualitative study by thematic interviews. Six diabetes nurses from various hospital districts in Finland, both from basic and specialized healthcare units, took part in the interviews. Material based content analysis was used to analyse the interviews.

The results revealed a wide range of factors affecting the use of digital treatment technologies in diabetes care in Finland. Patient and healthcare staff attitudes, technology skills, motivation levels and treatment technology's suitability to individual diabetic's needs and circumstances were brought out as human factors in using or not using digital technologies. External factors included issues like diabetes nurses' varied opportunities to affect procurement of treatment technologies at their work unit, cost of the devices, IT issues like compatibility of self-care devices with diabetic patient's mobile phone, and privacy and data security issues of IT systems and in remote monitoring between patient and healthcare unit. Tailored and continuous training and technical support for diabetes nurses was desired from digital treatment technology suppliers, as were studies and data demonstrating the concrete benefits for both the diabetic and for healthcare providers. Diabetes nurses had both positive and negative experiences and opinions of these factors, but the overall views were optimistic, and digital treatment technology was viewed as a standard, cost-effective, and necessary part of diabetes care in Finland in the future.

The results of the thesis can be used as a discussion opener to hear diabetes nurses' and diabetics' experiences and views on the benefits and challenges of digital diabetes care. Scientific studies on digital treatment technology of diabetes are non-existent in Finland and scarce internationally, so healthcare decision makers, medical technology suppliers and hospitals could use this study to reflect on the benefits, challenges and cost-effectiveness of these technologies, and facilitate open communication about and further research on these issues. The study could also advance best practice sharing between diabetes nurses and healthcare professionals, as it highlights differences in the quality and methods of diabetes care in different healthcare units and districts.

Keywords
digital treatment technology, diabetes in Finland, diabetes nurse, remote monitoring, cost-effectiveness

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Tiivistelmä

Diabetes on pitkäaikainen sairaus, joka vaatii jatkuvaa itsehoitoa ja seurantaa diabeetikolta sekä säännöllisiä tarkastuskäyntejä terveydenhuollon ammattilaisen luona. Se voi aiheuttaa erilaisia haittavaikutuksia stressistä ja itsehoitoon väsymisestä epämiellyttäviin oireisiin liian matalasta tai liian korkeasta verensokerista johtuen aina lisäsairauksiin, kuten munuais-, neurologisiin ja verisuonitauteihin. Vaikka diabetes on maailmanlaajuinen terveysongelma, Suomessa on yksi maailman korkeimmista taudin ilmaantuvuuksista, ja sen kustannusten on osoitettu vaikuttavan voimakkaasti kansantalouteen monin tavoin. Julkisen terveydenhuollon diabeteksen hoito vaihtelee laadun ja saatavuuden suhteen huolimatta pyrkimyksistä luoda yhtenäinen kansallinen hoitopolku ja -ohjeet diabeetikoille. Diabeshoitajiksi kutsutut erikoistuneet sairaanhoitajat ovat diabeetikkojen avohoitokäyntejä hoitavien ja diabeteksen hoitoa kehittävien ammattilaisten etulinjassa.

Tutkimuksen tavoitteena oli tuottaa tietoa diabeteshoitajien suhtautumisesta diabeteshoidon digitaalisiin teknologioihin Suomessa ja siitä mitä haasteita he kohtaavat työssään käyttäessään näitä teknologioita. Aikaisempia tutkimuksia, joissa keskitytään nimenomaan diabeteshoitajien suhteeseen digitaalisen hoitoteknologian laitteisiin ja sovelluksiin ei ole tehty Suomessa tai kansainvälisesti. Tutkimus tehtiin kvalitatiivisena tutkimuksena teemahaastatteluilla. Haastatteluihin osallistui 6 diabeteshoitajaa Suomen eri sairaanhoitopiireistä, perusterveydenhuollon ja erikoissairaanhoidon yksiköistä. Haastattelujen analysointiin käytettiin aineistolähtöistä sisällönanalyysiä.

Tulokset paljastivat monenlaisia asioita, jotka vaikuttavat digitaalisen hoitoteknologian käyttöön diabeteksen hoidossa Suomessa. Potilaiden ja terveydenhoitohenkilöstön asenteet, teknologiaosaaminen, motivaatiotasot ja hoitoteknologian soveltuvuus yksittäisen diabeetikon tarpeisiin ja olosuhteisiin tuotiin esiin inhimillisinä tekijöinä digitaalisten teknologioiden käytössä tai käyttämättä jättämisessä. Ulkoisia tekijöitä olivat esimerkiksi diabeteshoitajien erilaiset mahdollisuudet vaikuttaa hoitoteknologioiden hankintaan työyksikössään, laitteiden kustannukset, tietotekniikkakysymykset, kuten itsehoitolaitteiden yhteensopivuus diabeetikkopotilaan matkapuhelimen kanssa, sekä yksityisyyttä ja tietoturvaa koskevat kysymykset järjestelmissä ja etäseurannassa potilaan ja terveydenhuollon yksikön välillä. Digitaalisen hoitoteknologian toimittajilta toivottiin räätälöityä ja jatkuvaa koulutusta ja teknistä tukea diabeteshoitajille, samoin kuin tutkimuksia ja dataa, jotka osoittaisivat konkreettiset hyödyt sekä diabeetikoille että terveydenhuollolle. Diabeteshoitajilla oli sekä positiivisia että negatiivisia kokemuksia ja mielipiteitä näistä tekijöistä, mutta kokonaisuutena näkemykset olivat optimistisia ja digitaalisen hoitoteknologian katsottiin olevan jatkossa vakiintunut, kustannustehokas ja välttämätön osa diabeteksen hoitoa Suomessa.

Opinnäytetyön tuloksia voidaan käyttää keskustelun avaajana diabeteshoitajien ja diabeetikoiden kokemusten ja näkemysten kuulemiseksi digitaalisen diabeteshoidon hyödyistä ja haasteista. Diabeteksen digitaalista hoitoteknologiaa koskevia tieteellisiä tutkimuksia ei ole tehty Suomessa, ja niitä on kansainvälisestikin vähän, joten terveydenhuollon päätöksentekijät, lääkinnällisen teknologian valmistajat ja sairaalat voisivat käyttää tätä tutkimusta näiden teknologioiden hyötyjen, haasteiden ja kustannustehokkuuden pohtimiseen ja mahdollistamaan avointa viestintää ja jatkotutkimusta näistä aiheista. Tämä tutkimus voisi myös edistää parhaiden käytäntöjen jakamista diabeteshoitajien ja terveydenhuollon ammattilaisten välillä, koska se tuo esiin eroja diabeteksen hoidon laadussa ja menetelmissä eri terveydenhuollon yksiköissä ja alueilla.

Avainsanat
digitaalinen hoitoteknologia, diabetes Suomessa, diabeteshoitaja, etäseuranta, kustannustehokkuus

CONTENTS

INTRODUCTION

At the end of 2017, there were approximately 452 000 diagnosed diabetics in Finland. The estimation is that circa 53 000 of those are type 1 diabetics (type 1 is more common in Finland than in any other country of the world) and the rest type 2 diabetics, plus the approximately 50 000-100 000 Finnish adults who have an undiagnosed type 2 diabetes. (Koski 2019, THL 2020) In 2011, public healthcare costs for diabetics (excluding basic healthcare outpatient visits and the cost of treatment equipment) were 832 million euros and productivity costs (i.e. productivity losses due to sick leaves, premature retirement, premature deaths) were 2552 million euros (Koski et al. 2018b). The more additional (diabetes-related) diseases a diabetic has, the greater the healthcare costs are. Research indicates that if diabetes treatment could be improved by increasing resources allocated to it in public healthcare, the incidence of additional diseases could be halved. This has the potential to reduce healthcare costs associated with treatment of diabetics by over 550 million euros annually, and to improve the quality of diabetics' lives significantly. (Koski et al. 2018a:17)

Diabetes can affect a person's well-being in many ways in daily life and over time. Long-term effects include micro- and macrovascular complications affecting e.g. kidneys (nefropathy), eyes (retinopathy) and peripheral nerves (neuropathy). Everyday challenges with the disease include acute complications and symptoms of too high or too low blood glucose levels (hyper- and hypoglycaemias), especially in insulin-dependent diabetics. (Insuliininpuutosdiabetes: Käypä hoito -suositus, 2020) Too low (hypoglycemia) or high (hyperglycemia) blood sugar levels can be caused by several variables in things like insulin dose, diet, exercise, stress etc. Both conditions make the diabetic feel unwell and can lead to unconsciousness and hospitalization, if left untreated.

This thesis will combine **digital technology and Finnish healthcare** themes, focusing on treatment of diabetes. In recent years, many advanced technologies have been brought to the market for diabetics, making the very necessary continuous self-monitoring and self-treatment of the disease easier for them. Due to easier and better self-care of diabetes, complications and additional health conditions can be avoided. New digital technologies like bloodless glucose level measuring with a sensor and continuous blood glucose level monitoring insulin pumps also facilitate digital test result communication remotely to the medical professionals, for example diabetes nurses, who are the primary contact for diabetics in the Finnish public healthcare system when problems arise and also when it's time for regular check-ups. Thus, the **diabetes nurse** is in a significant role as the first-hand contact and provider of continuous support in healthcare institutions. Also, **good self-care equipment** is needed for each diabetic. These are the two supporting pillars of a diabetic's good treatment. This thesis examines the benefits and challenges of using digital treatment technologies and remote monitoring, specifically from the diabetes nurses' viewpoint.

DIABETES PATIENT CARE

1.1 Diabetes as a disease

Diabetes is a group of various diseases in which the common denominator is a disorder in the body's energy metabolism, causing blood glucose levels to rise. Most common classifications are diabetes type 1 and diabetes type 2, but main types additionally include pregnancy diabetes and diabetes due to other causes (e.g. pancreatic infection). There are various forms and symptoms within each diabetes type, so the disease is very individual. (Diabetesliitto, 2019) Though type 1 and type 2 diabetes are remain as the main categories of this disease, other types of diabetes with their distinguishing features have been defined in recent years, such as LADA (Latent Autoimmune Diabetes in Adults) and MODY (Maturity-Onset Diabetes of the Young) (Insuliininpuutosdiabetes: Käypä hoito -suositus, 2020). Treatments also vary from dietary changes to insulin injections, but currently type 1 diabetes *always* requires lifelong insulin treatment, whereas type 2 diabetic's blood glucose levels can sometimes be normalized for example by losing weight (genetic tendency for diabetes still remaining) (Diabetesliitto, 2019). S

Diabetes can affect a person's well-being in many ways in daily life and long-term. Long-term effects include micro- and macrovascular complications affecting e.g. kidneys (nefropathy), eyes (retinopathy) and peripheral nerves (neuropathy). Everyday challenges with the disease include acute complications and symptoms of too high or too low blood glucose levels (hyper- and hypoglycaemias), especially in insulin-dependent diabetics. (Insuliininpuutosdiabetes: Käypä hoito -suositus, 2020) Too low (hypoglycemia) or high (hyperglycemia) blood sugar levels can be caused by several variables in things like insulin dose, diet, exercise, stress etc. Both conditions make the diabetic feel unwell and can lead to unconsciousness and hospitalization, if left untreated. In addition to the physical load, diabetes is also known to impose a significant psychological burden due to the effort and large number of personal treatment related decisions each day. These can in time easily lead to "diabetes burnout" (Polonsky, 1999:3,4). Although diabetes-related stresses do not always meet the criteria for formal diagnosis, evidence shows that people with diabetes have an elevated prevalence of conditions like depression, anxiety and eating disorders, and these, in turn can be a cause of reduced capacity to self-manage and lead to inappropriate self-care behaviours (NHS Diabetes, 2010:11). As a response to stress (mental or physical), the adrenal glands of the body trigger the release of glucose, which can lead to elevated blood glucose, making the whole sequence of events harder to manage for a diabetic (Diabetes.co.uk, 2019). S

1.2 Treatment path in the Finnish healthcare system

Diabetics in Finland usually have regular check-ups (time between check-ups depends on the hospital district where the diabetic lives and on the individual treatment plan / personal needs) with diabetes nurse and / or doctor at either their local health center or at a central or university hospital's diabetes clinic. Check-up visits consist of the following medical features:

Every 6-12 mths	Yearly	Every 1-3 yrs
Self-treatment realization and challenges, mental state, energy for self-treatment	P-Krea, eGFR	S-ALAT
HbA1c count	Microalbuminuria	Lipids
Hypoglycaemias (glucose level which causes symptoms), ketoasidosis	Feet condition	Fundus images and level of vision
Weight, physical exercise, dietary habits, lifestyle	Oral and dental health	ECG and physical performance
Blood pressure level at home measurings	Blood pressure measurement and pulse	
Injection areas	PVK	
Feet inspection (feet at risk)	P-K and Na on patients using blood pressure medication	
	Vehicle driving ability	

Table 1. Adult diabetic's check-up visit.
Insuliinipuutosdiabetes: Käypä hoito -suositus, 2020 (reference on 29.12.2020). www.käypähoito.fi.

According to Terveyskylä, an online health guidance service maintained by the five university hospitals in Finland, an individual treatment plan should be made for each newly diagnosed diabetic. Treatment guidance should be continuous, as information must be updated and current and varying challenges must be solved. The main responsibility for diabetic's treatment guidance rests with the diabetes nurse and diabetes doctor, however other professionals like nutritionist, physiotherapist and psychologist should be utilized when needed for the comprehensive wellbeing of the diabetic. (Terveyskylä Diabetestalo, 2019) Self-care guidance and personal learning can be supported by health technology, for example online instruction, self-care mobile applications and health oriented social media channels, all of which the healthcare professional can encourage the diabetic to look at and use (Hotus-hoitosuositus, 2020:11,12). Individual responsibility is especially important in a long-term illness like diabetes, and treatment cooperation between diabetic and healthcare professional attempts primarily to ensure that he has the needed preparedness to self-care. Patient-centered treatment's goals are diabetic's coping in everyday life, optimal quality of life, and prevention of additional diseases. (Ilanne-Parikka, 2019a) S

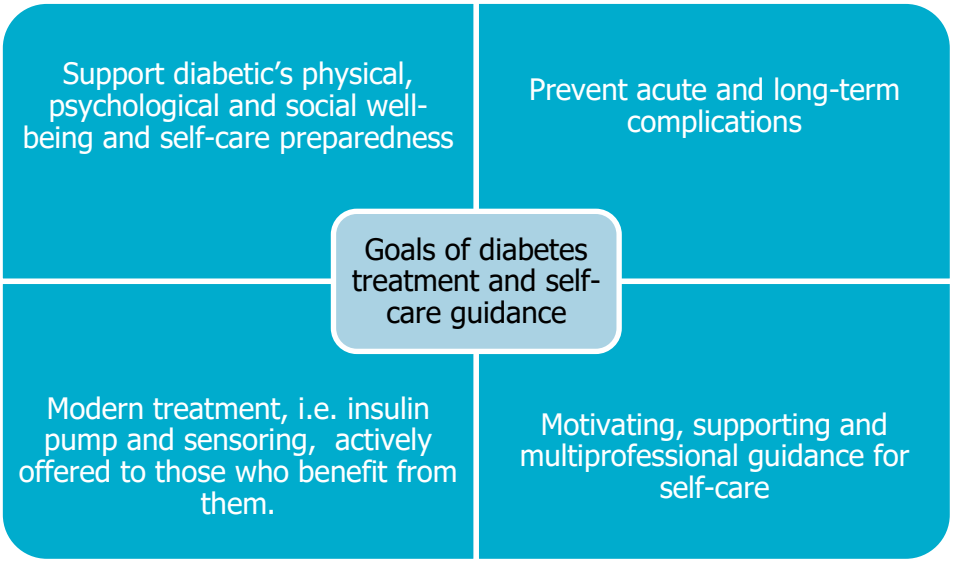

Figure 1. National treatment guideline goals for Insulin dependent diabetics. (Adjusted from Insuliininpuutosiabetes: Käypä hoito -suositus, 2020)

Most adult diabetics using standard treatment methods are treated in basic healthcare, whereas the insulin pump (a special medical device for insulin delivery) has traditionally been viewed as a treatment method requiring special knowhow by both the healthcare facility and diabetic himself, and therefore insulin pump treatment is usually initiated in a hospital or a centralized diabetes clinic, where there is expertise in pump treatment (Vehkavaara & Ojalammi, 2019). Although treating insulin pump patients in basic healthcare is rare in Finland, there are some healthcare units which have taken the initiative to gain the needed expertise and succeeded well, for example Nurmijärvi health centre located in a small city of 40 000 inhabitants. About 15% of the diabetics treated in the health centre now use an insulin pump with good results; for example, the median of long term glucose value HbA_{1c} (general reference level for insulin treatment diabetics = 48-59 mmol/mol, or 6,5-7,5%) for these diabetics decreased since the start of insulin pump treatment from 70 mmol/mol (8,5%) to 64 mmol (8,0%). They got rid of repeated hypoglycaemias and were generally satisfied with the pump treatment's effects on their quality of life. (Honkasalo & Miettinen, 2010; Ilanne -Parikka, 2019b) This goes to show that there are differences in the level and quality of treatment between healthcare units and some freedom of application of the national recommendations of diabetes treatment. S

1.3 Diabetes nurse's role

Although the diabetes nurse is in a critical role as the first-hand contact and support in healthcare institutions for diabetics, "diabetes nurse" is still not an official professional title in Finland. The Diabetes Nurses registered association is working on getting the title officially acknowledged and protected. Currently diabetes nurses are nurses who have specialized in diabetes care. The role also varies according to whether the nurse is working in basic healthcare (health centres) or specialized medical care (central and university hospital clinics), with adult or pediatric diabetics, etc. Consequently, various hospitals and health centres in Finland have their own definitions and job descriptions for diabetes nurses' work, if any. A common, unified job description is lacking, which adds challenges to development of the role and the work diabetes nurses do throughout the country. (Diabetes Nurses reg. association, 2019) Figure 2 shows an example of a specialized healthcare diabetes nurse's responsibilities in one Finnish central hospital:

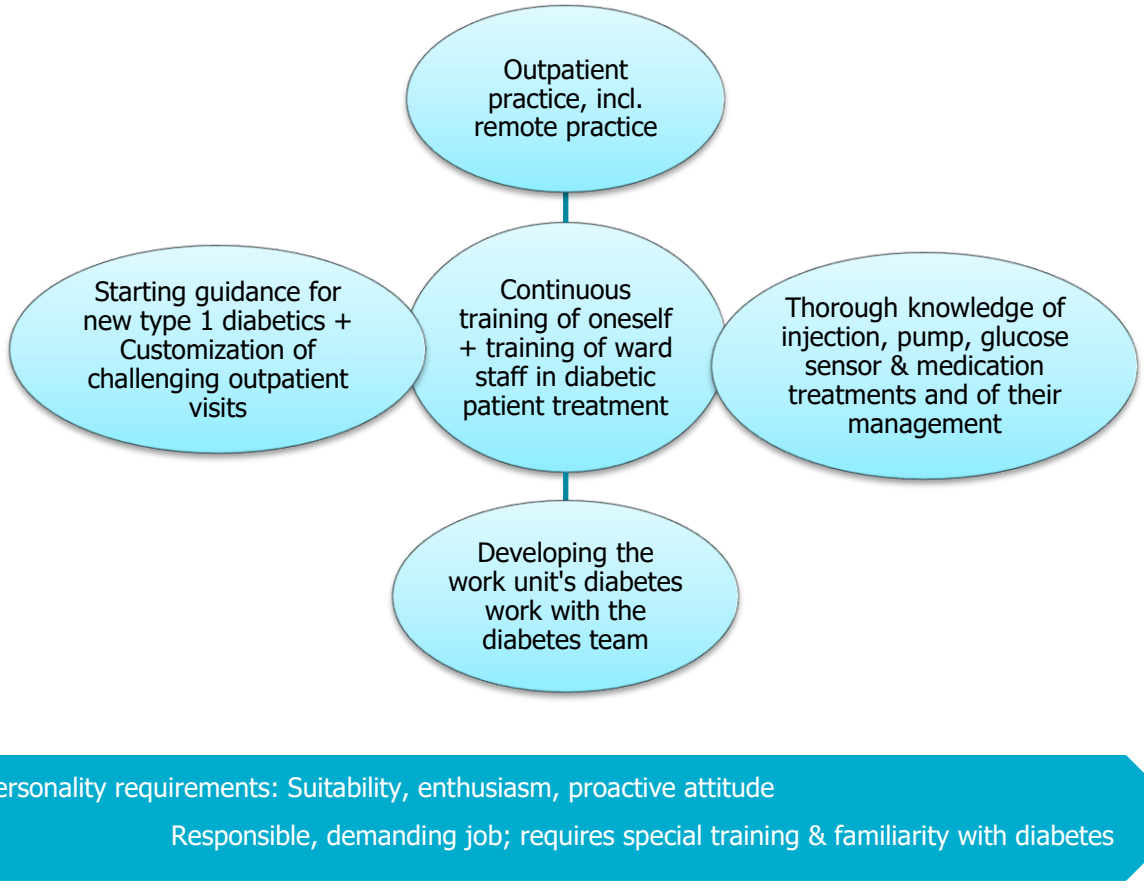

Figure 2. A specialized healthcare diabetes nurse's work description. (Diabetes Nurses Reg. Association, 2021) R

In addition to treating and monitoring treatment of diabetics, diabetes nurses in Finland often educate and train other healthcare professionals and the diabetic's family members, school personnel and healthcare students in schools and healthcare settings. Social influencing, taking part in diabetes research, and cooperation with local diabetes associations are also part of diabetes nurse's work. (Simonen, 2012) As type 1 diabetic numbers continue growing in Finland, it has been suggested that their treatment should be centered in specific centres of expertise rather than in basic health centres, where doctors and nurses currently have mostly type 2 diabetics in their care. Diabetes experts also recommend that a care system focusing on diabetes nurses with experience and special education should be created in Finland. Continuous treatment guidance given by specialized diabetes nurses (supported by an experienced doctor) facilitates a long-term, cost-saving, and better-quality treatment. (Tuomi and Saraheimo, 2014) S

International literature lists **education, counselling, and disease management** as the key tasks of the specialist diabetes nurse. Education involves imparting information about the disease and increasing the person's understanding of its various aspects and control methods. Education also means specialist education and providing support regarding diabetes to other healthcare professionals (e.g. those in primary care), and liaising between care providers. Counselling is needed for the diabetic to accept the life-long disease and the changes it brings, and disease management includes e.g. adjustments to the his medication and managing diabetes in context with other possible diseases or health issues the person might have. (Loveman, Royle and Waugh, 2010:3; Riordan, McHugh, Murphy, et al., 2017:1) While doctors focus mainly on standardized, medical control of diabetic patients, diabetes nurses often have a more personal approach to the diabetic person and endeavor to meet his psychological and emotional needs in dealing with the disease and everyday life issues, in addition to having the ability to make independent clinical judgements (Sørensen, Groven, Gjelsvik, et al. 2020:17). Specialist diabetes nurses have been shown to have a positive effect on diabetics' outcomes, for instance by acting as "negotiators" between the diabetics and clinical partners and thereby preventing problem escalation, reducing the HbA1c levels at least short-term, and improving patient satisfaction by providing personal, specific and longer length consultations. They promote and support diabetic's self-care management and facilitate digital healthcare into diabetes treatment, as well as refer the person to other specialist services when needed. (Lawler, Trevatt, Elliot, et al., 2019; Royal College of Nursing, 2020.) S

1.4 Diabetic's self-care – actions and goals

The main goals for a diabetic in his everyday actions are as few symptoms as possible and maintaining as normal a blood glucose level as possible. Too high and too low glucose as well as big changes ("rollercoaster") should be avoided. As for glucose measurements, the general guideline is for it to be mainly under 7 mmol/l when fasting, and mainly 8-10 mmol/l after meals. However, these limits should be set individually according to each diabetic's circumstances. LDL cholesterol count should be under 2,5 mmol/l, blood pressure <140/80 mmHg. Regular exercise, a healthy diet and weight management along with moderate alcohol consumption are the basics of diabetes management. To achieve the blood glucose goals, diligent checks of blood sugar levels and adjusting diet, exercise &

medication accordingly are essential in maintaining a good level of life quality and preventing complications. (Insuliininpuutosdiabetes: Käypä hoito -suositus, 2020) R

1.5 Diabetic's self-care equipment and its availability in Finland

Insulin delivery devices. Insulin can be delivered by an insulin pen, which is a pen-like device into which a single-use needle is attached. Injection times are tailored according to each diabetic's daily routines and dosages are defined mainly by blood glucose testing done several times a day by the diabetic himself, and by estimating carbohydrate amounts at meals. (Ilanne-Parikka, 2018) Insulin can also be delivered by an insulin pump, which is attached to a small subcutaneous cannula, which is changed by the diabetic every 2-3 days. The pump delivers a pre-set amount of basic insulin plus an extra dosage chosen by the user at mealtimes. Continuous or periodical tissue glucose sensoring can be combined with insulin pump treatment. Development of the devices has been expanding, and the technology has become almost like an artificial pancreas, independently regulating metabolism of the diabetic person and using learning algorithms to adjust blood glucose levels. In the latest pump models, a sensor can control basic insulin delivery and automatically stop delivery if blood glucose is too low. There are also differences in whether a pump delivers insulin through a catheter or, in more inconspicuous models, through a cannula penetrating the skin. Insulin pump treatment is especially beneficial (instead of insulin pen injections) for diabetics who are sensitive to insulin and have a lot of hypoglycaemias. (Ilanne-Parikka, 2018; Honkasalo, Miettinen and Saraheimo, 2018) S

Blood glucose measuring devices*.* Self-monitoring of blood glucose is essential for successful treatment of type 1 diabetes. Medication, meals and exercise can only be adjusted to support good treatment balance if blood glucose measurements at different times of the day are known. Although regular self-monitoring of blood glucose has not generally been viewed as important in treatment of type 2 diabetes, recent studies show that it is beneficial in most cases of type 2 diabetics and provides "clinical and statistical improvements in glycaemic control in Type 2 diabetes" also (Parsons et al., 2019). Especially the over 30 % of type 2 diabetics who are either very insulin resistant or their bodies do not produce enough insulin clearly benefit from regular glucose monitoring and sensoring, due to the increased risk of additional diseases (Ahlqvist, Storm, Käräjämäki, et al. 2018).

There are approximately twenty different models of blood glucose meters for individual self-monitoring purpose. The traditional meter is a small device, which reads blood glucose measurement from a small drop of blood taken from the finger. Continuous sensoring devices are also available for self-monitoring. A small sensor measures tissue glucose (measurement accuracy is +-10% and the delay a few minutes compared to blood glucose) and is set into subcutaneous fatty tissue and changed every 1-2 weeks. The sensor measurement is scanned with a mobile device, and it sends the measurement and the indication of change of direction to the reading device or the insulin pump screen. For most of the traditional glucose meters and for all of the sensoring devices, measurements can be transferred to a mobile application, computer, or a cloud server. From there, a diabetic can send the data to the healthcare facility, which allows commenting and instruction to happen for example

by telephone instead of a physical visit. (Ilanne-Parikka, 2018; Honkasalo, Miettinen and Saraheimo, 2018) Blood glucose meters and sensoring devices can be connected to various smart phone applications, which collect data of and also measure also the person's physical activity, nutrition, and energy consumption, which helps to take a comprehensive look at his diabetes treatment and self-care (Aisla, 2017).

Picture 1. A blood glucose sensor and its reading device. (Diabetes-lehti 2016.)

Availability issues in Finland*.* According to a statement by the Finnish Diabetes Association, "a diabetic has a right to get the needed amount of treatment equipment without charge from the health centre". The amount of equipment is individually defined in each diabetic's treatment plan. Healthcare law in Finland obligates municipalities to fulfill this requirement. (Diabetesliitto, 2019) The Current Care guideline also mandates that opportunities provided by modern treatment (pump treatment and sensoring) should be actively offered to persons who have insulin deficiency diabetes and for whom these treatment possibilities are beneficial (Insuliininpuutosdiabetes: Käypä hoito -suositus, 2020). In spite of the national recommendations and universal treatment guidelines and criteria for treatment, availability of treatment and technologies vary according to where the person lives. This is due to variation in financial and expertise resources and healthcare organization in different areas and municipalities. (Koski, 2019:56) Currently in Finland there are issues in availability of self-care equipment, treatment instruction services and in realisation of necessary check-up visits. The number of diabetics has increased in recent years, whereas healthcare resources have not. (Koski et al. 2018a:17)

In 2018, The Diabetes Association of Finland made an extensive inquiry of 713 type 1 adult diabetics regarding their experiences of the availability of sensoring devices and insulin pumps in different parts of Finland. The results showed that the Current Care criteria for diabetics who especially would benefit from using new treatment technologies did **not** facilitate getting the equipment from the public healthcare instances. Regional differences in availability and poor targeting of the equipment to diabetics who would benefit from them are among the main issues that came to attention. (Diabetesliitto, 2018)

1.6 Use of digital technologies in diabetes care

Healthcare-patient relationship*.* A 2018 report on the diabetes treatment path and its development in Finland it is mentioned that "the most important factor in patient's treatment is getting humane contact and support, which is best achieved when the patient has the possibility to get needed time, professional care and support at a time when his situation really requires it" (Europaeus et al. 2018:6). Technology and its wise and effective use can obviously assist in getting the right help at the right time. However, technology or devices are not a direct ticket to better treatment results, but it is important to choose the right device according to the diabetic's needs and monitor appropriate use of the device regularly. Results are best if diabetics are enrolled and taught well to use the new devices and solutions. The modern technological aids for diabetes care collect a vast amount of data, so extracting the essential information is important, which requires continuous training and education of the healthcare staff and the patient. (Honkasalo et al. 2018; Kaufman and Khurana 2016:59) From the diabetic's viewpoint, Kaufman and Khurana comment that "people are not looking for stand-alone interventions but prefer those that are sponsored by and integrated into therapeutic relationships" (2016:59). Diabetes nurses' concern in Finnish healthcare is that they are not currently allowed / able to plan customer check-up visits in the best interests of the patient, for example by deciding the length of the visit according to the person's needs. Technology, like blood sugar meters, is not utilized fully according to the nurses, since sometimes the results are only downloaded from the meter at the check-up visit and not electronically in between visits to support remote monitoring. Training is still needed for using technology and for guiding the diabetics to use it. (Europaeus et al. 2018:14,15)

Psychological effects*.* Technology can be used not only to measure and monitor self-care results, but also to give psychosocial support and improve a diabetic's self-management skills, with tailored education for the needs of each diabetic and his family. Improved self-management skills, in turn, can improve clinical outcomes and decrease complications. (Pralahad, Tanenbaum, Hood, et al., 2018:427) For example insulin pump therapy has been associated with reduced fear of hypoglycaemias in type 1 diabetics, and consequently improvements in their HbA1c values and psychological outcomes (Shaban, Knott, Jenkins et al., 2017:276). Similarly, current short-term studies indicate that blood glucose flash meters (sensoring) compared to traditional capillary blood sampling reduce not only pain and discomfort of testing, but that diabetics using flash meters also report them to be easier, more private, less stressful and more hassle-free to use (Al Hayek, Robert and Al Dawish, 2020:6).

Effects on HbA1c. According to a survey of a group of type 1 diabetics using so called flash-meters (blood glucose sensoring) in Kuopio University hospital, starting to use the flash-meter decreased the patients' HbA1c values remarkably, on average by 9,8 mmol/l or 0,9 %, which is much more than what has been accomplished for example by changing the type of long-acting insulin (HbA1c level decreased by 0,07 % according to one meta-analysis). Many diabetics also learned to

interpret their glucose values and use this information in their self-care, for example in adjusting insulin doses. (Mustonen, Laaksonen, Moilanen 2018) The effectiveness of flash glucose monitoring was proved also in a type 1 diabetic study in the UK, in which the results showed a mean reduction of 16,1 mmol/mol or 4,7 % in HbA1c over a 6-month follow-up. These improvements were accredited mainly to the graphs and trends provided by the flash glucose monitoring system, as these allow the diabetics to understand how different factors impact their blood glucose throughout the day and help them take charge of their self-care actions. (Heald, Yadegarfar, Anderson et al. 2019:3)

Telecare and remote monitoring. An international review of literature on the effects of telecare intervention (telecare = technologies such as telephone, internet-based disease management systems and text message service) in type 2 diabetics and inadequate glycaemic control found that there was a significant improvement in glycemic control when compared with routine follow-up monitored diabetics. In the reviewed studies, telecare gave promising results especially in monitoring and supporting the lifestyle changes of diabetics. (Huang et al. 2015) However, the conclusion of another study performed in the UK was that structured self-monitoring of blood glucose provides improvements in glycaemic control in type 2 diabetes, but no additional benefit was observed in glycaemic control with the addition of once-monthly TeleCare support (Parsons et al. 2019). Commercially produced mobile applications for diabetes self-care are also on the rise and help diabetics to collect health data and offer instruction on diabetes care. There is some evidence that certain mobile apps combined with healthcare staff support for the person may be useful in improving short-term outcomes (for example HbA1c values) for both type 1 and type 2 diabetics. (Veazie, Winchell, Gilbert et al. 2018:1173)

Short-term trials have been made and reported in the Finnish healthcare system for digital and remote diabetic care services. For example, there was a pilot project developing a web course for type 1 diabetics in Satakunta central hospital's diabetes clinic. The web course was meant to be a complementary part of diabetic self-care guidance and counselling. One of the purposes of developing a web counselling course was to motivate young diabetics and personalize the guidance provided to them. Although the pilot and the subsequent user questionnaire were very small-scale, the results showed that the participants got new insight into their disease's self-management and found peer support and professional online counselling effective. (Kuusisto 2016:2,8) Similarly, diabetics were positive about a 2017 trial made with a diabetes self-management application called Balansio in the North Carelia central hospital. The diabetic input information regarding his self-care and various measurements into the application, and the professional, in this case diabetes nurse, could review that information any time between physical check-up visits and answer the person's questions digitally. Generally, the concept was found good but the professionals found that because the application did not communicate with the hospital's existing patient information system, they had to do a lot of double work in recording what had been discussed with the patient etc. (Nykänen & Sihvo 2018:50-53) Professionals may have the will to use the latest devices, but if IT systems at their workplace do not support the technology, their willingness may end up in frustration. In a recent study, experts in different areas of diabetes care were interviewed on the possibilities of technology

in diabetes care practice in Finland. The interviewees were very positive about the potential of technology in supporting diabetics and healthcare professionals, but also voiced their concerns that there would have to be significant changes in the attitude and the organizational structure in the current healthcare system in order to make it work. They also mentioned legal aspects (like privacy) and the fact that not everybody would want or even benefit from more digitalized treatment. (Wiitakorpi 2018:30,31)

Although not directly related to diabetes, a Finnish study about public health centre staff's experiences in telehealth was published in 2009. Remote health care or telehealth is defined in the study as remote health care applications using video discussion technology, e.g. remote consultations, visits, training and meetings. Healthcare staff found remote health care models useful in increasing their training opportunities, making networking easier and reducing the need to travel. Similarly, the staff found the benefits for patients to be reduced travelling needs and improvements in treatment quality, and accessibility of services. The main factors affecting remote health care introduction and use in health centre environment are the real need for a new operating model, the expected and experienced benefits, user friendliness, and qualities in the employee's personality. The operational model's visibility and suitability and other social organization factors were not found to be as important in the introduction of remote health care technologies. (Vuononvirta et al. 2009:272-273, 279-280)

Healthcare organizations may slow some innovations due to required evidence of effectiveness, privacy requirements, integration into the existing technology ecosystem and demonstrated return on investment. Many of the reviewed digital health solutions have shown positive effects on diabetics' self-care, but only short-term. Long-term impacts have not been studied or demonstrated yet. One suggested solution to solve these issues is that health-care organizations should "rather than consider program or technology *purchases*… consider population **partnerships** with vendors who will start small and scale over time to impact population health". (Kaufman and Khurana 2016:68)

1.7 Cost of diabetes

One of the most common arguments for hesitating to use modern treatment technologies in healthcare is their assumed high cost. To understand the monetary and non-monetary value of diabetes treatment technologies better, the following section presents some statistics of costs and cost effectiveness of diabetes treatment in Finland.

The Finnish institute for health and welfare (Terveyden ja hyvinvoinnin laitos, THL) in Finland has estimated that diabetics' healthcare costs formed approximately 9% of all healthcare costs in the year 2011. In Europe, the percentage was 18% in the same year. Additional health problems caused by diabetes multiply healthcare costs as follows:

- diabetes care with no additional illnesses = approx. 1300 EUR / person / year
- diabetes care when connected with additional illnesses = approx. 5700 EUR / person / year

In addition to direct care costs, there are diabetes related productivity costs in the form of sick leaves, premature retirement and death. In 2011 these costs were estimated to have been over 2552 million euros nationally. In fact, the effect of diabetes on reduced labour supply is reported to have a greater negative effect on the country's economy than diabetes health care costs, and these factors together reduce Finnish GDP by more than one percent long-term. (THL 2020; Reini 2013:23)

The problem is that the most developed treatment technologies with sensoring or other remote monitoring capabilities have come to the Finnish market after the year 2007, and at the same time, the amount of diagnosed diabetics has grown, as mentioned before. Updated reports of treatment costs are unfortunately not available. Also, the available reports do not separate type 1 and type 2 diabetics, or insulin and other medication. It is thus not possible to get an accurate picture of where exactly the costs come from and how the latest treatment technologies affect care and productivity costs. However, the following chart published in 2007 in a research report gives a strong indication of the biggest "culprits" in diabetes care cost occurring in Finland:

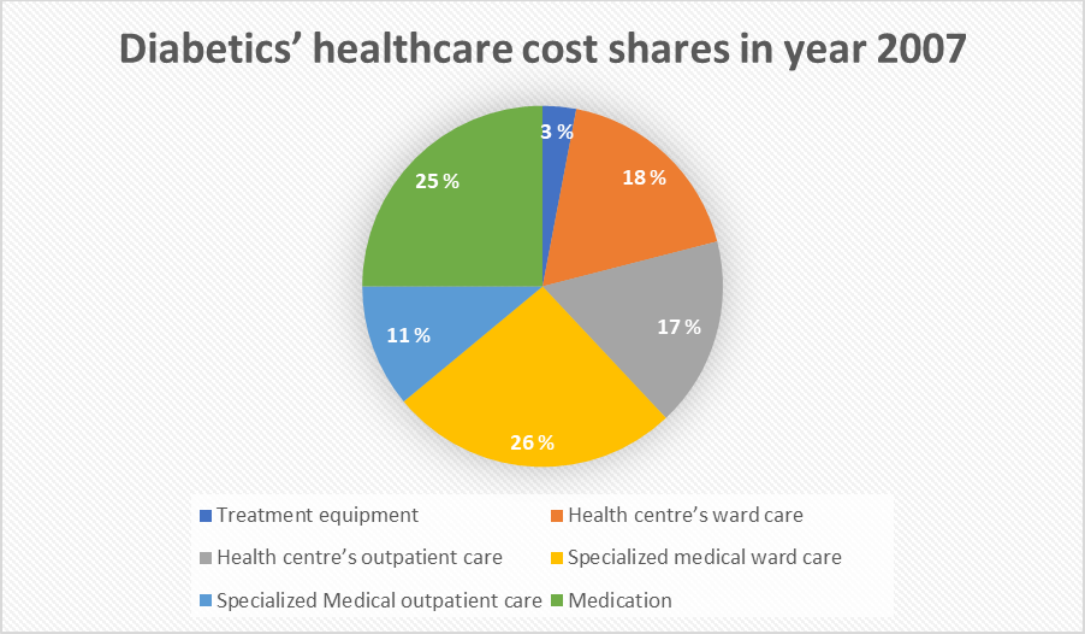

Chart 1. Diabetics' healthcare cost shares in year 2007. (Adjusted from Jarvala et al. 2007, 17)

As indicated by the above chart, treatment equipment given to diabetics for self-treatment and monitoring is a very small percentage of the total cost of diabetics' health care and nursing. The report where the chart is taken from, "Diabetes costs in Finland 1998-2007" also concluded that financially it is sensible to focus on treating diagnosed diabetics so that appearance of additional illnesses could be prevented or delayed as much as possible. Additional illnesses due to diabetes complications cause most of the inpatient and outpatient ward costs. The conclusion of the report also stated

that "if we want to lower diabetes caused costs, savings in treatment equipment usage does not make notable cost savings possible". (Jarvala et al. 2007:39) Koski et al. conclude the same by stating that it is a waste of money not to more efficiently allocate personnel and improve training for diabetics' treatment. There are currently problems with availability of self-care equipment, treatment guidance services, and in providing necessary check-up visits. (Koski et al. 2018a:17)

Tampere University Hospital estimates that blood sugar measuring with a traditional meter and strips costs approx. 180 EUR / year, with a blood sugar scanner approx. 1400 EUR / year, and with continuous sensoring approx. 4500 EUR / year. Insulin pump expenses are approx. 2100-6700 EUR / year per diabetic. However, there still is not enough information collected on the cost-benefit ratio. For example, one might ask how much money is saved when a diabetic avoids just one unnecessary hospital visit or ward stay? (Europaeus et al. 2018:16) As more flash-sensors and competition come to the market, prices will likely go down in the future, but already now real-life studies support the average decrease of 14 mmol/l i.e. 1,3 % in HbA1c values of diabetics using this form of technology. This makes the cost-effectiveness of sensor monitoring obvious. (Honkasalo et al. 2018)

Cost reduction is an especially important issue in a sparsely populated country like Finland. For example diabetic patients' travel costs to check-up visits are indirect costs that are often ignored in economic analyses. This intriguing issue was addressed in a recent study conducted in the region of North Karelia, where distances are generally long, and inhabitants scattered. The study, by Laatikainen et al., used type 2 diabetics' patient data from a regional electronic patient database and developed a georeferenced cost model to calculate optimal routes for primary-care follow-up visits. The study found that in North Karelia, the average annual total costs of type 2 diabetics' follow-up screening of long-term blood glucose level HbA1c are 280 EUR / patient. Combined travel and time costs are 21% of the total costs. Using self-monitoring for a half of the follow-up visits, the average annual total costs could be reduced by 57%, from 280 EUR / patient to 121 EUR / patient. (Laatikainen et al. 2018). Self-monitoring technology combined with remote support via the internet or a phone connection with healthcare professionals like diabetes nurses can have major effects on healthcare cost effectiveness.

2 PURPOSE AND OBJECTIVES OF THE STUDY

The aim of the study is to produce information on how diabetes nurses view digital treatment technologies for diabetes in Finland and identify obstacles they find in their work when using these.

The **core objectives** of this thesis study are:

- describing how digital treatment technologies and remote monitoring are used by diabetes nurses in public healthcare in Finland
- finding out what are the professional, personal, and societal benefits and challenges of using these technologies from diabetes nurses' point of view

The study results will form a firm foundation for evaluating the role of new technologies in treatment of diabetes in Finland, their effect on patients' wellbeing, and on healthcare costs. This information will benefit both the healthcare sector and authorities making healthcare policies and setting procurement guidelines. The thesis will also give valuable information to health technology manufacturing companies and their representative organization in Finland, Sailab MedTech, so that they can facilitate better, sustainable care for patients, and improve support to healthcare professionals.

3 METHOD AND EXECUTION OF THE STUDY

3.1 Study method

The study's focus is on diabetes nurses' **opinions and experiences***,* so it does not produce primarily numerical information, but rather, explanations and reasons for people's actions. Thus, the study was defined as **qualitative**, as opposed to quantitative. In her book "Tutki ja kehitä" ("Study and Develop"), Hanna Vilkka explains that when using a qualitative study method, "the goal is to describe and explain the horizon of understanding in which a person acts" (2017, ch. 3).

A group of public healthcare diabetes nurses were selected to be interviewed by video or phone calls. The interview questions were planned with input from Sailab Diabetes Division, the thesis' cooperation organization. In the beginning of the interview, some basic background questions were posed (age, work years as a diabetes nurse, work location, etc.). Key terms of the interview questions were also explained to the interviewees. The actual interview questions were the same for each individual, but the wording of the questions was slightly varied according to the situation during the interviews, and the interviewees were encouraged to answer with their own words and examples from real-life situations. This interview style is called *thematic* or *half-structured interview,* based on the description by Hirsjärvi and Hurme. (2015 ch. 4.2.3)

Please see **Appendix 1**: Interview questions (both in Finnish and English)

3.2 Planning and execution of the interviews

Based on the information Sailab had, all children with type 1 diabetes in Finland are currently guaranteed to get insulin pumps and sensoring or otherwise remote monitoring facilitating blood glucose meter systems if they desire to have them. The issue of unequal distribution or use of the mentioned equipment is connected to adult type 1 and type 2 diabetics in Finland. All diabetics who use an insulin pump have their check-up visits and treatment in the university or central hospitals, whereas diabetics who use insulin injection pens or tablet medication (or both) are usually treated in local basic healthcare centres. (Sailab Diabetes Division 2019) To include these variables, the plan was to interview two (2) diabetes nurses (treating adult diabetics) from each of the five (5) university hospital districts in Finland; one nurse working at a hospital clinic (specialized healthcare) and one in a health centre (basic healthcare). Total amount of interviewees would be ten (10) persons.

The Diabetes Nurses registered association offered to send an invitation to attend the interview to all diabetes nurses on their member list (approx. 1200 nurses), who have previously given the association a permission to be approached by email for marketing and other purposes. The final interviewees would be selected from those who replied to the invitation. To ensure the fulfillment of the

interviewee specs mentioned above, some background information was asked in the invitation email. The desired number of interviewees was not achieved by the invitation email from the Diabetes Nurses association in the autumn of 2019, therefore healthcare facilities and hospitals were contacted directly in the spring of 2020, and research applications were made to the appropriate units within these. Some of the interviewees came through the Diabetes Nurses association invitation, others through research applications to hospitals.

Interview permissions and responses from the planned amount of interviewees could not be secured in the time frame for this thesis study, so in the end, **six (6) interviews** in total were conducted, 3 to specialized healthcare nurses and 3 to basic healthcare nurses. All 5 university hospital districts were represented. The interviews were conducted via video call (Skype, Teams) or by phone according to the interviewee's preference during the spring and autumn of 2020. Each interview lasted 40-55 minutes. The interviews were conducted in Finnish. Each interviewee got the interview questions, a study information notice and an acceptance form before the interview by email. The study information notice also discussed how the interviewee's personal information would be used and stored during the thesis process, and gave the interviewee an opportunity to refuse attending the thesis interview.

3.3 Processing of interview material

Due to limited time and resources, the interview transcripts are not provided in their entirety. For example, Hirsjärvi and Hurme explain that an alternative to transcribing is making conclusions or coding themes directly from the recorded interview materials (2017 ch. 7.2). Accordingly, the interviews were analyzed directly from voice recordings and written notes made during the interviews.

The interviewees were coded with simple letters, from A to F, and these codes are mentioned instead of the nurse's personal information after quotations. In addition, it is noted whether the nurse works in a University hospital, i.e. specialized healthcare, or in a basic healthcare unit; these are abbreviated as 'sh' for specialized healthcare and 'bh' for basic healthcare. All interviewed nurses were women, between ages 38-61 years. The content and contextual meaning of speech has been retained as carefully as possible in the quotes. Note that text in square brackets ([]) is text added to clarify the meaning of the quote in the absence of the context / question asked.

4 ANALYSIS OF THE STUDY MATERIAL

4.1 Material based content analysis

To analyse the interview information, the content analysis method of qualitative study was used. The academic literature generally mentions two options for content analysis: **material based** and **theory based** content analysis. According to Vilkka's (2017 ch. 6) description, material based content analysis means that the researcher tries to find some kind of action logic or typical story from the research material. Theory based content analysis, on the other hand, takes existing theories and previous studies about a topic as guiding principles in analysing the study material, and parts of existing theoretical concepts are used as framework for study material classification. Material based content analysis suited the objectives of this thesis better, because the thesis set out to find new perspectives and opinions from diabetes nurses' personal comments.

The logic or typical story that was looked for in the diabetes nurses' interview materials was **benefits and challenges** of using digital treatment technologies. The study material was analysed from this viewpoint. This logic can also be described as the analysis unit of this study; analysis unit can be for example a word, a sentence, or a body of thoughts determined by study objectives and the quality of the study material (Tuomi & Sarajärvi 2017 ch. 4). Material based content analysis has several phases, one model of it is described in the below chart:

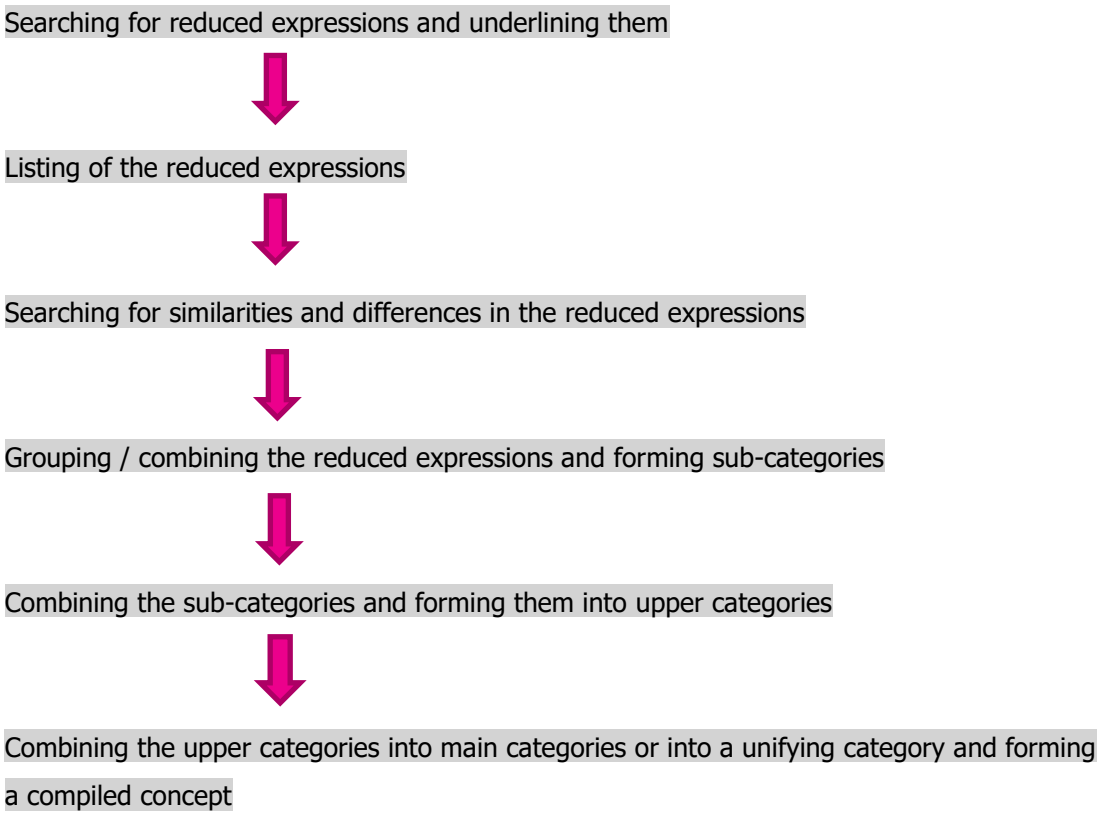

Chart 2. Material based content analysis progress. (Adjusted from Tuomi & Sarajärvi 2017 ch. 4)

Differing forms of qualitative material analysis are explained by the fact that the analysis is always based on the researcher's conclusions and has elements of the researcher's personal interpretation (Puusa 2020). Related to this, Tuomi and Sarajärvi (2017 ch. 4) also write that examples and models of analysis methods vary according to the study material and thus the analysis can have variations for example sometimes in the amount and format of levels and categories formed from the material. The flexibility of content analysis means that there is no 'right way' of doing it and that the researcher has a lot of power in judging what is the most appropriate way for his study; this makes the analysis process interesting but also challenging and labor intensive (Elo & Kyngäs 2008).

4.2 Reduced expressions, their grouping and sub-categorizing

Following the analysis model in Chart 2 (see chapter 5.4), the process began by listening to the interview recordings, reading written notes of the interviews several times and then underlining key expressions which are most relevant to the objectives of the study and / or which come up repeatedly in the interview material. In the table shown in **Appendix 2**, the chosen quotations are in the left side column, and from each quotation, a reduced / simplified expression or expressions are formed and written out in the right side column of the table. The table follows the structure of the model table "Esimerkki aineiston redusoinnista eli pelkistämisestä" ("Example of reduction, i.e. simplifying of material") given in Tuomi & Sarajärvi (2017) chapter 4.4.3.

Because all six interviews were analyzed at the same time, it seemed reasonable to gather similar expressions from different interviewees together, and the groupings naturally somewhat follow the order of the interview questions. Consequently, grouping or clustering at a basic level was done already at this stage of the analysis.

4.3 Sub-categories and upper categories

The next step of content analysis was to form sub-categories and upper categories from the grouped simplified expressions. The upper categories formation is shown in the table below.

Simplified expressions	Sub-categories	Upper categories
Patients' devices and their non-compatibility with treatment technology	End-user issues with treatment technology usability	Technological and privacy issues pose challenges
Lack of know-how to use treatment technology		
Nurse acting as IT support	Patients fear data protection is not strong enough when using technologies	
Patients lack trust in personal data security		
Compatibility of device manufacturers' systems and hospitals' data systems poor	Healthcare facilities' data systems not "talking" with treatment technology systems	
Older patients' need of meter with a large display	Elderly patients' physical and emotional needs regarding devices	Age-group-specific challenges in usage of digital treatment technology
Older patients want traditional methods		
Some youth not interested enough in their diabetes treatment	Devices don't motivate young patients enough	
Not every patient needs technologies for sufficient treatment	Individual patient needs require individual treatment solutions, one device and one type of appointment not appropriate for everyone	Flexible and open-minded attitude required from healthcare staff and patients to release the full potential of treatment technologies
Treatment technology's benefits depend on the patient's motivation and other health issues		

Phone appointments challenging due to language and communication barriers, takes more time Patients not cooperating with healthcare staff	Treatment technology only effective if patients utilize it fully	
Patients don't always utilize technology fully	Decision making in healthcare technology selection	External factors in selection and usage of treatment technologies
Political authorities think primarily about costs Varied possibilities to affect procurement of devices / technology	Lack of unity in hospital procurement processes	
Remote appointments benefit patient and society Long-term cost-effectiveness Prevents additional diseases Use of technology saves nurse's time and helps to focus on essential information Proactive approach to treatment Improvements in patients' motivation and knowledge-based treatment Benefits the patient's treatment balance	Wide-range benefits in life quality and in practical and financial terms Makes diabetes' nurse's work more effective and improves relationships to patients Improves self-care motivation and quality	Diabetes nurses see multiple benefits in using digital treatment technologies

Table 2. Sub-categories and upper categories

4.4 Main categories

Age, attitudes and other similar features affecting the use of digital treatment technologies could be categorized as **human factors,** which is the first main category formed from the interview content analysis (see Table 3). These factors apply both to diabetes nurses and diabetics and affect their choices, motivation and ability to use certain diabetes treatment methods and technologies.

Upper Categories	**Main Category**
Age-group-specific challenges in usage of digital treatment technology Flexible and open-minded attitude required from healthcare staff and patients to release the full potential of treatment technologies	**Human factors in the use of digital treatment technologies**
AFFECTS BOTH DIABETIC & HEALTHCARE PROFESSIONAL	

Table 3. Main Category 1: Human factors affecting the use of digital treatment technologies.

The second main category formed from the interview content analysis collects **external factors** affecting diabetes nurses' and their patients' use of digital diabetes treatment technologies. "External" here refers to factors that come from outside the person (diabetes nurse or patient) himself and for which he may have little or no control, such as IT systems, hospital procurement systems, and device user interface functions and design. Some of these factors overlap with the human factors discussed previously, for example an older person's desire for 'traditional' blood glucose meter may be a human factor, but one of the reasons for it may be that the person doesn't have a personal computer with which to download and review results from a flash glucose meter, i.e. IT system issue, which is an external factor. For the sake of clarity, however, these factors are separated into their own main categories in this study and content analysis.

Upper Categories	**Main Category**
Technological and privacy issues pose challenges External factors in selection and usage of treatment technologies	**External factors in the use of digital treatment technologies**

Table 4. Main Category 2: External factors affecting the use of digital treatment technologies.

The third, and final, main category combining the rest of the themes in the previous stages of the content analysis is benefits and future opportunities that diabetes nurses see in digital treatment technology.

Upper Categories	**Main Category**
Diabetes nurses see multiple benefits in using digital treatment technologies	**Benefits and future opportunities**

Table 5. Main Category 3: Benefits and future opportunities of digital treatment technologies.

The three main categories form the results of the study and are discussed in more detail in the following chapters.

5 DISCUSSION OF RESULTS

5.1 Human factors

All interviewed diabetes nurses use digital treatment technologies for diabetes in their work. These technologies are generally seen as part of standard care for diabetes in Finland and their use is expected to increase in the future. However, the extent to which treatment technologies with remote monitoring capabilities and remote patient appointments are used differ significantly from one healthcare unit to another. As expected, diabetes nurses with mainly type 2 diabetics (non-insulin users) in their care distribute and use blood glucose sensors and other digital treatment technologies much less than those who have more type 1 diabetics (insulin users) in their care. This is partly due to the age profile in type 2 diabetics population and the predominant age profile of the population in remote, more rural geographical locations, where basic healthcare units operate.

"The devices have not replaced physical appointments… We are a small health centre, it is easy to get a physical appointment time." (Nurse F, bh)

Patients' age and attitudes toward digital treatment technologies and self-care came up in several interview answers, but the same features were also mentioned when commenting on diabetes nurses' willingness and ability to use modern treatment technologies:

"The nurse must have an interest in diabetes, for example some older nurses should get motivated." (Nurse D, sh)

Elderly patients were mentioned in several interviews as not having either the skills, equipment or willingness to use digital treatment technology. It was noted that for some patients, the small size of the blood glucose sensor readers and user interface text causes challenges. Interviewees also mentioned younger age group patients in connection with at least two specified challenges regarding digital treatment technologies: **lack of sufficient motivation in self-care** (in which case modern devices alone cannot improve results) and child diabetics who are now **growing up with digital technology** and may be so used to it that they don't appreciate and use all its possibilities in their self-care in the future. Patients' emotional and psychosocial needs, including other illnesses in addition to diabetes, were identified as affecting whether the patients want to use digital treatment technology and remote monitoring capabilities and are committed to their self-care. Emotional needs include patient trust issues with respect to measurement results provided by the technology, and also concern about information security regarding cloud services and remote monitoring.

Diabetes nurses also need to feel skilled and comfortable in using treatment technologies to guide their patients in using them. **Lack of time** to train and practice the use of treatment devices and digital technologies was a common concern among the nurses, as they felt that their workload does not allow enough resources and time to learn new aspects of diabetes care. More healthcare staff training and support from medical device suppliers and sales representatives was hoped for by almost all interviewed nurses. One initial training was not seen to be sufficient:

"Reporting tools [of digital treatment technologies] should be as unambiguous as possible. Training should not be left at once-off training. It would help that in the initial training [of healthcare staff] the concrete benefits for patients would be highlighted more." (Nurse C, sh)

"The [medical device supplier] representative visits us, but more training is needed. They usually visit only when there are new devices." (Nurse A, bh)

"Devices are good… When you use cloud services and so on rarely, you forget them. [Medical device supplier] should contact diabetes nurses more. Pharma representatives visit more often." (Nurse F, bh)

One special healthcare diabetes nurse summarized the need for healthcare staff training by stating that training and attitude change is still needed among the staff and that medical device suppliers should provide more targeted training according to each healthcare facility's needs.

As for remote monitoring, facilitated by the use of digital treatment technologies, comments given by the interviewees reflected challenges in some patients not downloading their treatment results from their devices to a cloud service or other medium from where the diabetes nurse would see them. This comes back to the theme of some patients not utilizing treatment technologies to the full. Cooperation between the patient and his healthcare team was seen as an essential factor. Remote patient appointments were perceived as mainly positively, but **individual patient needs** also created challenges for these. For instance, if the patient speaks a foreign language, or has problems

with his self-care and diabetes treatment balance, these were found as an obstacle to honest and meaningful communication with the diabetes nurse, more so on the phone or video connection than in a live meeting. Some nurses said that phone appointments take more time than live appointments, as time is needed to confirm if the patient agrees and understands everything discussed.

5.2 External factors

Information technology related comments came up often in the interviews with diabetes nurses. They can be roughly divided in two themes: **Patients' issues** with the devices, technology usage and privacy settings, and **healthcare staff's issues** with treatment technology and healthcare facility's IT systems. Diabetes nurses found that many patients would like to use for example a certain flash glucose meter, but the meter's results could not be downloaded to the patient's personal mobile phone, tablet or another device due to meter compatibility limitations. One basic healthcare nurse mentioned that her patients feel that digital treatment technology applications are complicated to use, and that patients are suspicious about personal data security of the applications. IT systems in general were viewed as needing improvement, both from the healthcare facility's side and the medical device manufacturers':

"Information technology is vulnerable, if disturbances occur, we cannot rely fully on these methods." (Nurse C, sh)

Four out of six interviewees mentioned treatment technology's incompatibility with their local healthcare facility's patient information systems as an obstacle for effective use of technology. This problem highlights the fact that there is no unified national healthcare information system in Finland currently, although projects to create one have been started in the past. When asked about obstacles for using digital treatment technologies and about hopes for future improvements of diabetes care, diabetes nurses specified some features needing development from healthcare facilities, treatment device manufacturers, and national healthcare authorities:

"We use an electronic [patient] transaction service in our health centre… Many patients send messages to the [diabetes] nurse there, they tell how they are doing and so on. It's not possible to attach reports to the message there. The nurse immediately gets a notification of a new message in the transaction service, but for example Libre [flash glucose meter system] does not send a notification separately." (Nurse F, bh)

"It would help if it [advancing the use of digital treatment technology in Finland] would be the whole country's agenda, and the systems could be connected to the patient information system." (Nurse A, bh)

"There should be one platform where all [medical device] companies would be obligated to connect their systems and these should be made compatible with patient information systems… It should be a national goal." (Nurse C, sh)

It was also brought out in several interviewee comments that due to **using several IT systems** within a healthcare facility and from treatment technology manufacturers, problem solving becomes difficult and time-consuming. Sometimes nurses don't know whether to contact their facility's IT support or the medical device manufacturer / sales representative when a problem arises with a treatment technology device or system. Healthcare facility's IT departments on the other hand do not usually realize how quickly a problem needs to be solved (e.g. during a patient's visit to the clinic). One nurse also commented that digital treatment technologies and hospital IT systems' data security regulations sometimes slow down problem solving. **Data security issues** also have a major impact on starting to use advanced remote patient appointments via video or online message system connections; only two of the 6 nurses mentioned video appointments being used in their special healthcare unit, and in one of them this system had been set up due to the Covid-19 pandemic which started in the spring of 2020. Typically remote patient visits are handled by phone calls made by diabetes nurses.

Procurement and financial issues are another external factor affecting the use of digital treatment technologies and their availability according to the interviewed diabetes nurses. Cost of digital treatment technologies featured in all interviews as an obstacle for their wider use. Diabetes nurses were generally aware of the cost of the technologies and devices, but also viewed the cost to be worth it relative to their effectiveness in diabetes treatment, motivating patients and preventing complications. The issue of limited availability of the devices due to their higher cost was ascribed mainly to the healthcare facility's procurement department, but also to the local politics, as can be seen from the following comments:

"Municipality politics does not see the issue [cost] in the same way [as the healthcare facility], they are more in the current moment, they make a one-year budget… In many municipalities they [authorities] go by money first… If the municipality cannot afford them [devices], they cannot…" (Nurse B, sh)

"There should be competition in the devices, for example prices should come down and get them in use to as many [patients] as possible." (Nurse E, bh)

Cost effectiveness of digital treatment technology was discussed with 5 out of 6 the interviewed nurses as a side point; there was no direct question about this in the interview structure, but it came up as a substantial issue after the first interview was already conducted and a question about whether it has been discussed at the nurse's workplace was asked from nurses B-F. The table below shows how nurses commented on a) whether cost effectiveness of diabetes treatment technologies has been discussed, and b) whether they feel they have a chance to affect procurement decisions of diabetes treatment technologies in the healthcare unit where they work.

Interviewee	Cost effectiveness discussed at workplace	Possibilities to affect procurement decisions at workplace
Nurse A, bh	N/A (not discussed in interview)	University hospital takes care of tender competition; health care centre does not have a say. Procurement office may give for example two options for blood glucose meters and the diabetes nurse can choose which one to give to the patient.
Nurse B, sh	Cost of treatment has been discussed, for example the criteria for which patients get a sensoring insulin pump. Cost effectiveness discussed to some extent.	Nurses and doctors take part in procurement. The interviewee belongs to the hospital's procurement groupand feels she can affect procurement decision.
Nurse C, sh	Cost effectiveness is discussed at workplace, but the interviewee feels that showing long-term effectiveness of digital treatment technologies is difficult at the hospital level. The university hospital she works in has made an analysis on cost effectiveness of diabetes treatment together with the local university. The analysis showed a remarkable monetary benefit due to prevention of diabetes-related additional diseases on patients using digital treatment technologies.	The interviewee takes part in procurement and feels she can affect procurement decision, although senior physician and service unit's manager are the main influencers.
Nurse D, sh	The interviewee doesn't recall that there would have been discussion about cost effectiveness at workplace.	The interviewee can affect procurement, diabetes nurse is asked which devices they would like to have. She says that diabetes nurse, doctor and patient are all influencing procurement decisions.
Nurse E, bh	The doctor of endocrinology has talked about cost effectiveness to diabetes nurses and others at workplace. Nurse believes this has helped in introducing treatment technologies into her hospital dis-	Previously procurement was done in the university hospital district's main procurement office, and the interviewee with her (diabetes nurse) colleagues took part in it. A municipal / areal procurement office took over, and now the interviewee feels that

	trict. Nurse also mentions that specific Current care (Käypä hoito) recommendation for her hospital district includes quality / pricing matters. The topic is constantly held up at workplace, and she thinks device sales representatives may also have talked about it.	although she has taken part in procurement preparations, the procurement office can decide what they want. Only nurses were part of procurement preparations, not doctor.
Nurse F, bh	The interviewee thinks that digital treatment technologies are cost effective in long-term use, but their benefits and challenges have not been discussed in her work unit or staff trainings in much detail.	A working group including a representative of diabetes nurses and doctors takes part in procurement at the Central hospital procurement office. The interviewee has not seen any invitations or opportunities to take part in procurement in any way. She can contact central hospital's diabetes nurses if she has feedback.

Table 6. Diabetes nurses' comments on cost effectiveness discussion and on possibilities to affect digital treatment technologies' procurement at their workplace.

5.3 Benefits and future opportunities

The interviewed diabetes nurses found that in general, digital treatment technologies have benefits in their work as diabetes professionals and that they also benefit patients. Nurses had seen in their work that the benefits for patients included such things as improvements in patient's self-care motivation, initiative, and taking responsibility over knowledge-based decisions about his own treatment, and also measurable improvements in blood glucose values. Remote consultations and remote patient appointments were viewed as saving travel costs and efforts especially in rural areas, and thus their benefits would reach beyond the patient, to the whole society. All in all, digital treatment technologies were viewed as a positive development in diabetes treatment and as a means of reducing healthcare costs in the long run, mainly by preventing complications and additional diseases of diabetic patients. Diabetes nurse's proactive contact to patients and to their treatment was also mentioned as a valuable outcome facilitated by digital treatment technologies:

"It facilitates maintaining a more intense and more flexible customer contact… It helps to monitor invisible patients, to have a proactive approach to treatment." (Nurse E, bh)

Although it takes time to learn to use treatment technologies and nurses still must prepare for patient appointments, whether remote or face-to-face, worktime saving and the opportunity to focus on essential information were generally attributed as advantages of these technologies.

The interviewed nurses were also asked about their view about changes in diabetes patient care in the future due to new treatment technologies. All interviewees had a positive view and hoped technology would make diabetics' lives easier and reduce complications further. The following features were seen as **future trends in diabetes treatment in Finland**:

- improvements in quality of and equality of treatment (not depending on area or hospital district)
- increase of digital services, also in basic healthcare
- developments in technology, e.g. automatic insulin pumps, no more finger blood tests
- glucose sensoring and insulin pumps possible for more and more patients
- remote monitoring will increase, but face-to-face appointments still have their place in patient-nurse relationship and in the physical examinations necessary for diabetics (e.g. feet)

5.4 Additional observations

Additional observations about the study include the wide variety of practices among the small pool of interviewees, all from different areas of Finland. In the background information there was a question about how many diabetics the diabetes nurse care for, how many of these are type 1 and type 2 diabetics, how many use insulin, and how many of all the patients use a sensoring (flash) glucose meter, a sensoring insulin pump, or a traditional glucose meter equipped with a reporting application. Numeral statistics of the answers will not be shown here, because some of the interviewees (especially those working at bigger clinics such as university hospital) found it difficult to estimate these numbers and gave a very approximate number or just an approximate percentage of patients, so the answers are not fully reliable or comparable. Also, the question about how many patients use a sensoring glucose meter and how many use a traditional meter equipped with a reporting application turned out to be a slightly inaccurate / irrelevant question, because all patients using a sensoring glucose meter currently also get a traditional meter as a back-up and to check the accuracy of the flash meter's measurements from time to time. Therefore, the amount of various glucose meters does not correlate directly to patient numbers. However, as a general observation based on the above background questions and answers, it can be said that the majority of type 2 diabetics do not use (or receive) sensoring glucose meters, and very few of them (even fewer in small, rural basic healthcare units compared to capital area basic healthcare units) use a traditional meter equipped with reporting application. Type 1 diabetics, on the other hand, use or receive sensoring devices more often. Rural basic healthcare units in general have mainly type 2 diabetics in their care.

Differences were also obvious in the ways of using remote monitoring and remote patient appointments. In some places, these had been introduced recently, in others they had been used for years and were used to a great extent in addition to traditional appointments:

"About a quarter of my patient appointments are telephone appointments… We have done remote appointments (by telephone) already for about five years." (Nurse E, university hospital)

In some healthcare units, nurses actively suggest remote monitoring and appointments to patients of their selection, and in other places, it is patients who take the initiative. Types of remote contact or appointment and equipment / channels used for them also vary greatly from place to place (with no obvious differentiation between basic and specialized healthcare units); channels include cloud services, phone, video call, chat, text, and email. In other words, each healthcare unit has their own systems and channels, with no unified national application for these.

6 CONCLUSION

6.1 Consideration of study results

The interviewed diabetes nurses were all familiar with and used digital treatment technologies in their work. Differences in the distribution of and proactively offering sensoring blood glucose devices to patients were notable in the study, and in some basic healthcare units and areas these devices were given to very few diabetics. This confirms what Koski and others (2018a) have written about device availability issues, and also what the Diabetes Association (2018) concluded in their inquiry regarding regional differences in the distribution of treatment technologies. This thesis study showed that diabetes nurses felt that although digital treatment technologies benefit many diabetics, the persons receiving these devices should be carefully selected, as not all need or benefit from them. For example age, patient's attitude, and diabetes type (1 or 2) and complications were important factors to consider when distributing treatment technologies. Indeed, it seems to be pretty much at each diabetes nurse's and healthcare unit's individual judgment which patients are the ones who according to the national Current Care guideline (2020) should be actively offered these treatment technologies and for whom they are beneficial.

Some researchers, such as Huang et al. (2015) and Laatikainen et al. (2018) have higlighted the tangible health and economic benefits of remote check-up visits and support for type 2 diabetics, and Parsons et al. (2019) emphasized the importance of regular self-monitoring of blood glucose for type 2 diabetics. The interviewed diabetes nurses did not describe a specific effort to extend digital treatment technologies and remote monitoring services to type 2 diabetics. In fact, the general outlook was that type 2 diabetics don't often need or want these technologies.

Continuous and thorough training of diabetes nurses and other healthcare staff both to use, and in turn train and motivate diabetics to use digital treatment technologies is a necessity and also an ongoing issue in Finnish healthcare, as described by Honkasalo et al. (2018), Europaeus et al. (2018) and others. In addition, Kaufman and Khurana (2016) highlight that extracting essential information from the flood of data produced by digital treatment technology poses a challenge for training and education of healthcare staff and patients alike. This also came up in the interviews, as diabetes nurses unanimously voiced their concern about insufficient training in the use of digital technologies, the main reasons for this being lack of time and the heavy workload of the nurses and sometimes insufficient support from a healthcare facility's IT services and from device manufacturers. It was

also mentioned that data protection and healthcare laws make it difficult for device manufacturers to help train diabetic persons directly, so this is left almost completely for diabetes nurses to do. Except for the lack of time and heavy workload in healthcare, these factors did not feature in studies and articles researched for this thesis.

Diabetics' improved self-care skills and clinical outcomes when using digital treatment technologies are highlighted in several studies, such as Pralahad et al.'s (2018) and Shaban et al.'s (2017). Al Hayek et al. (2020) also discuss positive psychosocial effects of treatment technologies in diabetics' lives. The interviews confirmed diabetes nurses' observations to be similar, as they described seeing improvements in their patients' motivation, self-care skills and treatment balance after using digital treatment technologies for a period of time. This led the interviewed nurses to conclude that benefits to patients and society are more important than the seemingly high cost of self-care devices, and most of the nurses agreed that use of modern technologies is cost-effective long-term as it reduces diabetes-related complications and additional diseases. Finnish diabetes professionals and experts like Koski et al. (2018a) and Jarvala et al. (2007) have long defended this view publicly, however scientific research and study regarding diabetes treatment technologies' cost-benefit relationship is still missing in Finland.

Procurement is closely related to cost of digital treatment technology and its availability, but it was not specifically mentioned in the literature researched for this thesis. However, it deserves a mention here, because it did come up in the interviews and divided opinions of the diabetes nurses quite drastically. In some healthcare units, nurses said they have a say in the tender requests and procurement of treatment technology. In others, nurses felt they had little or no power over the procurement decisions made in the hospital district.

Hyppönen et al. (2015) describe the Finnish government's 2020 strategy for e-health and e-welfare, according to which citizens should be able to use online services and produce data for the use of healthcare professionals, and which professionals should have access to information systems that support their work. The strategy also addresses issues related to interoperable information system architecture and cooperation in development and procurement of infostructures. The diabetes nurses' comments reflected this strategy by confirming both the diabetic person's and the nurse's access to various information and health technology patient data systems in Finnish healthcare. The challenging issue from diabetes nurses' viewpoint is the interoperability of systems, particularly the healthcare facility's IT systems and diabetes self-care technology manufacturers' systems. All nurses commented on difficulties in this regard, as patient data systems and treatment technology systems do not "talk" to each other. This was viewed as a major stumbling block, although not a complete barrier, to the most effective use of digital treatment technologies.

Data protection and privacy regulations also featured in the interviews, for example some nurses felt that these make using treatment technologies slower and more complicated within the hospital setting. They found that some patients are suspicious about sufficient personal data protection and

therefore may hesitate to use certain devices or remote monitoring software. Cooperation between healthcare IT departments, procurement departments and health technology suppliers regarding more seamless information security and data protection is also behind the National Emergency Supply Agency's Cyber Health project 2018-2019. As part of this project, a reference list of information security and data protection requirements for social and health care sector procurements was developed, reports Traficom (2020). These types of projects hopefully unify standards and improve compatibility of suppliers' systems with healthcare systems, which in turn could make using treatment technologies less complicated and scary for both nurses and patients.

6.1 Ethical issues and reliability of the thesis

Ethics is a moral viewpoint and it can be manifested for instance in situations in which a person considers his own and other people's actions, or in considerations of what is allowed or not allowed and why. Research ethics includes norms of reliability of information, norms of dignity of the research objects (persons), and norms of relationships between researchers. (Kuula 2011, ch. 1)

This thesis follows the instructions of ethical recommendations for thesis writing at Universities of Applied Sciences (ARENE 2019) and the Research Ethichs Advisory Board's ethical principles for human focused research in Finland (TENK 2019). A written thesis agreement was signed between the commissioner of Sailab MedTech, the author of the thesis, and Savonia thesis supervisors. The reference works and studies quoted or referenced in the thesis are not presented as the author's own text, and references and their availability information are listed accurately. There are no known conflicts of interest. Before agreeing to be interviewed, the diabetes nurses who were invited to take part in the interviews received a notification explaining the purpose and content of the study and how their personal data would be handled. Their personal data from which they could be recognized was not included in the thesis report, and interview notes and recordings containing this data will be completely deleted from the author's personal computer after publishing of the thesis. The potential interviewees were given a possibility to refuse to be interviewed with no consequences to them or their work.

When considering the objectivity and reliability of a qualitative study, it is necessary to distinguish trustworthiness and neutrality in observations. Does the researcher understand and listen to the objects of the study neutrally, or does he or she filter these through his or her own frame of understanding and background? (Tuomi & Sarajärvi 2017, ch. 6) It is virtually impossible to have a completely neutral viewpoint as a qualitative study researcher. For example, the author's personal history of living with type 1 diabetes for over 30 years undoubtedly affected having interest in the topic of the thesis and in the comments of the diabetes nurses; however, the author has strived to research the topic and to analyze the study material as objectively as possible. Voicing the author's personal views of the issues in the interviews was carefully avoided, so that the interviewees would not be affected by these views but would express their own. The interviewees' expressions and

opinions were recorded accurately regardless of the author's opinion of the importance or reliability of their statements.

Both Finnish and international articles and literature was used in developing the theoretical part of this thesis. Savonia online library's CINAHL Complete health sciences database, as well as Google and Google Scholar were used in the search for studies and articles. The main search phrases included "diabetes treatment technology", "diabetes in Finland", "diabetes nurse + technology", "diabetes remote monitoring", "diabetes cost", and "diabetes nurse role". This study focuses on diabetes treatment in the Finnish healthcare system, but due to lack of studies on the topic in Finland, articles and data from medical experts, healthcare officials and associations, and even some university thesis studies were included as references. However, they were carefully selected and the choice is viewed justified in the absence of scientific studies on the subject matter.

Elo and Kyngäs (2008) highlight that a trustworthy study requires that a link between the results and the data is clearly shown, and that the qualitative content analysis is performed in a way that enables someone to follow the process and procedures of the inquiry. The content analysis process is extensively described in this thesis from its beginning to the end results. The initial quotations from which categories were drawn, are also shown in the table in Appendix 2. Although showing all the quotes is not necessary when reporting the study, the appendix provides a way to follow the analysis process closely and determine how well the formed categories cover the research material. Qualitative study content analysis methods were not familiar to the author of this thesis prior to this work, and as there are several possible ways to perform content analysis, it is likely that further experience in this method would improve reliability of the study. On the other hand, performing content analysis for the first time meant thoroughly following each step of the process and not taking many liberties, which may be seen as a positive factor when considering the trustworthiness of the results.

The size of the study was relatively small with only six (6) interviewed diabetes nurses. However, since a qualitative study's purpose is not to produce statistical generalizations but to describe a phenomenon and understand certain actions, the most important factor was that all the interviewees were experts in their field and as such had a lot of knowledge about the research topic. **Saturation** was also reached to the author's satisfaction in this study. Saturation in a qualitative study means a point where the research material starts to repeat itself and no new information relevant to the research problem is brought out by bringing in more material. (Tuomi & Sarajärvi 2017, ch. 3)

6.2 Professional growth

Researching and producing this thesis has contributed to my personal and professional growth in many ways. It was not an easy task to define the topic and select relevant information, as digital treatment technology in diabetes is such a vast field and has many aspects. Researching articles for the thesis revealed that there are very few studies on specifically diabetes nurses' views on treatment technologies and on the cost-effectiveness of these. My understanding of what kind of data

would be needed for diabetes treatment development and of the need for multi-disciplinary collaboration in diabetes treatment deepened while studying the topic. As I work in the administrative and commercial side of healthcare, I also got a better view into healthcare professionals' viewpoint, which is very advantageous for example in consultive and educative work in the healthcare business.

My skills were also enhanced in research and project management, as I had no experience of qualitative content analysis method previously, and the thesis work required planning, time management, cooperation with various partners, and familiarizing myself with academic report writing requirements. All of this was challenging and sometimes overwhelming as the project evolved to be larger than expected. But in the end, I am satisfied with the results and with having challenged myself in the process, and I am confident I can use these project management skills in my work in the future.

It is important to look at the performed work critically, and there are some things I would do differently if starting a similar project. I would start applications for interview candidates earlier and more methodically, as the hospital research application processes takes a lot of time and research. In this thesis, interviews covered basic healthcare units and university hospitals, but between these two in healthcare organization are central hospitals, which were not represented in this study. A test interview would also be a good idea to make the interviews more effective from the start and to ensure their uniform quality.

6.3 Usability and ideas

The purpose of this study was to describe how public healthcare diabetes nurses in Finland use digital diabetes treatment technologies and what benefits and challenges they see in using these. Similar previous studies in Finland have not been done, so this study could be a discussion opener with diabetes nurses, whose professional experience and first-hand dealings with diabetics makes their insights to diabetes treatment extremely valuable. More academic study is also needed on the cost-benefit ratio of healthcare technologies, and perhaps universities and university hospitals could take more initiatives to facilitate this research. Studies are also needed for effective and data-based decision making in healthcare procurement and also in politics.

This thesis study also revealed inconsistencies and obstacles in communication within healthcare units, for example between IT and ward personnel, between procurement offices and nurses and doctors, and between healthcare technology suppliers and nurses and patients. Open discussion and multi-field cooperation is needed, and organizations like Sailab MedTech, Diabetes Nurses Registered association, and others should continue facilitating this kind of discussion and development. Specific action points for Sailab MedTech Finland Diabetes division, based on this thesis study, are listed in **Appendix 3**. Sailab organizes trainings and seminars on for example healthcare procurement, and could use the results of this study in showing and resolving the gaps and development

needs in national procurement standards regarding digital treatment solutions. They can also continue bringing up the issues of diabetes care in Finland to healthcare authorities and politicians. Since this study also showed that policies and practices regarding procurement, distribution, and usage of digital treatment technologies differ quite a lot depending on the hospital district and healthcare unit (basic or specialized), cooperation and best practice sharing among hospitals and healthcare units could also undoubtedly be developed further and increased.

Training of both diabetes nurses and diabetic patients regarding the use of treatment technologies is a continuous need and there is room for improvement. Diabetes nurses' comments regarding training needs may help at least technology suppliers to develop new, more tailored trainings for healthcare staff. As for diabetic individuals, there is a need to motivate, not just to give them self-care technology. Perhaps features like gamification and interactive education in self-care applications would be one way to go in product development. Sailab Diabetes division's member companies who develop, manufacture and sell treatment equipment can directly apply the above mentioned points brought out by this study in their activities.

This study could be further developed in future research by interviewing a larger pool of diabetes nurses (as mentioned, also from central hospital clinics). It would also be interesting to compare the comments that diabetes nurses made concerning their patients and what the patients themselves say. For example, are the reasons that diabetes nurses mentioned for diabetics not wanting to use digital treatment technologies in line with the reasons diabetics themselves would say? Remote monitoring and remote patient consultations were briefly considered as an additional category of digital treatment technologies in this study, but their various methods and effectiveness in diabetes treatment in Finland could form another research topic also. Overall, more research on patients using digital diabetes treatment technologies should be performed to produce data on the long-term effects of these devices on diabetics' physical and mental wellbeing.

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APPENDIX 1: INTERVIEW QUESTIONS

IN ENGLISH

Sensoring treatment technology in this study means sensoring insulin pumps and blood glucose measuring devices based on subcutaneous sensor, which can be combined with insulin dosage and / or glucose measurements automatically reporting software, facilitating e.g. diabetic patient's home performed self-care results' reporting to diabetic nurse via email or through another electronic data application. Therefore, also so called *remote monitoring* of self-care results becomes possible without patient physically visiting the care unit or clinic.

Treatment technologies with remote monitoring possibility in this study mean, in addition to the above mentioned, also so called traditional blood glucose measuring devices using a blood sample from the fingertip, for which there is available an application or software facilitating self-care results' remote monitoring.

Respondent's background information

Age (years)
Years worked as a diabetes nurse under 1 yr 1-5 yrs 6-10 yrs over 10 yrs
University hospital district under which you work (abbreviations in Finnish):
PPSHP (OYS) PSHP (TAYS) VSSHP (TYKS) PSSHP (KYS) HUS
Health Centre diabetes nurse
Hospital Clinic diabetes nurse

Questions

1. How many diabetics are you caring for at the moment approximately? (If you don't know exact number, please give an estimate.)

   Type 1 diabetics
   Type 2 diabetics …of whom xx are insulin users
   Total

2. How many of the diabetics under your care currently use public healthcare distributed sensoring insulin pump (sensoring function actively in use), sensoring glucose meter, or a traditional glucose meter for which there is available an application or software facilitating self-care results' remote monitoring? See definitions above. (If you don't know exact number, please give an estimate.)

   Sensoring insulin pump
   Sensoring glucose meter
   Glucose meter for which an application is available
   Total

3. Do you use data management systems that come with these devices? Have such data management systems for instance replaced part of physical patient visits?
   If data management systems that come with the devices are not used, what is the biggest reason?

4. What are the major obstacles for the use of sensoring or otherwise remote monitoring facilitating treatment technologies for you personally in your work?
   (E.g. staff or patient attitudes, high cost of technology, difficult to use, e.g. lack of time needed for remote monitoring, etc etc…. Explain as widely as you can!)

5. What are the biggest opportunities of sensoring or otherwise remote monitoring facilitating treatment technologies for you personally in your work (benefits)?

6. What would help you to overcome the obstacles you mentioned in question 4, or what kind of solutions would you suggest for the work of diabetes nurse, so that sensoring or otherwise remote monitoring facilitating treatment technology would start to be utilized more widely in Finland?

7. What concrete actions would you wish for from the manufacturers / importers of sensoring treatment technologies to support the introduction and use of these in your work?
   (E.g. additional training, device / system availability, additional features in devices,…)

8. In your opinion, who are the most important influential persons at your workplace when new diabetes treatment and monitoring devices are selected to be used and distributed to diabetics in your region? (E.g. diabetes doctor, diabetes nurse, patien, procurement office, political influencers, sales representatives,…) In your opinion, do you get to to affect procurement process sufficiently and how (procurement preparation, process etc…)?

9. Finally, how do you see patient care changing in the future with the developments in treatment technologies?

IN FINNISH

Sensoroivalla hoitoteknologialla tarkoitetaan tässä tutkimuksessa sensoroivia insuliinipumppuja sekä ihonalaiseen sensoriin perustuvia veren glukoosipitoisuuden mittauslaitteita, joihin on yhdistettävissä insuliinin annostuksen ja / tai mittaustulokset automaattisesti raportoiva ohjelmisto, joka mahdollistaa mm. diabeetikon kotona suorittaman omahoidon tulosten raportoinnin diabeteshoitajalle sähköpostitse tai muun tietoliikennesovelluksen kautta. Näin ollen myös niin kutsuttu hoitotulosten *etäseuranta* mahdollistuu haluttaessa ilman potilaan fyysistä vastaanottokäyntiä.

Etäseurannan mahdollistavalla hoitoteknologialla tarkoitetaan tässä tutkimuksessa yllä mainittujen lisäksi myös ns. perinteisiä, sormenpäästä otettavaa verinäytettä käyttäviä veren glukoosipitoisuuden mittauslaitteita, joihin on saatavilla ohjelmisto tai sovellus, joka mahdollistaa hoitotulosten etäseurannan.

Vastaajan taustatiedot

Ikä (v)				
Työvuodet diabeteshoitajana	alle 1 v	1-5 v	6-10 v	yli 10 v
Sairaanhoitopiiri jossa työskentelet	PPSHP (OYS)	PSHP (TAYS)	VSSHP (TYKS)	PSSHP (KYS) HUS
Terveyskeskuksen diabeteshoitaja				
Sairaalan poliklinikan diabeteshoitaja				

Kysymykset

1. Montako diabeetikkoa sinulla on keskimäärin vastuullasi tällä hetkellä? (Jos et tiedä tarkkaa lukumäärää, anna oma arviosi.)

1-tyypin diabeetikoita	
2-tyypin diabeetikoita	…joista insuliinia käyttää:
Yhteensä	

2. Monellako hoidossasi olevista diabeetikoista on tällä hetkellä käytössään hoitopaikasta saatu sensoroiva insuliinipumppu (jonka sensorointi potilaalla aktiivisessa käytössä), sensoroiva glukoosimittari, tai perinteinen glukoosimittari johon on saatavilla sovellus? Ks. määritelmät yllä. (Jos et tiedä tarkkaa lukumäärää, esitä oma arviosi.)

Sensoroiva insuliinipumppu	
Sensoroiva glukoosimittari	
Glukoosimittari, johon saatavilla sovellus	
Yhteensä	

3. Käytätkö laitteiden mukana tulevia tiedonhallintajärjestelmiä? Ovatko kyseiset tiedonhallintajärjestelmät esimerkiksi korvanneet osan fyysisistä potilastapaamisista?
   Jos laitteiden mukana tulevia tiedonhallintajärjestelmiä ei käytetä, mikä on suurin syy?

4. Mitkä ovat suurimmat esteet sensoroivan tai muutoin etäseurannan mahdollistavan hoitoteknologian käyttöönotolle sinulle henkilökohtaisesti työssäsi?
   (Esim. hoitohenkilökunnan asenteet, potilaiden asenteet, teknologian kallis hinta, vaikea käyttää, esim. etäseurantaan tarvittavan ajan puute, jne jne…. Kerro mahdollisimman laajasti!)

5. Mitkä ovat sensoroivan tai muutoin etäseurannan mahdollistavan hoitoteknologian suurimmat mahdollisuudet sinulle omassa työssäsi (hyödyt)?

6. Mikä auttaisi sinua voittamaan kohdassa 4 mainitsemasi esteet, tai millaisia ratkaisuja ehdottaisit diabeteshoitajan työhön, jotta sensoroivaa tai muutoin etäseurannan mahdollistavaa hoitoteknologiaa alettaisiin hyödyntää laajemmin diabeteksen hoidossa Suomessa?

7. Mitä konkreettisia toimenpiteitä toivoisit sensoroivan hoitoteknologian laitteiden valmistajilta / maahantuojilta tukemaan näiden käyttöönottoa ja käyttöä omassa työssäsi?
   (Esim. lisäkoulutus, saatavuus, lisäominaisuudet laitteisiin,…)

8. Ketkä ovat mielestäsi tärkeimmät vaikuttajat työpaikallasi kun uusia diabeteksen hoito- ja seurantalaitteita valitaan käyttöön ja jaettavaksi alueenne diabeetikoille? (Esim. diabeteslääkäri, diabeteshoitaja, potilas, hankintatoimisto, poliittiset vaikuttajat, myyntiedustajat,…)
   Pääsetkö mielestäsi vaikuttamaan hankintoihin riittävästi ja miten (hankintavalmistelu, prosessi ym…)?

9. Lopuksi, miten näet potilashoidon muuttuvan tulevaisuudessa hoitoteknologian kehittymisen myötä?

APPENDIX 2: REDUCTION OF ORIGINAL EXPRESSIONS

In this phase of the material based content analysis, original expressions extracted from interviews were reduced, or simplified for further processing.

Original expressions / quotations	**Simplified expressions**
"Patients' devices or the lack of them is the reason for them not knowing how to use or not being able to use [treatment technology]… Some don't even want to try. Having to act as IT support is a little bit tiring, having to guide the patients to use the devices." (Nurse E, bh) *"Patients' negative attitudes are decreasing. One obstacle is compatibility with applications and devices, all phone models are not compatible [for reading treatment results]." (Nurse D, sh)* *"Patients and their knowledge of technology… phone models, patients don't have a computer or interest… The nurse doesn't always think of asking whether the patient wants a device, because the majority of patients doesn't want to or doesn't know how to use [it]… For older ones a blood glucose meter with a larger display is often given. Not everyone needs them [treatment technologies], blood glucose monitoring for example weekly or monthly is sufficient." (Nurse A, bh)*	Patients' devices and their non-compatibility with treatment technology Lack of know-how to use treatment technology Nurse acting as IT support Older patients' need of meter with a large display Not every patient needs technologies for sufficient treatment

"Patients' attitudes, for example elderly ones want traditional methods." (Nurse F, bh) *"Patients don't download [insulin] pump data before coming for their appointment, although it's been agreed on. Some just don't bother, for example teenagers who are not interested in their self-care." (Nurse B, sh)*	Older patients want traditional methods Patients not cooperating with healthcare staff Some youth not interested enough in their diabetes care

"Sometimes patients' attitudes… suspicion towards cloud services and so on. For example security and reliability of these services… some don't want to give their passwords." (Nurse C, sh)	Patients lack trust in personal data security
"A long-term observation I've made is that complications are not necessarily reduced [with the use of treatment technology]… The psychosocial load of the patient affects [the results], we have patients with multiple health issues. The device itself doesn't help if nothing is done about the results. My estimation is that 30 % of patients don't utilize technology fully." (Nurse D, sh)	Treatment technology's benefits depend on the patient's motivation and other health issues Patients don't always utilize technology fully
"In many municipalities they [authorities] go by money first… If the municipality cannot afford them [devices], they cannot… Also, data transfer is an issue, device manufacturer systems do not 'discuss' with hospital's systems. Data transfer is currently slow." (Nurse B, sh)	Political authorities think primarily about costs Compatibility of device manufacturers' systems and hospitals data systems poor
"It saves time, when you can focus on the essential, you have the facts already before the patient appointment… You can take more patients in the same time." (Nurse C, sh)	Use of technology saves nurse's time and helps to focus on essential information
"[Technology] has overturned treatment. It gives motivation to patients, information about changes in glucose… It's a key to guidance and treatment based on knowledge… Patients are happy." (Nurse D, sh)	Improvements in patients' motivation and knowledge-based treatment
"It helps to monitor invisible patients, to have a proactive approach to treatment. We can focus on blood glucose changes and problem points. It is beneficial for treatment balance." (Nurse E, bh)	Proactive approach to treatment
"It has a positive effect on the appearance of additional diseases… In my opinion, it is cost-effective in the long run." (Nurse F, bh)	Benefits the patient's treatment balance
"[Diabetes] nurses are seemingly involved in the procurement [of the devices], but in real life the decision [of the procurement office] is	Prevents additional diseases

different. We have communicated to our supervisor about non-satisfactory choices… Nurse's own initiative is a must." (Nurse E, bh)	Long-term cost-effectiveness
"*I get to affect procurement. The nurse is asked what they want. I am happy with the procurement." (Nurse D, sh)"*	Varied possibilities to affect procurement of devices / technology
"The patient is not able to express everything with remote connection [appointment]." (Nurse A, bh)	Phone appointments challenging due to language and communication barriers, takes more time
"Sometimes for example phone appointments are more challenging, for instance there may be a language barrier with foreigners… [Phone appointments] take more time, are you and the patient for example talking about the same thing? The nurse decides and evaluates to whom remote appointments are offered." (Nurse B, sh)	Remote appointments benefit patient and society
"There is a societal benefit, when the patient doesn't always have to come physically to the appointment, with long distances and so on." (Nurse C, sh)	

APPENDIX 3: ACTION POINTS FOR SAILAB DIABETES DIVISION

Sailab is an influential lobbying organization representing health technology companies in Finland. Its goal is to "facilitate healthier and more independent life for people and help healthcare professionals to give best possible care" (Sailab 2019). This thesis is commissioned by Sailab's Diabetes division, where the issue of helping medical professionals use better devices and digital technologies to improve diabetes treatment in Finland is a focal goal.

Based on this thesis, the following **6 action points** for Sailab and its Diabetes division to work on (with various partners) were defined:

1. **Incorporating digital technology** into each diabetic's **individual treatment plan.**
2. Creating a uniform standard on **What kind of patient benefits from digital treatment technologies?** Targeting right technology to right patients to receive maximum benefits.
3. How could different companies' systems be connected to a national patient data platform? **Active advancement of a national database.**
4. Including features that **motivate, educate and promote commitment to self-care** in diabetes self-care devices and applications.
5. Considering the role and opportunities of Sailab and Diabetes division in **educating patients and increasing awareness of new selfcare standards / possibilities** especially among type 2 diabetics.
6. **Re-thinking and planning training of diabetes nurses in the use of digital treatment technologies.** Tailoring training according to each healthcare unit's needs; demonstrating the concrete benefits that diabetics get from using technologies to the full. Reviewing training and support needs often.