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# “Cutting Complications and Costs in Diabetes Care”

## Exploring the possibilities of technology in diabetes care practice in Finland

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Diabetes is a worldwide problem, affecting approximately 425 million adults around the world and causing health expenditure for USD 727 billion dollars in 2017. In Finland, approximately 6 % of the population is suffering from diabetes and the number is rising. It is estimated that the number of cases might double within the following 10-15 years. The care is currently expensive and ineffective, as even as much as 70 % of the costs are caused by complications that could be avoided when people at risk are identified early enough and treated sufficiently.

The aim of this study is to explore how the current diabetes care practice in Finland could be improved by using technology in a way that decreases both the amount of complications and the healthcare expenditure. More specific, the study is concerned with which investments should be made in order to minimize the amount of complications. Furthermore, it strives to provide a deeper insight into how technology could be used for preventive care, both improving care results and saving costs.

The qualitative study was carried out conducting theme interviews with leading specialists in the area of diabetes treatment, health technology (with focus on diabetes care), public health and diabetes work in Finland.

Research results show that a patient-centred focus striving for as stable blood glucose control and good quality of life as possible were found to be essential in order to reach better care results, i.e. less complications. Managing, teaching and supporting patients would be the area where technology could prove to be most useful, as it could help making everyday decisions, serve as a reminder system and a channel for mental support and engagement. Enhanced visibility and knowledge of information for both patient and healthcare providers were also considered key factors. As healthcare professionals gain better overview of patients’ care, resources can be allocated in better ways. Further development and use of technology as well as focus on engaging, individualized diabetes care could lead to a shift towards a more preventive care model, reducing the number of complications, saving healthcare expenditure as well as improving the life of people with diabetes.

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| Keywords | diabetes care, blood glucose control, knowledge management, diabetes technology |

**Contents**

# 1 Introduction

Diabetes is a worldwide problem, affecting approximately 425 million adults around the world and causing health expenditure for USD 727 billion dollars according to the figures presented by the International Diabetes Federation (IDF) (2017). The number is estimated to rise to 629 million by the year 2045, with an increasing number of persons with type 2 diabetes (IDF 2017).

In Finland, the diabetes rate is 9 % and it is estimated that the number of cases might double within the following 10-15 years. Diabetes care in Finland is currently both expensive and ineffective. Direct costs caused by diabetes are responsible for 15 % of the total healthcare expenses in Finland, and at least 60 % due to the treatment of avoidable complications. (Käypä hoito 2018.) However, recent figures suggest that the healthcare expenditures counted for only 25 % of the overall costs, the rest 75 % was made up of productivity costs (Diabetes lukuina 2018:1).

Complications are what makes diabetes care expensive, as they, according to research, double the medical costs (Diabetes lukuina 2018:1). Complications also significantly increase the additional costs for patients with diabetes (DEHKO, Jarvela 2010). Good ways for minimizing the risk of complications are lifestyle change, early detection, diagnosis and cost-effective treatment (IDF 2018). When it comes to minimizing the risk of diabetes-related complications, maintaining near normal levels of blood glucose is of great importance (DCCT 1993). The monitoring of HbA1c (haemoglobin A1c) is a sufficient meter when striving for strict blood glucose control (Mustajoki 2007). HbA1c is a haemoglobin molecule of the red blood cells' that is corresponding to the amount of glucose in the blood during the past 2-8 weeks. The risk of developing organ transformations, i.e. complications, increases rapidly as the Hba1c value increases. (Käypä hoito 2018 - Mustajoki 2007.)

# 2 Theoretical background

Chapter 2 presents the theoretical background of this Master's thesis. It covers the presentation of diabetes as a condition, the treatment and complications related to it as well as related healthcare expenditure on both a global and national Finnish level. It also presents aspects of technology in current diabetes care.

## 2.1 Diabetes in general

According to the World Health Organization (WHO) (2017), the trend in global prevalence has been rising from 4.7 % in 1980 to 8.5% in 2014 and the number of cases has risen too. Low- and middle-income countries are most affected (IDF 2018).

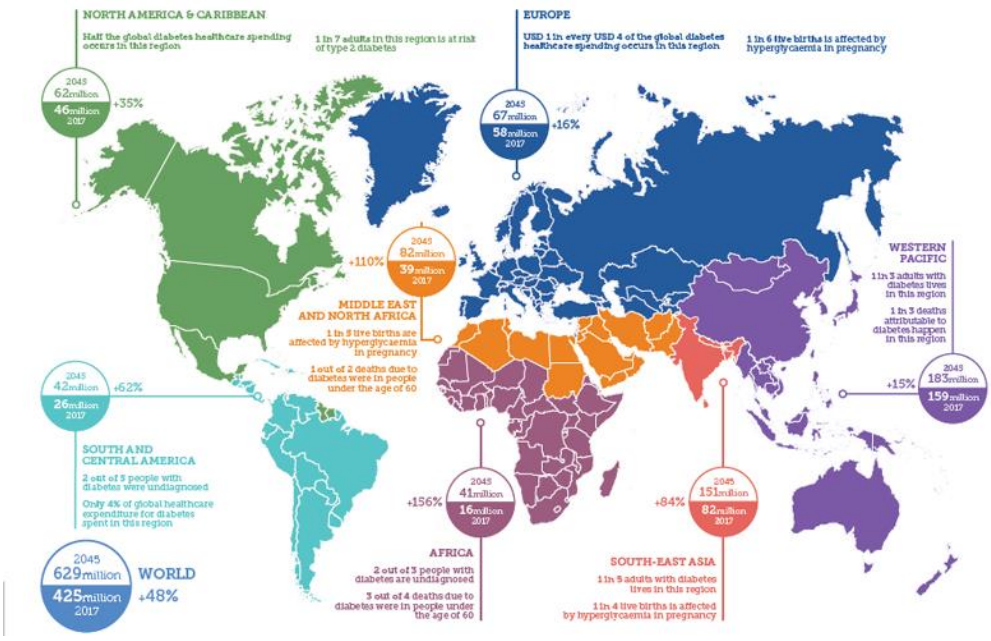


Figure 1. Diabetes prevalence worldwide 2017 and 2045 (estim.) (IDF Atlas 8th Edition 2017

In general, 4 out of 5 people with diabetes live in low- and middle-income countries (IDF Diabetes Atlas 2017). Some of the highest rates of diabetes are found in some Pacific island nations (Micronesia 36 % and Kiribati 26 %), but the Arabian countries show high rates too (Saudi-Arabia 24 % and Kuwait 23 %) (Worldatlas 2017). This is at least partly due to lifestyle changes and poor diet, containing calorie-rich and nutrient-poor imported food. (WHO 2017.) Figure 1. describes the diabetes prevalence worldwide in 2017 as well as the estimated prevalence in 2045.

In 2017, 212 million people were undiagnosed and 352 million people were at risk of developing type 2 diabetes (IDF 2018). In its global report on diabetes 2016, WHO pointed out that diabetes is an important public health problem as it affects both the individual and the society as a whole. The complications bring significant economic and social losses on an individual level as well as a national level. (WHO Global report, 2016.)

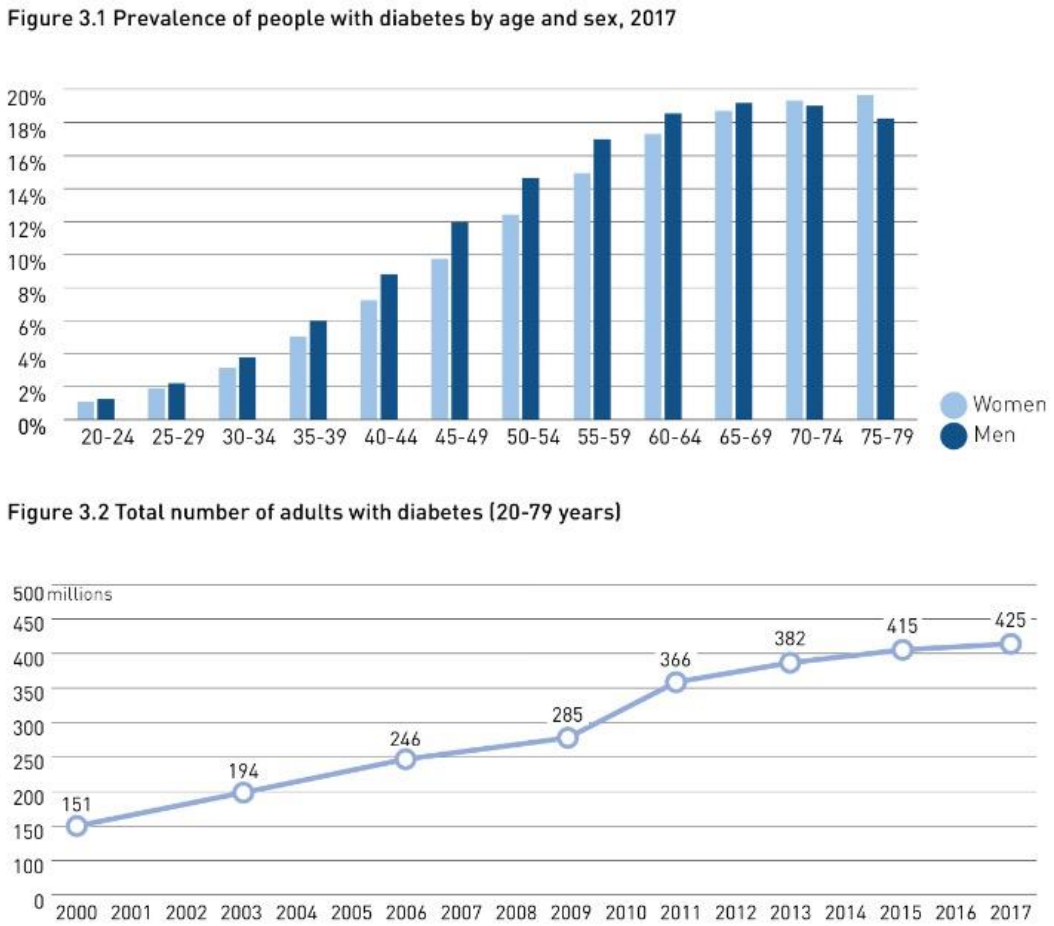


Figure 2. Diabetes prevalence by age and gender and total number of adults with diabetes (IDF Atlas 8th Edition 2017).

Figure 2. presents the development of diabetes prevalence by age and gender and total number of adults during 2000-2017.

## 2.2 Diabetes in Finland

In Finland, approximately 6 % of the population is suffering from diabetes. There are about 50 000 people with type 1 diabetes, 300 000 with type 2 diabetes and another estimated 150 000 undiagnosed cases of type 2 diabetes. (Finnish diabetes association, 2017.) When considering also the undiagnosed cases, the diabetes rate for Finland is 9 %. It is estimated that the number of cases might double within the following 10-15 years (Käypä hoito 2018).

According to the National Institute for Health and Welfare in Finland (THL), the prevalence of type 2 diabetes in Finland represents the average of European standards. The high prevalence of type 1 diabetes on the other hand is most likely due to the Finnish genome. (THL 2018.)

The number of patients diagnosed with diabetes type 2 have increased during the past years. This is most likely due to increased overweight and less physical activity but also better diagnosis, renewed diagnosis criteria and an aging population is to be considered. All in all, people also live longer today. (THL 2018.)

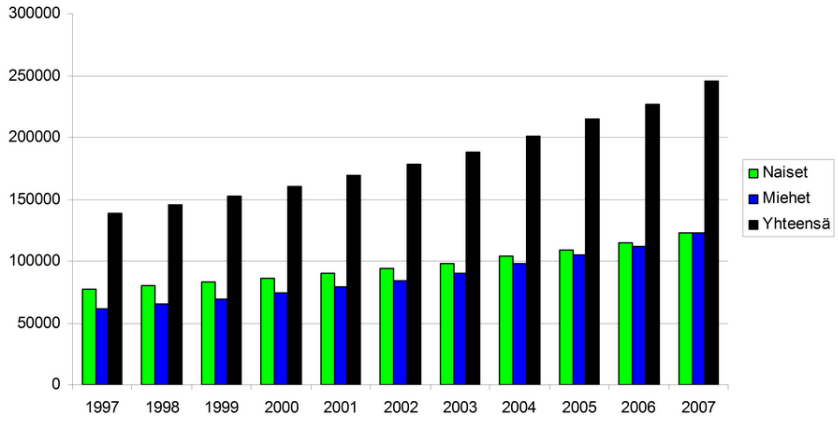


Figure 3. The prevalence of type 2 diabetes in Finland based on medical reimbursement and hospital registers (THL 2018).

Figure 3 shows the prevalence of type 2 diabetes in Finland during 1997-2007.

Based on Finnish register research, the age standardized mortality rate for individuals with type 1 diabetes is three times higher for men and four times higher for women compared to the general population. For both men and women with type 2 diabetes it is almost two times higher. (Käypä hoito 2018.)

## 2.3 Diabetes Mellitus

Diabetes (lat. Diabetes Mellitus) is a chronic disease, occurring when the pancreas is unable to produce insulin, the effect of the insulin is diminished or a combination of both (IDF 2017, Duodecim Käypä hoito 2016). Insulin is a hormone, playing an important role in the metabolism of the body. The digestive tract breaks down carbohydrates from food to glucose that enters the blood. Insulin helps the cells in the body to absorb the glucose in the blood and produce energy. (IDF 2018, NIDDK 2018.) The lack or insufficient use of insulin leads to hyperglycaemia, i.e. high levels of glucose in the blood plasma. (IDF 2017, Duodecim Käypä hoito 2016.) Acute and chronic complications are associated with hyperglycaemia, negatively affecting both the quality and expectancy of life for the patient (Duodecim Käypä hoito 2016).

## 2.4 Classification of diabetes

Diabetes is not a homogeneous disease, rather it can be divided into several different categories depending on appearance and aetiology. The classification is based on consensus definitions. (Käypä hoito 2018.)

Diabetes is usually divided into 3 different types; type 1 diabetes, type 2 diabetes and gestational (GDM) diabetes. Other specific types also exist. (IDF 2017.)

### 2.4.1 Type 1 diabetes

Type 1 diabetes, juvenile-onset diabetes or insulin dependent diabetes is the result of a cellular-mediated autoimmune destruction of the β-cells of the pancreas. This form of diabetes accounts for only 5-10 % of the patients with diabetes. (American Diabetes Association 2010.) The destruction of the insulin producing β-cells leads to insulin deficiency, which untreated leads to ketoacidosis, coma and death. Both genetic and environmental factors are associated with type 1 diabetes. (Käypä hoito, insuliininpuutos diabetes 2018.) The reason for this autoimmune reaction is not yet fully understood (IDF 2018).

LADA (Latent Autoimmune Diabetes in Adults) is considered a form of type 1 diabetes although it in the early stages resembles type 2 diabetes more. At first, it doesn’t nec-

essarily require insulin treatment but over time half of the patients develop significant insulin deficiency. (Käypä hoito, insuliininpuutos diabetes 2018.)

Type 1 diabetes can develop at any age, but usually affects younger people and children. Type 1 diabetes requires insulin treatment (injections) in order to manage blood glucose levels. Without insulin the patient dies. (IDF 2018.)

In Finland, the number of patients with type 1 diabetes is 10-15 %, and the incidence is one of the highest in the world. (Käypä hoito, insuliininpuutos diabetes 2018).

### 2.4.2 Type 2 diabetes

Type 2 diabetes, adult-onset diabetes or non–insulin-dependent diabetes refers to individuals who have different degrees of insulin resistance and usually relative (rather than absolute) insulin deficiency (American Diabetes Association 2010). Type 2 diabetes may be undetected for many years, as the hyperglycaemia develops gradually, and it can occur at any age although the risk increases with age. Obesity seems to be the single most important risk factor, and other associated risk factors are i.e. lack of physical activity, prior GDM in women and hypertension. Also, psychosocial factors such as depression, stress and insomnia as well as socioeconomic factors seem to affect the development and progression of type 2 diabetes. (IDF 2018, Käypä hoito Tyypin 2 diabetes 2018)

The frequency of type 2 diabetes varies in different ethnic/racial subgroups, and it looks as it is more common in individuals with African American, American Indian, Hispanic/Latino and Asian American background. It is more associated with a strong genetic predisposition than type 1 diabetes but the genetics is not clearly defined. (IDF 2018, Diabetes Care Journal 2015.) Many patients with type 2 diabetes can at least initially manage their condition through exercise and diet, but many require insulin treatment over time (IDF 2018).

Type 2 diabetes accounts for 90–95% of all cases of diabetes in the world and the number is increasing (Käypä hoito Tyypin 2 diabetes 2018). In Finland, there are approximately 300 000 individuals with type 2 diabetes and another 150 000 yet undiagnosed (Finnish Diabetes Association 2018).

### 2.4.3 Gestational diabetes (GDM)

Gestational diabetes is a form of diabetes that can occur when the blood glucose levels are high during pregnancy. It is associated with complications for both mother and baby and approximately one of 25 pregnancies worldwide are affected. (IDF 2018.) GDM is likely to disappear after pregnancy but it is associated with a higher risk of developing type 2 diabetes later on (Käypä hoito, Raskausdiabetes 2018).

## 2.5 Diagnosing diabetes

Diabetes can be diagnosed with a random plasma glucose value higher than 11 mmol/l in patients experiencing “classical diabetes symptoms” like abnormal thirst, frequent urination and sudden weight loss (Käypä hoito, insuliininpuutos diabetes 2018).

The following criteria are used to diagnose diabetes:

1) A1C criteria, where HbA1c ≥ 48 mmol/mol (6,5 %)
2) Plasma glucose criteria

a) fasting plasma glucose (FPG), with a value of 6,1–6,9 mmol/l showing an impaired fasting glucose, IFG.

b) 2-h plasma glucose (2-h PG) value after a 75-g oral glucose tolerance test (OGTT), with a value of 7,8–11 mmol/l showing impaired glucose tolerance, IGT.

(American Diabetes Association 2010, Käypä hoito 2018.)

Both IFG and IGT are considered preliminary stages of diabetes (Käypä hoito, insuliininpuutos diabetes 2018).

As stated previously, there were 212 million people with undiagnosed diabetes in 2017. This means that 50 % of all 20-79 years with diabetes are unaware of their disease. (IDF Atlas 8Th Edition.) As we shall see later on, it would be crucial for people to be diagnosed as early as possible, in order to prevent harmful and expensive complications. The IDF (IDF Atlas 8th Edition 2018) points out the obvious need for efficient screening, diagnosing and treatment to people suffering from diabetes.

## 2.6 Treating diabetes

According to the national Finnish Current Care Guidelines (CCG) (Käypä hoito 2018), the diabetes treatment in both type 1 and type 2 diabetes aims to achieve a as normal and long life as possible for the patient, avoiding complications and maintaining a smooth everyday life. Furthermore, the patient should be symptomless and maintain blood glucose levels close to normal range, avoiding fluctuation between hyper- and hypoglycaemia. (Käypä hoito 2018).

Figure 4. presents the specific goals regarding hbA1c, fasting glucose, post-meal glucose, LDL-cholesterol and blood pressure.

| Meter | Goal | Notice |
|---|---|---|
| HbA1c-concentration (mmol/mol, %) | < 53 (7,0 %) | Unless severe cases of hypoglycaemia |
| Fasting glucose concentration (mmol/l) | < 7 | Main level for own blood glucose measurements |
| Post-meal glucose concentration (approx. 2 h after meal) (mmol/l) | < 10 | Main level for own blood glucose measurements |
| LDL-cholesterol concentration (mmol/l) | < 2,5 | All patients with diabetes |
| | < 1,8 or ≥ 50 % decrease of initial value | Patients with diabetes and cardiovascular disease, microvascular complications or other cardiovascular risk factors |
| Blood pressure (mmHg) | <140/80 | |

Figure 4. General goals for patient with diabetes (glucose levels, blood lipids and blood pressure (Käypä hoito 2018).

The treatment varies depending on the patient and the type of diabetes:

In type 1 diabetes insulin treatment is lifelong, combined with blood glucose monitoring and the assessment of carbohydrate intake, of which the insulin dosage is based. (FDA 2018) Continuous glucose monitoring (CGM) is important for assessing the effectiveness and safety of treatment when it comes to insulin pump therapy and multiple-dose insulin treatment (American Diabetes Association 2018).

In type 2 diabetes, weight control based on diet and exercise is central. Medication can be needed, both oral drugs and/or insulin. The treatment focuses on the following main areas:

a) blood sugar
b) blood pressure
c) blood lipids
d) blood coagulation factors.

They are important factors when it comes to preventing and treating complications. (Käypä hoito Tyypin 2 diabetes 2018, FDA 2018.)

Diet and exercise also play a key role in gestational diabetes but unless satisfactory blood glucose levels are reached by these means, oral drugs or insulin can be used (FDA 2018).

The Finnish CCG focuses on giving the patient sufficient skills and support to manage the condition in their everyday life, making the right decisions regarding self-treatment and this way prevent both acute and long-term complications (Käypä hoito 2018). The same applies to other organizations such as the American Diabetes Association and the International Diabetes Organization.

In March 2018, the Finnish CCG for treating diabetes was revised, with separate guidelines for type 1 and type 2 diabetes. The revised edition also brought more focus on supporting self-treatment and also added a more practical approach regarding lifestyle management. Furthermore, it stated that for type 1 diabetes, the current treatment results do not meet the treatment and blood glucose monitoring possibilities brought by technology. Also, patients should actively strive for individual treatment goals and it should be supported by e.g. modern pump treatment and the use of sensors for patients that benefit from them. (Käypä hoito 2018.)

## 2.7 Complications

Acute and chronic complications are associated with hyperglycaemia, negatively affecting both the quality and expectancy of life for the patient (Duodecim Käypä hoito 2018). According to the American Diabetes Association (2010), chronic hyperglycaemia caused by diabetes is associated with “long-term damage, dysfunction, and failure of

different organs, especially the eyes, kidneys, nerves, heart, and blood vessels." (American Diabetes Association 2010.)
A comprehensive treatment of dyslipidaemia, high blood pressure, smoking, hyperglycaemia and psycho-social risk factors is of great importance when preventing diabetes-related complications. (Käypä hoito 2018.)

The most common cause of death and morbidity is macrovascular complications, such as cardiovascular diseases, leading to failure in heart and blood vessels, causing heart attack and stroke. (Käypä hoito 2018, IDF 2018). According to research, CVDs are the cause of death in approximately 65 % of individuals with diabetes (Grundy et al 1999).

Diabetic nephropathy (kidney disease) is much more common in patients with diabetes. It occurs when blood vessels in the kidneys are damaged, leading to the kidneys losing efficiency and ultimately failing altogether. (NIDDK Diabetic Kidney Disease 2018 - IDF 2018.)

Other complications are diabetic neuropathy (nerve disease), leading to problems with digestion and erectile dysfunction as well as nerve damage in the feet (peripheral neuropathy). This is problematic, as it may lead to loss of feeling in the feet, which in turn can cause serious damage, infections and possible amputations. The risk of amputation for persons with diabetes is estimated to be even 25 times greater than that of people without diabetes. (IDF 2018.) Also, eye-related complications such as diabetic retinopathy occur. Diabetic retinopathy affects approximately 80-100% of the individuals with type 1 diabetes developed under the age of 30, when the condition has lasted for 20 years. For type 2 diabetes, it might be present already at the point of diagnosis. Diabetic retinopathy is associated with both the duration of diabetes and high levels of blood glucose, hyperglycaemia (Henricsson et al, 1996 - Käypä hoito 2018.)

Figure 5. below show the most common complications related to diabetes.

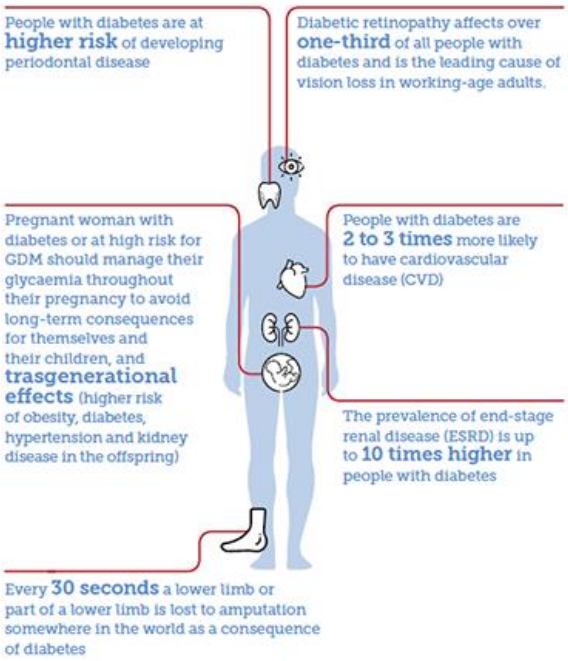


Figure 5. Complications associated with diabetes (IDF Atlas 8th Edition 2017)

Several studies have shown that diabetic complications are closely related to depression, anxiety and decreased physical performance and quality of life (Käypä hoito, insuliininpuutos diabetes 2018, Käypä hoito, Tyypin 2 diabetes 2018).

According to an international group of researchers, a person with diabetes lives on average 6 years less than a non-diabetic person. Furthermore, the researcher concluded that "*In addition to vascular disease, diabetes is associated with substantial premature death from several cancers, infectious diseases, external causes, intentional self-harm, and degenerative disorders, independent of several major risk factors.*" (Rao Kondapally Seshasai S et al. 2011.)

As further on will be demonstrated, the rise of complications is a huge challenge also from an economical aspect, as it significantly increases the total costs of diabetes treatment. However, the true impact of costs caused by diabetes and its associated complications are likely to be underestimated or even unmeasured, according to a London School of Economics report from 2012 (Kanavos et al, 2012). This is mainly due to poor record keeping and variation in both the availability of outcomes data as well as the quality of the relevant indicators between the countries. The study was car-

ried out in five EU countries (Germany, France, Italy, Spain and the UK), comparing the diabetes burden of disease, costs (direct and indirect) and diabetes outcomes, with focus put on complications. According to the study, inpatient costs are significantly higher due to diabetes-related complications as they require increased medical care. The cost of prescribing medication for diabetes complications is 3 to 4 times higher than prescribing regular diabetes medication. (Kanavos et al, 2012.)

In the United Kingdom, the cost of treating diabetes is almost 16 billion euro a year, with annual outpatient care costs (including medication and monitoring supplies) of 340 to 420 euro per patient. The annual inpatient costs are estimated to be 2000 to 2800 euro per patient, including the treatment of both short- and long-term complications due to diabetes. (Diabetes.co.uk, 2018.)

In Finland, the annual cost for treating diabetes without complications was 1300 € per patient in 2007. For treating diabetes with complications, the annual cost was 5700 € per patient. (THL, 2018.)

## 2.8 The Importance of preventive care

Type 1 diabetes cannot be prevented at present, although it is an area of big interest and research. Prevention of type 2 diabetes is mainly concerned with addressing life-style factors, and it has been shown that lifestyle behaviours associated with urbanization is one of the most influential factors in the development of type 2 diabetes. (IDF 2018.) WHO lists the following actions everybody should take in order to help prevent type 2 diabetes and complications (Figure 6):


Figure 6. Actions to prevent type 2 diabetes and complications (WHO 2018).

According to the Finnish Diabetes Prevention Study (DPS) (Lindström et al 2003), intensive lifestyle intervention proved very beneficial for preventing type 2 diabetes as it produced long-term positive changes in both diet, exercise and weight reduction, fasting plasma glucose and blood lipids. As the lifestyle intervention reduced the risk of diabetes it was suggested to be implemented in primary healthcare systems. (Lindström et al 2003.)

The benefits of healthy diet and/or exercise intervention were also proved by The Da Qing IGT and Diabetes Study in 1997 (Xiao-Ren Pan et al 1997). A healthy diet consists of plenty of greens and fruits and whole grain and limited amount of high sugar foods, white wheat and processed foods. Restricted amounts of saturated fats and salt as well as alcohol is also recommendable. Smoking should also be avoided. (Käypä hoito, Tyypin 2 diabetes 2018.) The American Diabetes Association (2018) suggests meal planning and following eating pattern in order to better managing diabetes.

In order to furthermore prevent type 2 diabetes, it would be important to create supportive policy and both social and physical environments that enables healthy lifestyles. (World Health Organization Global report on diabetes 2016).

IDF suggests that in order to save lives and prevent and/or delay diabetes-related complications and reduce healthcare expenditure, population-wide lifestyle changes are required as well as early detection, diagnosis and cost-effective treatment (IDF Atlas 8th Edition 2017).

## 2.9 Healthcare expenditure caused by diabetes care

As stated previously, diabetes is one of the biggest health problems in the world. It has a very negative effect on national healthcare budgets and burden on healthcare systems. It slows economic growth and reduces productivity and can cause economic disaster for vulnerable households. (IDF Atlas 8th Edition 2017.) Families may be subject to higher out-of-pocket health-care payments and family income may be lost due to disability and premature death. Especially in developing countries researchers have found that people with diabetes are significantly more likely to encounter catastrophic medical expenditure than people without diabetes. (World Health Organization Global report on diabetes 2016.)

### 2.9.1 Cost structure for diabetes care on a global level

The American Diabetes Association released new research in March 2018, showing that the estimated total costs of diabetes have risen from $245 billion in 2012 to $327 billion in 2017 in the U.S. In other words, an increase of 26 % in 5 years. The figure for 2017 includes direct medical costs for $237 billion and $90 billion in reduced productivity. This gives a good view of the burden diabetes imposes on society. Into account was also taken the societal burden, caused by pain and suffering. (American Diabetes Association 2018.) The second highest healthcare expenditures in 2017 were found in China (ID 110 billion), followed by Germany (ID 41 billion) and India (ID 31 billion). (IDF Atlas 8th Edition 2017.)

According to IDF, the estimation is that total healthcare expenditure on diabetes is going to rise to USD 727 billion (for persons aged 20-79 years) in 2017. This equals an 8% increase compared to the 2015 estimate. The economic burden of diabetes is estimated to grow further, reaching USD 776 billion by 2045. (IDF Atlas 8th Edition 2017.)

According to the WHO global report on diabetes (2016) the economic impact of diabetes and its complications are massive. Direct annual costs caused by diabetes have been estimated to more than US$ 827 billion to the world according to recent systematic. The major cost drivers are hospital and outpatient care, but the use of patented, branded medicines including both oral medication for type 2 diabetes and the use of more expensive analogue insulins is a contributing cost factor too. (World Health Organization Global report on diabetes 2016)

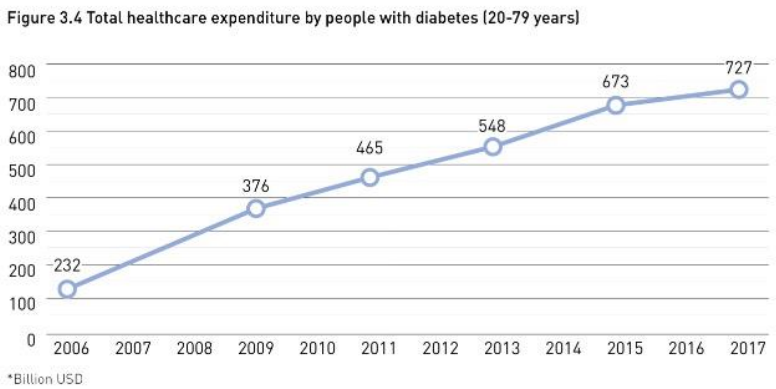


Figure 7. Total healthcare expenditure by people with diabetes (20-79 years) (IDF Atlas 8th Edition 2017).

Figure 7. presents diabetes-related healthcare expenditure during 2006-2017. As can be seen, the total healthcare expenditure by people with diabetes have risen with over 200 % in this period of time.

### 2.9.2 Cost structure for diabetes care in Finland

Currently, the diabetes care in Finland is expensive and ineffective. Direct costs caused by diabetes are currently responsible for 15 % of the total healthcare expenses in Finland, and at least 60 % due to the treatment of avoidable complications. The costs are increasing fast. (Käypä hoito 2018.)

In 2015, as presented in Figure 8., total Finnish healthcare expenditure was 19,5 billion euro (THL Terveydenhuollon menot ja rahoitus 2015). This means that diabetes causes healthcare expenditure for almost 3 billion euro annually. However, it is estimated that even as much as 70 % of the costs caused by complications could be avoided when people at risk are identified early enough. This equals possible savings of approximately 1,5 billion euro. (Terveystalo 2013.)

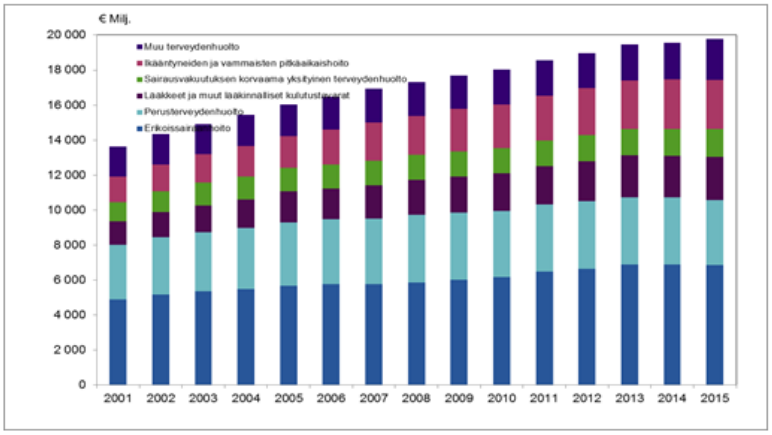


Figure 8. Finnish healthcare expenditure 2000-2015. (THL Terveydenhuollon menot ja rahoitus 2015)

During 2002-2011 the number of patients with diabetes in Finland have risen with 70 %. In the same time, healthcare expenditure and productivity costs for patients with diabetes have risen 49 %. (Diabetes lukuina 2018:1)

Taru Haula et al (2017) presented research showing that the amount of diabetes patients in the Helsinki metropolitan area have grown from 4,2 to 5,9 % during 2006-2014. Despite the increasing overall costs, both overall and additional costs per patient have shown a decrease. In this case additional costs refers to the difference in healthcare expenditure between individuals with diabetes and those without diabetes. This is due to the change in cost structure, where focus have shifted from in-patient care to out-patient care. According to the same research, the amount of type 2 diabetes is increasing as the population gets older, in 2014 every 5th elderly in the metropolitan area suffered from diabetes. (Haula et al, 2017.)

## 2.10 Complications effect on costs

It is known that poorly treated diabetes leads to complications consuming medical services and increasing the costs significantly. Diabetes is considered one of the most prominent chronic diseases in Finland due to the complications strongly linked to it. Cardiovascular diseases are the single largest group of complications, causing heart attack, stroke and lower limb amputations. (Niemi – Winell 2005.) In the study on diabetes-related costs in Finland during 2002-2011, committed by the University of Tampere and Finnish Diabetes Association, results showed that the emerge of complications doubles the medical costs.

In 2011, the annual costs per person (with type 1 diabetes) was 3508 euro and 3036 euro (type 2 diabetes). The emerge of complications increased the costs to 5915 euro and 7069 euro respectively, as seen in Figure 9. (Diabetes lukuina 2017:1)

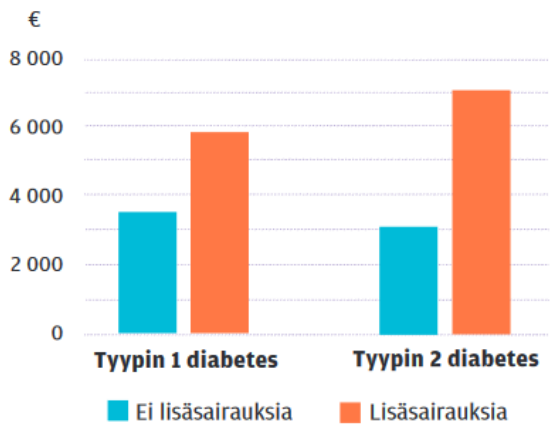


Figure 9. Annual healthcare expenditure for type 1 (left) and type 2 (right) diabetes without (blue) and with complications (orange). (Diabetes lukuina 2017:1)

This means that complications generate 1,7 times higher costs for type 1 diabetes and 2,3 times higher costs for type 2 diabetes.

However, according to the same study, the general healthcare expenditure has remained on approximately the same level or even slightly started to decrease (Figure 10.).

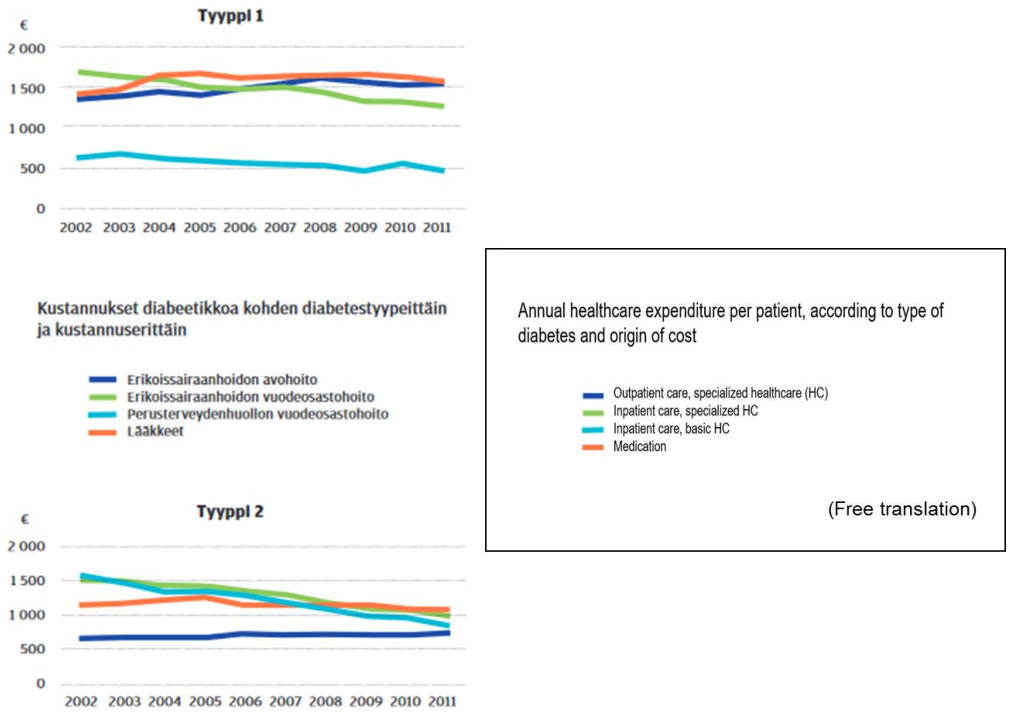


Figure 10. Cost structure development for patients with type 1 and type 2 diabetes (Diabetes lukuina 2017:1)

The in-patient costs (green and light blue) have decreased steadily and the out-patient costs (dark blue) have remained on approximately the same level. Costs related to medication (orange) first showed an increase but have since decreased. (Diabetes lukuina 2017:1)

Already in 2010, the DEHKO-report (Jarvela 2010) studying diabetes-related cost development in Finland during 1998-2007 showed that the costs caused by complications were almost 65 % of the overall diabetes-related costs. In 2007 the diabetes-related costs were 8,9 % of the total Finnish healthcare expenditure. (DEHKO, Jarvela 2010.)

Since then the costs have further increased to 15 % of the total healthcare expenditure in Finland (Käypä hoito 2018).

The DEHKO-report found that complications increased the costs by 2,4 (type 1 diabetes) and 3,2 (type 2 diabetes) times (4,7 and 5,1 compared to the control group). Furthermore, the additional costs for diabetics with complications were 3,7 times higher on average (type 1 diabetes: 6 times, type 2 diabetes: 4,5) compared to the patients without these complications. (Figure 11. and 12.)

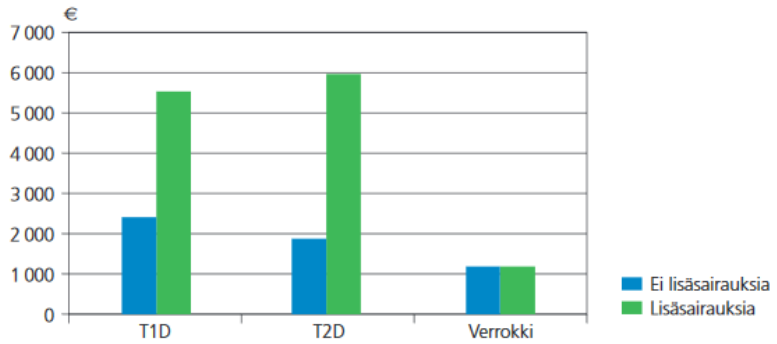


Figure 11. Overall costs per patient for diabetes patients without (blue) and with complications (green) in 2007 (DEHKO, Jarvela 2010).

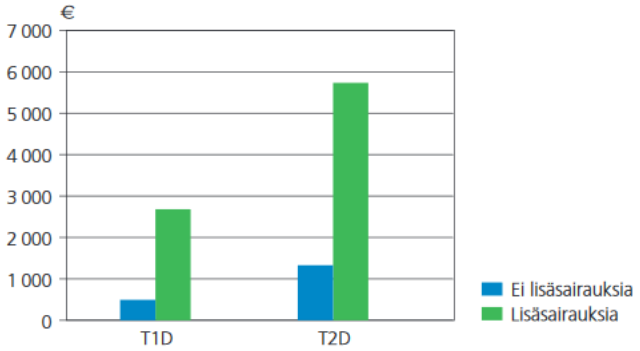


Figure 12. Additional costs per patient for diabetes patients without (blue) and with complications (green) in 2007 (DEHKO, Jarvela 2010).

Additional costs refer to the costs originating from the treatment of other conditions caused by diabetes and treatments more expensive to perform on patients with diabetes compared to the general public (DEHKO, Jarvela 2010).

The DEHKO-report also studied regional cost differences, the costs associated to the last two life years as well as the productivity costs.

Costs associated with diabetes have grown slower (24%) than the non-associated ones, which have almost doubled. The improved early diagnosis of type 2 diabetes since the beginning of year 2000 seems to have had a positive effect on the overall costs. This also points out the importance of resourcing personnel and knowledge for the best possible treatment of diabetes. (Koski et al, 2018.) According to Diabetesbarometri 2017, a Finnish national diabetes survey, the healthcare sector is lacking sufficient resources and have not received more resources despite the fact that the number of patients with diabetes have grown over time (Diabetesbarometri, 2017).

In 2007, the productivity costs were 1 333 million euros, with premature retirement representing 962 million euros (72%) with diabetes-related additional costs responsible for 68 % of them (DEHKO, Jarvela 2010).

In the study committed by the University of Tampere and Finnish Diabetes Association on Diabetes-related costs during 2002-2011, productivity costs were also highlighted. The results showed that healthcare expenditures counted for only 25 % of the overall costs, totalling 832 million euros and consisting of in- and out-patient care provided by specialized and general healthcare as well as drug-related expenses. The resisting 75 % was made up of productivity costs, totalling 2 552 million euro. They originate from sick leaves reported for 16-65-year-old individuals with diabetes, reimbursed by Kela, the Social Insurance Institution of Finland, after the waiting period, premature retirement and premature death. Figure 13. presents the development of healthcare and productivity costs.

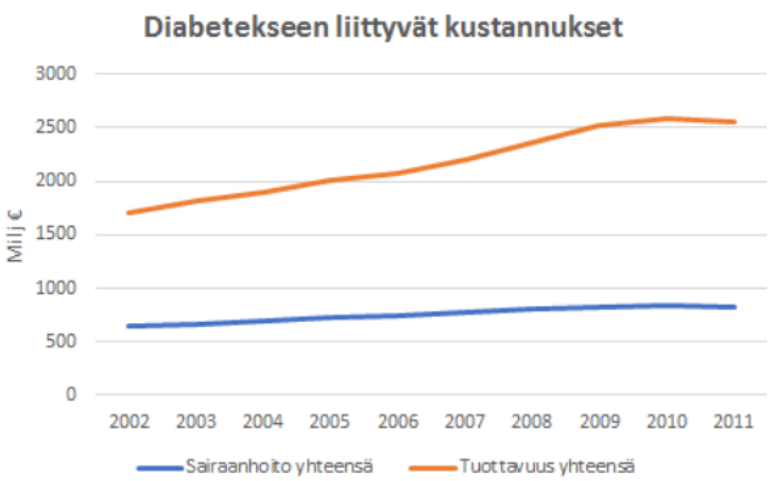


Figure 13. Annual diabetes-related costs; healthcare expenditure (blue) and productivity costs (orange) 2002-2011 (Diabetes lukuina 2018:1).

Also, the London School of Economics report from 2012 points out that the indirect costs related to i.e. reduced productivity, absenteeism, early retirement and social benefits are significant in the five EU countries examined and can *"exceed direct costs by at least a factor of 2-or even 3-to-1 depending on the country."* (Kanavos et al, 2012).

Premature retirement is considered to be the biggest factor contributing to the productivity costs, but according to the report retirement due to diabetes have not increased during the period examined in the report. (Diabetes lukuina 2018:1.) Also, recent research (Bonsdorff et al 2018) following up individuals throughout their working career showed that individuals with diabetes actually retired approximately two years later than those without diabetes.

However, according to the report by the University of Tampere and the Finnish Diabetes Association (2018) the lack of efficient resourcing in the treatment and guidance of diabetes at general healthcare level is likely to show quickly in terms of increased productivity costs (higher levels of sick leave). The effect on healthcare expenditure is delayed. (Diabetes lukuina 2018:1)

The study did not comprise data from general healthcare, occupational healthcare, open services, self-treatment equipment and rehabilitation, not available in all districts.

The Finnish medical magazine Diabetes ja Lääkäri also published an article based on the results from the study on diabetes-related costs in Finland during 2002-2011. The article pointed out that significant savings of up to 550 million euro annually could be made if the amount of complications were 50 % less. Very significant financial benefits could to be achieved for society and the benefits for individuals (e.g. improved quality of life) are not to be understated. (Koski et al, 2018)

According to Koski et al (2018) it would be most beneficial, from both individual and cost perspective, to aim for more efficient prevention of type 2 diabetes but the importance of good diabetes treatment still remains. As untreated diabetes leads to complications and additional conditions it will most likely eventually be even more expensive for the society (Haula et al, 2017).

## 2.11 The benefits of strict blood glucose control

As seen above, maintaining near normal levels of blood glucose is of great importance when it comes to minimizing the risk of diabetes-related complications.

The benefits of strict blood glucose control i.e. glycaemic control when treating diabetes was demonstrated already in the early 1990s by the Diabetes Control and Complications Trial Research Group. (DCCT 1993) The purpose of the study was to examine whether intensive treatment with insulin pump or multiple insulin injections daily in order to maintain blood glucose near normal range would reduce the frequency and severity of complications in patients with insulin-dependent diabetes mellitus. (IDDM). According to the results, the development of diabetic retinopathy was reduced by 76 %, the occurrence of microalbuminuria by 39 % and that of clinical neuropathy by 60 %. Therefore, the research group concluded that “Intensive therapy effectively delays the onset and slows the progression of diabetic retinopathy, nephropathy, and neuropathy in patients with IDDM.” However, the cases of severe hypoglycaemia were considerably higher (approximately 3 times) in the intensive therapy group compared to the control group. (DCCT 1993.)

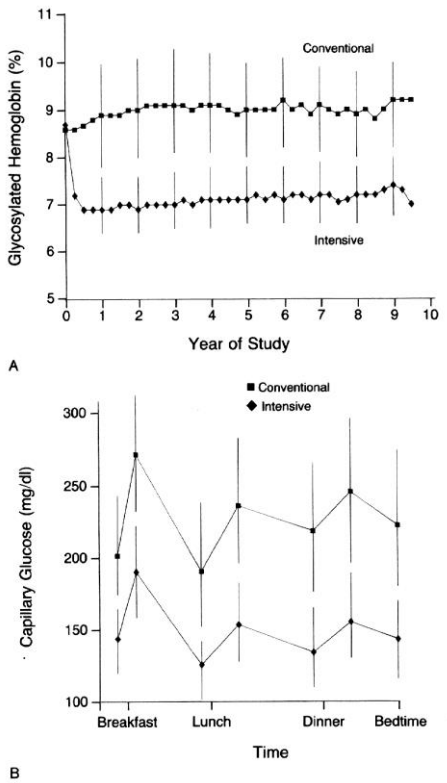


Figure 14. Median hbA1c levels and mean blood glucose levels (DCCT 1993).

Figure 14. presents the medians of hbA1c levels as well as the mean blood glucose levels during a 24-hour period (based on 7 measurements) for the intensive therapy group and the control group during the study.

The DCCT/EDIC research group followed up on the study, further demonstrating that “previous intensive treatment of diabetes with near-normal glycemia during the DCCT has an extended benefit in delaying progression of diabetic nephropathy.” (DCCT/EDIC research group 2003).

30 years after the DCCT study was initiated, the DCCT/EDIC Study Research Group performed a follow-up study on the effects of previous intensive treatment on CVDs. Results showed that intensive therapy reduced the incidence of any cardiovascular disease by 30% and the incidence of nonfatal myocardial infarction, stroke or cardiovascular death by 32%. Furthermore, the research group were able to state that “The lower HbA1c levels during the DCCT/EDIC statistically account for all of the observed treatment effect on cardiovascular disease risk”. (DCCT/EDIC 2016.)

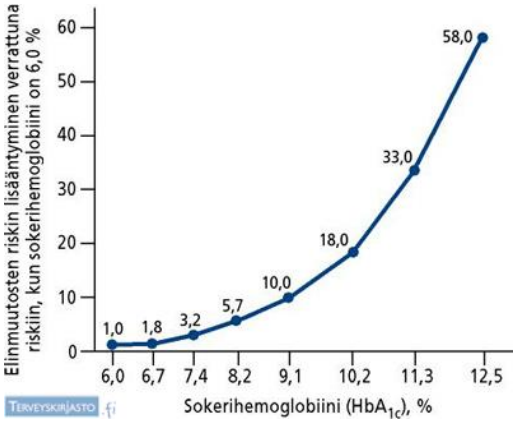


Figure 15. The relationship between hbA1c and the risk of diabetic organ transformation (Mustajoki 2007)

Figure 15. illustrates the relationship between HbA1c and the risk of diabetic organ transformation. The risk linked to HbA1c reference value 6.0% (42 mmol/mol), which is considered “normal”, is marked number 1. The risk of developing organ transformations, i.e. complications, increases rapidly as the Hba1c value increases. E.g. with HbA1c value 9 % (75 mmol/mol) the risk is ten times bigger and 12 % (108 mmol/mol) equals a 50-times risk. (Mustajoki 2007.)

Glycaemic control has not been optimal in Finland during the last years. A reported average hbA1c of 8.6 % (79 mmol/mol) in the DEHKO-report (Valle 2010) is clearly above the ideal target of 7,0 % (62mmol/mol) (Duodecim Käypä hoito 2016). Comparing with the graph above (Mustajoki 2007), this means that there is a continuous almost 10-times risk of developing complications.

Research has shown that continuous glucose monitoring (CGM) and self-monitored blood glucose (SMBG), HbA1c and oral glucose tolerance test (OGTT) seem to be useful for indicating dysglycemia during preclinical type 1 diabetes (Helminen et al 2016).

## 2.12 The use of technology in diabetes care

Health information technology (HIT) is an evolving and expanding field and health apps have lately been influencing and changing the healthcare industry greatly, taking healthcare out of hospital environment and giving more power to the people when it comes to treatment and prevention (Workman, 2013). According to consulting company Research2Guidance (2018), the number of mobile health apps available was 325 000 in 2017, with Android being the leading mobile health platform.

The benefits of HIT are also recognized in diabetes care. Digital programs enable new models for value-based care and have been clinically proven to improve health and reduce costs. According to research, both short- and long-term health and self-management improvements can be expected for patients using digital health technology, which makes it a sufficient population management strategy for health. (Kaufman – Kurana, 2016.)

Arnhold et al (2014) examined all diabetes apps available at the time for a systematic review of the evaluation considering the special requirements of diabetes patients age 50 years or older. 656 apps in total were found, approximately half of them (54,1%) containing only one function and 53.0% providing documentation function for documenting and tracking blood sugar levels. There were big similarities between the apps and according to the review, usability of diabetes apps for patients aged 50 or older was found to be moderate to good. (Arnhold et al, 2014.)

Usability and improvement in diabetes management are key factors for patient satisfaction when it comes to modern, digital technology-enabled devices and applications in diabetes care. Also, devices with possibility to interact with healthcare professionals and/or peers were considered to be of high value to the patients. (Harrison et al, 2014.)

Research have found that internet delivered self-management education is more effective when it comes to improving diabetes knowledge and glycaemic control as compared to traditional diabetes care (Pereira et al, 2015). A systematic review of randomized controlled trials investigating the effects of telecare intervention on glycaemic control in type 2 diabetes (Huang et al, 2015), also showed that “telecare monitoring resulted in significant improvements in glycaemic control in patients with type 2 diabetes”. Average HbA1c values were reduced by −0.54 (95% CI, −0.75 to −0.34; $P<0.05$) compared to the control group receiving standard care. Those patients with higher starting hbA1c levels (above 8 %) showed better results. (Huang et al, 2014.)

Likewise, a review on Health Technologies for Monitoring and Managing Diabetes (Russell-Minda et al, 2009) demonstrated the positive effect of self-monitoring of blood glucose on glycaemic control in patients with noninsulin-treated type 2 diabetes and concluded that “wireless technologies can improve diabetes self-care”.

According to Kaufman – Kurana (2016), HIT is most likely to change health-care delivery and self-management education. However, the healthcare system is rigid and evidence-based and therefore likely to slowly adapt to organizational challenges brought by HIT, including adopting new innovations. At the same time the demands and expectations of consumers and patients rise. Kaufman and Kurana (2016) therefore suggests that healthcare organizations engaged in “(1) pilots to learn about the unique impacts of digital health programs on their populations, and (2) road maps to scale digital health solutions over time”.

Finnish nursing students Max Millner and Ollimatti Salovaara (2017) evaluated the usability of mobile applications for diabetes self-care available on Google Play Apps Store for their Bachelor thesis. Among 250 applications found, they focused on 11 in particular and discovered that even though the applications were suitable for monitoring diabetes care, they did not improve the care as such and were not e.g. helping the user with calculating insulin dosage. However, Millner and Salovaara did acknowledge that developing application technology is likely to change this, as telemedicine enables

more support to the patient. Applications examined in the thesis were MySugr, Diabetes:M and OnTrack to name but a few. (Millner – Salovaara, 2017.)

In April 2018, Finnish health technology company Quattrofolia released the newest version of their diabetes care application Balansio. Not only is the application providing automated clinical intelligence for daily Ac1 estimation and insulin dosage calculation, it also assists to improve care and identifies issues in care routines. It enables remote care and communication with diabetes care professionals, providing the care and support for the patient when it is most needed and acting as a holistic care platform. In this way it is also serving healthcare professionals and clinics. (Balansio, 2018 – Quattrofolia, 2018.)

Quattrofolia (2018) is relying heavily on modern technology and automated clinical intelligence claiming, that even up to 60 % of the diabetes-related complications can be avoided using the Balansio care model. This would in turn enable major savings in public healthcare worldwide. (Quattrofolia, 2018.)

As stated previously, the revised edition of the Finnish CCG (Käypä hoito 2018) acknowledges the possibilities and advantages brought by technology in diabetes care although the results are not currently meeting the levels possible to achieve especially for patients with type 1 diabetes.

# 3 Purpose, aim and research objectives

Limited amount of research is done on how to practically tackle the problem with a rapidly growing rate of diabetes and the costs arising from the treatment of complications. Currently the only guidelines for diabetes care in Finland are posed by the Current Care Guidelines. (Käpyä hoito 2018).

The aim of this study is to explore how the current diabetes care practice in Finland could be improved by using technology in a way that decreases both the amount of complications and the healthcare expenditure. More specific, the study is concerned with which investments should be made in order to minimize the amount of complications.

Furthermore, it aims to provide a deeper insight into how technology (especially automated clinical intelligence and remote assistance) can be used for preventive care, both improving care results and saving costs.

This research addresses diabetes in general and does not distinguish between type 1 and type 2 diabetes.

The terms costs, healthcare expenditure and expenses are used interchangeably.

# 4 Research Methods

The approach of this study is qualitative and the data is analysed using conventional inductive qualitative content analysis. Content analysis enables a systematic and objective analysis of data gathered, in this case interviews. Data is describing the phenomenon in question, and by reducing, clustering and abstracting the data, one is able to find the conceptual meaning behind the phenomenon of interest. (Tuomi - Sarajärvi, 2018: 117; 122-127.) The process of data analysis is further described in chapter 4.3.

## 4.1 Sampling

The sampling was done in order to obtain an as comprehensive understanding as possible of the challenges and possibilities that the current Finnish diabetes care is facing. Therefore, purposive sampling technique was used in this study. When a phenomenon is to be understood as thoroughly as possible, as done in qualitative research, the persons providing the data play a key role. They should have great knowledge or be experienced in the field in question, in order to provide the best possible information of the phenomenon in case. It is up to the researcher to select the persons possessing these qualities. (Tuomi – Sarajärvi, 2018: 98)

In order to explore how technology can improve the management of diabetes care and reduce complications as well as costs, I wanted to gather expertise in diabetes, health technology (with focus on diabetes care) and public health. The interviewees were chosen based on their experience and expertise in respective field. Interview request letters in Finnish (Appendix 1) were sent via email to five potential interviewees during June 17th - 28th 2018, with an option for four more potential interview requests. As I

wanted to obtain different angels to the research question, the interviewees were selected according to them representing:

1) health tech, focusing on developing professional healthcare technology (Interview 1)
2) clinical field of diabetology (Interview 2)
3) healthcare district administration, manager level (Interview 3)
4) research in Finnish public health (Interview 4)
5) the Finnish Diabetes Association (Interview 5)

I received five answers with the interest of participating in the research and the interviewees chose a convenient time and place for the face-to-face interviews scheduled.

## 4.2 Data Collection

Data was collected using semi-structured theme interviews. In semi-structured theme interviews the themes correlate with the phenomenon of interest and what is known of that particular phenomenon beforehand. The interview process proceeds according to these themes and relevant additional specified questions enables the interviewer to deepen the questions depending on the interviewee's answer. (Tuomi-Sarajärvi, 2018: 87-88.) This type of data collection is preferable when one is interested in the content, i.e. what the interviewees actually are saying (Jacobsen 2007: 92-93). In order to explore the possibilities of technology in diabetes care in Finland, five face-to-face theme interviews were performed during June 19th – August 15th 2018. In order for the interviewees to be able to express themselves in the most natural way, the interviews were performed in the language preferred by the interviewee, thus four in Finnish and one in Swedish. The time and place were also chosen by the interviewees.

At the start of the interview, I informed the interviewees of what I'm studying and what the purpose of my research was. Already in my initial email the interviewees had been informed of why they had been chosen, i.e. their respective experience in the field of question. They had also been informed of the fact that participation was voluntary, that they could withdraw from the research at any time and that all information including identity would be handled confidentially. I presented the structure of the interview, explaining the purpose of openly discussing the questions, which also had been included already in the initial email. The point was that they should be able to freely express their thoughts about the themes in question and that I might add specifying questions if needed. Furthermore, the interviewees were informed that the session would be rec-

orded with a recording application on my phone and that all identities and places would be masked when the interviews were transcribed. This was of great importance as the anonymity of the participants was confidential and as I wanted them to be able to freely and openly talk about the themes in question. Interviewees were able to ask further question if they wanted to. A consent form was also signed (Appendix 3).
The duration of the interviews varied from 45 minutes to 1 hour and 20 minutes, and I obtained 5 hours and 30 minutes in recording, which was transcribed in maximum three days from the interview. It resulted in 47 pages of written material in Arial font 11 (with line spacing 1,15. I regarded the data collection as successful and after four interviews I decided not to send out more interview requests as I found that the data started to repeat itself and I was satisfied with the coverage it provided. The fifth interview furthermore confirmed my impression and I was satisfied with the size of this sample.

I concentrated on listening during the interviews and made very few notes. Afterwards I did consider the atmosphere and based on that, the interview sessions were quite relaxed and open and interviewees were able to openly discuss the themes. In all five cases I noticed the conversation was drifting off and I had to steer it back to the topic. However, this comes as no surprise as diabetes care is a big and broad topic and as the interviewees are working closely with it, they tend to be passionate about it and get carried away. Listening to the interviews I still feel we managed to stick to the topic quite well.

## 4.3 Data Analysis

After the interviews were performed, I listened to the recordings, transcribed them and printed them out for reading. I read the material several times in order to get a good overview. Following the steps of content analysis described by Tuomi and Sarajärvi (2018: 122-127.), I started to underline words, sentences and phrases that were related to my research questions. I copied and colour-coordinated these sentences to a separate document as they represented meaning units of research data. The separate colours helped me see from which interview the data was originating. I furthermore regrouped the reduced units of meaning to correspond with my research questions and grouped them into subcategories and categories, ending up with three themes: “Mental support”, “Clinical quality and “Knowledge management”.

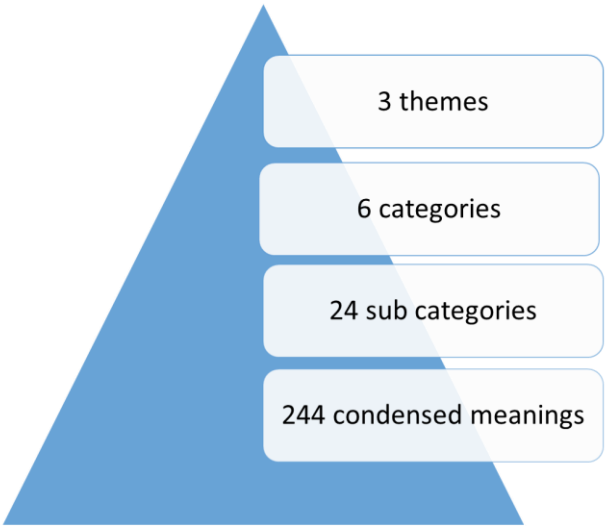


Figure 16. Data reduction process in numbers

Figure 16. describes the data reduction process, in total 244 condensed meanings, 24 sub categories, 6 categories and 3 themes.

After processing the data to themes, I went back to the original interviews to verify that I hadn't missed anything and that the themes were representing the original data. I made a few minor shifts within the subcategories but considered the data processing successful.

# 5 Results

Due to the limited number of interviewees in this kind of research, anonymity is a challenge. However, the identity of the interviewees is not relevant for the outcome or quality of the research, rather is the experience in the interviewees' respective field. This was also the criteria upon which the interviewees were chosen. Their respective experience ranged from 10 years to 27 years, three were men and two were women and geographically three different regions in Finland were represented. All of the interviewees had worked closely with diabetes care during their respective career.

In the beginning of each interview I began with addressing the balance of care as it is one of the corner stones in diabetes care. My specific interest was in which ways the balance of care can be affected, especially in a cost-efficient way and possibly involv-

ing technology. All interviewees agreed on that the patient needs to be put in the centre and that main focus should be put on reaching and retaining a blood glucose balance as stable as possible while maintaining good quality of life. It was highlighted, that there currently is a big contradiction between care results and increased treatment possibilities.

> ”… se [diabeteshoitomaailma] on mennyt koko ajan teknillisesti parempaan suuntaan ja mahdollisuudet on lisääntynyt mut ihmisen… omahoidollisesti niin se on mennyt todella paljon huonompaan suuntaan. ihan koko ajan.” (Interview 5)

> ” … it [diabetes care] has been constantly improving from a technical viewpoint and the possibilities have grown but…self-treatment wise it has gone a lot worse. all the time. “ (free translation)

The interviewees stressed the importance of life-style changes and mental support for patients, and saw potential in the use of technology for supporting the patient in their daily lives, both with concrete recommendation relating to the care plan and the mental support.

When addressing the big issues in the current diabetes care model the interviewees were also very unanimous, expectedly mentioning complications as the single biggest problem, causing not only big healthcare expenditure but also lost productivity and significant suffering for individuals. Lack of or poorly allocated resources was also mentioned, as well as an old-fashioned attitude and approach within the healthcare system.

On the subject of where to invest in order to cut the complications and solve these issues many aspects came up, i.e. identifying patients at risk, supporting patients with the help of technology, taking a more holistic and inclusive approach towards patients and securing the quality of the care by developing common quality standards and information systems. A thing that also was stressed was that both patients and healthcare professionals need to recognize the need for continuous learning when living with and treating a chronic disease like diabetes, and this was something that interviewees found to be well worth investing in. This was also considered an area where technology could play an important role.

In general interviewees found technological devices and software helpful and useful for both the patient but also for the healthcare professionals. At best, technological solutions could provide support for patients and ease the burden of healthcare professionals, helping to better allocate resources. However, all interviewees acknowledged that there would have to be significant changes in both the attitude and the organisational

structure in the current healthcare system in order to make it work. Concern was also voiced regarding legal aspects and the fact that not necessarily all would want or truly benefit from more digitalized and technologically driven treatment.

According to the results, managing and supporting patients would be the area where technology could prove to be most useful. This corresponds to the three main themes in the research; mental support, clinical quality and knowledge management.

## 5.1 Mental support

The importance of mental support was emphasized in all interviews, and especially the fact that there needs to be more knowledge and empowerment. Figure 17. presents the categories and sub categories related to “Mental support”.

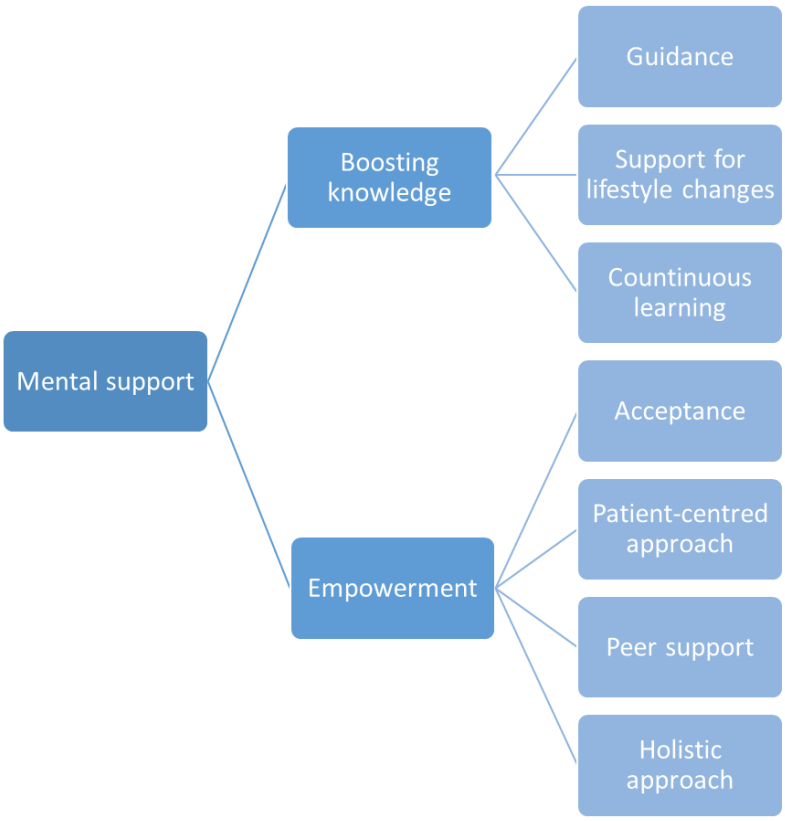


Figure 17. Themes, categories and sub categories related to areas where technology could provide to be most useful

It would be crucial for patients to be encouraged to continuously learn about their condition and how to cope with it occurred in 27 condensed meanings. Better understand-

ing helps patient treat themselves better, which would in turn decrease the amount of complications.

> ”[Komplikaatioiden hoito on kallista] …ja sen takia tavallaan tärkeämpää ja halvempaa ja kustannustehokkaaampaa… on opettaa ihmisiä hoitamaan itseään diabeetikkoina ennen ku ne tulee komplisuiduks,koska siinä komplikaatiossa sä oot sitten niinku se on vaan …” (Interview 1)

> ”[Treating complications is expensive] ..and that’s why it makes more sense and is cheaper and more cost efficient to tech people to treat their diabetes before they end up with complications...because then it’s just…” (Free translation)

In this suggested learning process patients with diabetes take control of their condition, and are able to make the right decisions in everyday life. According to the interviewees, many patients are afraid of making even small changes, e.g. relating to medication.

> “Suurin osa tekee niin et niille on sanottu et tämä pilleri aamulla ja tämä pilleri illalla tai näin.. ja ykköstyypin diabeetikoissakin, hirveen paljon sellaisia joille on sanottu et näin monta yksikköä ateriainsuliinia ja perusinsuliinia.. ja ei niitä muuteta vaikka elämässä tapahtuu kaikenlaista ja sit se verensokeri tekee tätä [aaltoliikettä] ja sit ihmetellään mistä se voi johtua. ku ei synkata keskenään. … Ku ei oo ymmärrystä ja sit ku ei oo tarpeeksi ohjausta ja ymmärrystä niin ei oo myöskään uskallusta muuttaa.. Ja tää koskee erityisen paljon lasten vanhempia.” (Interview 5)

> ”
> Majority just follows instructions, take this pill in the morning and this in the evening. And there are even a lot of type 1 diabetics who’s been told to take a certain amount of insulins and they don’t change anything even though a lot happens in life and then the blood sugar goes like this [wave movement] and then you wonder how come. Because you don’t synchronise. … there’s no understanding and when there’s not enough guidance and understanding there’s also not enough courage to change anything. And this goes especially for parents.” (Free translation)

Interviewees suggested that that technology could help provide useful tools for this kind of learning. With the help of e.g. mobile applications collecting data, patients gain a better overview and understanding of their condition. Crucial would be for the data to be available also for the healthcare professionals, preferably transferred automatically, who can provide recommendations and support online. At the same time, the healthcare professionals also increase their own knowledge.

> “kakkostyyppiläisenä perustervydenhuollosta ku lääkäri ei ymmärrä jotain asiaa niin sun ei tartte sen takia lähteä sinne erikoislääkärin luokse, että sä voit kertoa ja näyttää ne excelit sille erikoislääkärille, koska se data on siellä joka tapauksessa jo olemassa. Jolloin se erikoislääkäri voi vaan katsoa datan ja antaa sulle ja sun hoitavalle lääkärille ohjeet miten mennään eteenpäin, jolloin jälleen kerran henkilö itse oppii... ja se lääkäri oppii...” (Interview 1)

> ”as a type 2 diabetic in basic healthcare you don’t have to go to the specialist if the GP doesn’t understand something, the data is there anyway and the specialist can check it and give guidelines to you and your GP and once again the patient learns... and the doctor learns something...” (Free translation)

Cloud services, automatized systems and augmented intelligence was mentioned as tools for teaching. Also, in the case of lifestyle intervention this was considered to possibly be useful.

> ”...om vi kan genom de här undervisningen... från molnet, de automatiska systemen, om vi kan hjälpa di här diabetikerna.. att komma till de bättre med sin sockerbalans.. o då e de frågan om estimerad HbA1c och lägre antal av svåra hypon.. då kommer vi på längre sikt att minska risken att hamna in i komplikationer...” (Interview 2)

> ”.. if we could use this kind of cloud teaching and automatized systems to help people reach a better glycaemic balance, with estimated HbA1c and less severe hypoglycaemias… then we would decrease the risk of complications in the long run.” (Free translation)

The empowerment, or diabetes work, was also highlighted in the research with focus on activating the patient, putting him or her in the centre and in charge. A patient-centred approach was mentioned 18 times in the condensed meanings. The interviewees thought that it would be important to invest in the encountering with patients, to hear them out and to gain a good understanding of the patient’s everyday life. This way the patient would also be more committed to treating his or her condition in the best way possible.

> ”Tärkeetä on se et me saatais se potilas keskiöön ja kuljettajan paikalle pikemmin kuin kohteeksi. Ja siinä nää teknologiat… on merkitystä et potilas saa sen kokemuksen et hän voi vaikuttaa, niin se on tärkeetä sitoutumisen kannalta.” (Interview 3)

> ”It would be important to get the patient in the centre, in the driving seat rather than being a target. And here the technology is of significance, as the patient gets the feeling that he/she can have an influence, and that’s important for commitment.” (Free translation)

In general, interviewees felt that a more holistic approach towards the patient is lacking in the current healthcare system, and that technology could play a role there, with online support. However, interviewees also pointed out that it isn’t necessarily for everybody, once again highlighting the individual needs. Also, the need for peer support was mentioned as an important thing for diabetes work, and interviewees considered it to already have taken quite a good advantage of digitalization and technology as it mostly happens online nowadays.

## 5.2 Clinical quality

Striving for and maintaining high clinical quality rose to the second theme in the research, with focus on allocating resources in an efficient way as well as meeting the individual needs of the patients, much like on the part about mental support presented above. Figure 18. presents the categories and sub categories related to the theme.

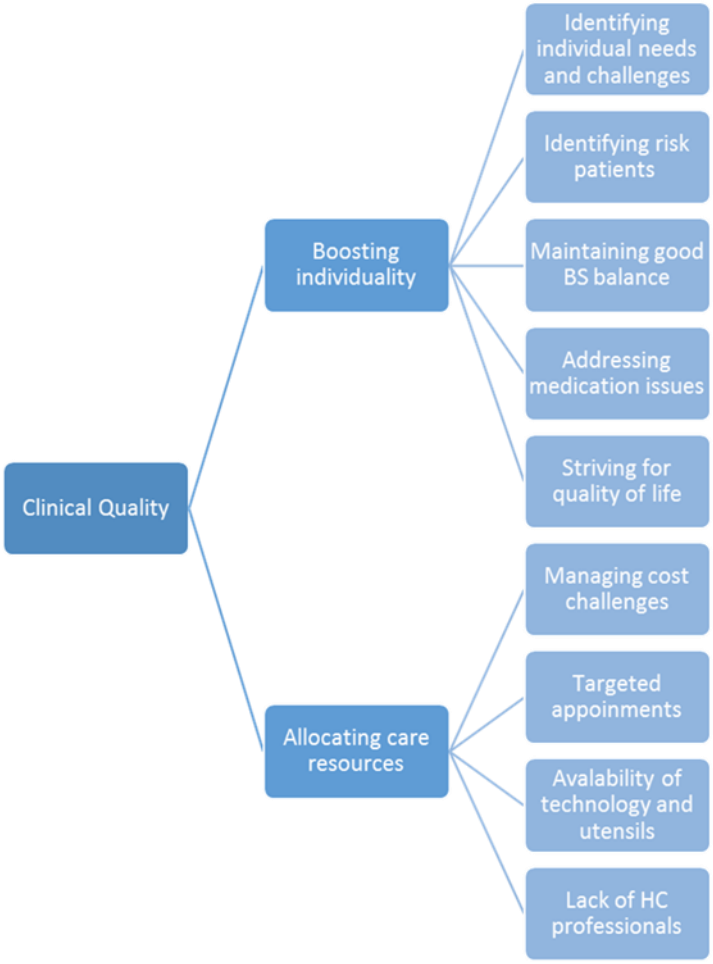


Figure 18. Themes, categories and sub categories related to areas where technology could provide to be most useful

Regarding the individuality, the different needs that emerge in type 1 and type 2 diabetes became clear also from a technological aspect.

> ”Niinku ykköstyyppisissä tai monipistoshoidossa, silloin tietysti korostuu nimenomaan se rutiinien helppous. … Kakkosissa taas, itse asiassa se helppous ei ole se juttu vaan itse asiassa se, että joku järjestelmä muistuttaa sinua tekemään oikeanaikaisesti asioita, jotka sä et tee rutiiniomaisesti joka päivä.” (Interview 1)

> ”In type 1 diabetes, focus is put on how to make the routines as easy as possible. … In type 2 diabetes again, easiness isn’t actually the thing, rather a system re-

> minding you to do things that you don't do on a routine everyday." (Free translation)

Patients with diabetes have very different needs and according to the interviewees, the current system isn't able to meet them.

> "Mutta kun nää terveydenhuollon resurssit ei oikein tarjoo oikeesti mahdollisuutta semmoseen yksilöllisyyteen ja riittävän hyvään .. et siihenhän ne yksilölliset tavoitteetkin perustuu et mikä olis semmonen riittävän hyvä.." (Interview 5)

> "But the resources of the healthcare system don't quite offer a possibility to individualised an good enough.. that's what the individual goals are about, what-would be good enough [for the individual]" (Free translation)

However, as one of the interviewees stressed, the system could and should be built according to common standards enabling the healthcare system to better follow up on the quality of care.

> "…tätä kansallista diabetesraportointia laaturekisterityötä kehitettäisiin… et ruvettais luomaan näitä kansallisia laatustandardeja ja minimitietosisältöä, mikä tieto ainakin pitäis saada ulos potilastietojärjestelmistä, että voitais luoda tämmöset kansalliset diabeteksen laatuindikaattorit. tai hoidon laatuindikaattorit. … hoidon laadun raportointi. et onpa se sit potilastasolla tai niinku laajemmin … vaikka yhden lääkärin tai hoitajan oman asiakaskunnan tasolla." (Interview 4)

> "…developing this national diabetes quality report system… creating national quality standards and minimum information content required, what kind of information we'd need to get out of the patient data system, in order to create quality indicators for diabetes care. .. Quality of care reports… on patient level or on a doctor's or nurse's customer base." (Free translation)

According to the interviewee, this kind of system would be beneficial for following up on patients, making sure that good blood glucose balance was being maintained e.g. on larger patient scale.

> "Lääkäreiden on vaikka helppo nähdä että ketkä ja kuinka iso osuus niiden potilaista ei ole hoitotasapainossa. ja täntyyppisisä niinku perus niinku laatuindikaattoriraportointia" (Interview 4)

> "Doctors can easily see who and how big a part of their patients who doesn't have a good care balance.. Basic quality reporting like this" (Free translation)

Interviewees also stressed that quality of life played a very big role and that technology would bring assistance to self-treatment, especially in the form of support.

> ”Eihän se ohjelma sinänsä paranna .. mut se on apuväline ja siihen tarvitaan sitten kuitenkin potilaan motivoituminen ja potilaan elämäntapamuutokset … Mutta ohjelma varmasti voi, ohjelmistot voi TUKEA … sillä tavalla että sieltä tulee herätteitä, voidaan niinku itsehoito-ohjeita automatisoida sinne. kun sinne vaan syötetään dataa, esimerkiksi sokerikäyttäytymisestä …” (Interview 3)

> ” The software itself doesn’t cure anything, but it’s a tool and on top of that you need motivation and lifestyle changes from the patient’s side. But the software could surely SUPPORT, you could have “wake-up calls” and automatized self-treatment guidelines. Based on data input, e.g. blood sugar behaviour…” (Free translation)

Technology and automatized intelligence were also mentioned to be used by healthcare professionals in addressing issues with medication. As previously mentioned, interviewees reported that there are problems with patients who are afraid of changing insulin dosage due to lack of understanding and support, leading to a poor care balance. Technology was also suggested to help e.g. determining right dosage of insulin:

> ”Tuodaan teknologiaa, joka esimerkiksi tän insuliinin aloituksen hoitaa automaattisesti.. ja automaattisesti titraa sen potilaalle, sen insuliinin määrän. Ja seuraa sitä.” (Interview 1)

> ”We bring technology that e.g. takes care of starting insulin treatment, and it will automatically titrate the insulin dosage for the patient. And follows it.” (Free translation)

Using technology for identifying patients at risk of developing diabetes was also mentioned, especially combined with bio marker technology. Identifying patients at risk was also considered from an economical perspective.

> “Et kokonaan ehkäisty kakkostyypin diabetes on varmaan se kaikkein edullisin. Jos kustannustehokkuutta ajatellaan.” (Interview 3)

> “Completely prevented type 2 diabetes is probably the cheapest one. In terms of cost-efficiency.” (Free translation)

> “Jos edes osa niistä [seurantakäynneistä] voisi korvata sillä et voiskin itse mitata ja se tieto oikeesti siirtyis sinne järjestelmään johon lääkäri tai hoitaja voisi reagoida, niin olis sillä iso merkitys. [resurssien säästämisessä] … ja myöskin potilaan aikaa [säästetään]. onhan se kaikilta, häneltäkin pois. ja työnantajiltakin.” (Interview 4)

> ”If even some of the appointments could be replaced with a model where the patient takes measurements him- or herself, and the information would be transferred to the system where the doctor or the nurse could react on it, that would be of great significance [for saving resources] … and also the time of the patient [is saved], it’s everybody’s loss. the patient’s. and the employer’s too.” (Free translation)

The economical aspect was also considered from a patient-point-of-view, as diabetes medication is rather expensive for individuals, especially with the revised special reimbursements for medicine. As the medication costs rise, an increasing number of patients are likely to be forced to choose, which medicine to buy and when. According to the interviewees, this might have very harmful long-term consequences both on individual and societal level. In the words of one of the interviewees:

> "et jos tavallaan lääkkeiden hintaan voi vaikuttaa niin et kaikki pystyis ostamaan itselleen tarpeelliset lääkkeet ja myös käyttämään ne… sillä päästäis jo ihan hirveän pitkälle." (Interview 5)
>
> " if it would be possible to affect the price of medication, in a way that enables everybody to buy the medicines they need and also to use them.. With that we'd go very far." (Free translation)

When it came to allocating resources, the availability of technology and utensils needed for self-treatment was mentioned. The amount of more traditional self-treatment utensils, e.g. blood glucose test sticks are limited, which affects the care balance. The demand for new technology, e.g. Libre sensors is higher than the availability.

> " koska tälläkään hetkellä esimerkiks Libreä ei saa läheskään niin paljon Suomeen ku mitä niitä terveydenhuollossa jopa myönnettäis. et siellä myydän ihan täyttä ei oota tällä hetkellä." (Interview 5)
>
> "Because at the moment e.g. we can't get as many Libres in Finland as the healthcare system even would issue, they're completely out of stock." (Free translation)

Interviewees also voiced concern about there being enough diabetes care professionals now and in the future. On the other hand, two interviewees pointed out that as the use of technology increases, the care is likely to shift from appointments to everyday life and becoming more real-time.

> "…sen takia nää softaratakisut on niin tärkeitä … tavallaan ku tulee …työkaluja niin se muuttaa sitä hoidon mallia ja kun hoidon malli muuttuu enemmän siihen niinku reaaliaikaseen ohjaukseen." (Interview 1)
>
> "…that's why the software solutions are so important.. it's like.. when you get tools, it changes the care model and as the care model shifts towards more real-time guidance.." (Free translation)
>
> "Online som sku hjälpa till de att man sku sen ge tips till den... situation när de behövs, int fyra veckor efter eller tre månder efter." (Interview 2)
>
> "Online possibility, which would help to give guidance at the moment when it's needed, not four weeks or three months after." (Free translation)

Then again two other interviewees pointed out that the amount of appointments according to the current system is enough as long as they are well-targeted and appropriate and that possibly technology could bring some assistance.

## 5.3 Knowledge management

In order to face the challenges with complications and decreasing care results, interviewees mentioned the visibility of information and change of both attitude and structure in the field of healthcare as important factors. Figure 19. presents the categories and sub categories related to the theme.

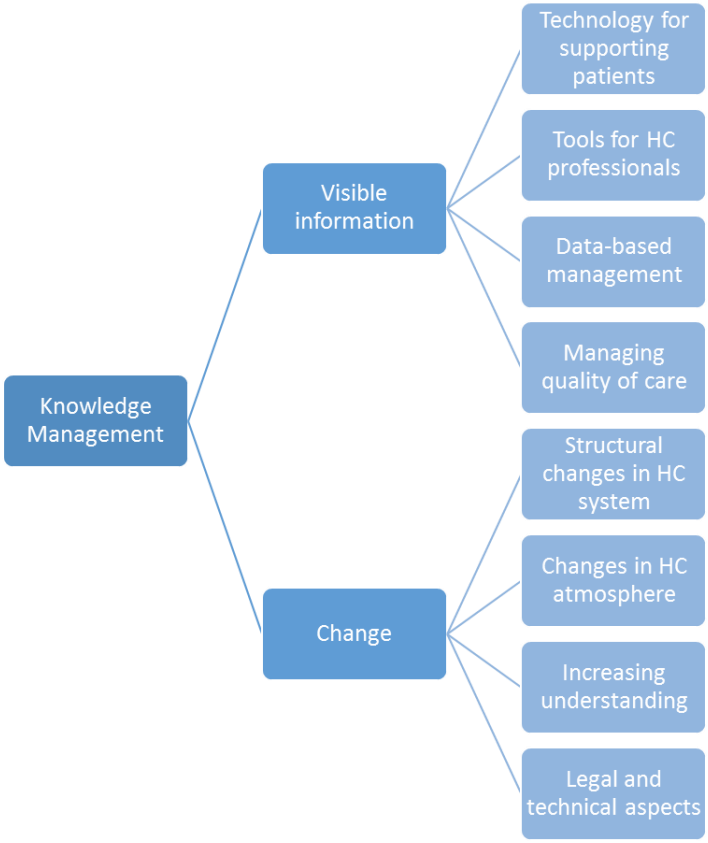


Figure 19. Themes, categories and sub categories related to areas where technology could provide to be most useful

The opinion that technology would be useful for guiding and supporting patients occurred 71 times in condensed meanings, structural changes and changes in the atmosphere in the field of healthcare 30 respectively 17 times. Structural changes related to intensified preventive care and appropriate and efficient care paths, and shifting the

care from calendar-based appointments and treating complications as they occur to a more preventive, need-based care, linked to the everyday life of the patient.

> “Sairaanhoitopiirissä olisi kohtuullisen vahvat diabeteskeskukset, jotka pystyis sitten tukemaan perusterveydenhuoltoa työterveyshuolto siinä että kiinitettäis diabetekseen riittävän ajoissa huomiota ja olis selkeät hoitopolut joilla voitais sitten .. tämmönen sekundaaripreventio toteuttaa.” (Interview 3)

> ”There would be quite strong diabetes centres in the healthcare districts, supporting basic healthcare and occupational healthcare in a way that makes it possible to attend to diabetes early enough, and there would be clear care paths where this kind of secondary prevention could be implemented” (Free translation)

> ”Toinen tärkeä osa tätä mallin muutosta on se että nyt ku se hoito viedään pois sieltä vastaanotolta sinne arkeen niin se mahdollistaaa niinniin kaks asiaa: toinen on se proaktiivinen puoli järjestelmä... Ja toinen asia mikä siinä on tärkeetä on se että voit ratkaista yksittäisiä asioita kerrallaan, jolloin ku sä ratkaiset niitä yksittäisiä asioita niin sä opit sen yksittäisen asian ja kun sä opit sen ja näät et sä osaat sen niin sit tulee se motivaatio.” (Interview 1)

> “Another important part of this change in the [care ]model is that when care is taken out of the appointment into the everyday-life of the patient, it enables two things: one is the proactive part of the system… and the other thing that’s important is that you can solve single issues at a time, and as you solve one thing at a time, you learn that thing and you realize that you can do it and that’s what gives you motivation.” (Free translation)

Also, interviewees once again stressed the big need for holistic approach and argumented for increased understanding and the encountering of the patient, enhancing a more holistic and preventive approach in the healthcare system in general.

> “et erikoissairaanhoito varsinkin on keskittynyt .. ongelmien hoitamiseen. . et se on ehkä semmonen.. tähän kuitenkin liittyy semmonen niin paljon itsehoitoa joka tälle terveydenhuoltokulttuurille on vähän vieras kuitenkin.” (Interview 3)

> “especially special healthcare is very focused on… solving problems. that’s maybe… after all this is quite a lot about self-treatment, which is a bit unfamiliar to this healthcare culture after all.” (Free translation)

Technology was thought to be useful in boosting communication and getting better overview of the care, helping to reach care goals. Also, with more visibility and information available, healthcare professionals would be able to better manage their work too, assuring the quality of care.

> “se tiedon jatkumo, se iso kokonaisuus… et se ei oo mikään yks appi tai vimpula tai vempula joka sen asian ratkaisee, vaan se jatkumo siitä et tieto siitä potilaan hoidosta syntyy niin on myös käytettävissä ja toisaalta myös raportoitavissa eri

> tasoille, potilaalle itselleen, hoitavalle ammattilaiselle, sille työtä johtavalle tasolle,ja sitten myös ehkä niille muille [terveydenhuollon ammattilaisille], et on myös tätä vertailutietoa, benchmarking tietoa koska kyllä se vaikuttaa." (Interview 4)

> "the continualness of the information, the pig picture. It's not one single app or gadget that solves everything, rather the continualness and the knowledge that the information regarding the patient's care is available and on the other hand also reportable to different levels; to the patient, the healthcare professional, the management level and maybe also for others [healthcare professionals]. There would also be comparison, benchmarking information, because it does make a difference." (Free translation)

According to the results, the learning and support aspect were where technology was thought to be most useful.

> "siihen teknologialla on monenlaisia apuja. et esimerkiks sensoroinnin avulla on tavallaan hirveen hyvä kouluttaa itsensä et oppii et tästä se lähtee ylös ja tästä se lähtee alas ja tosta tulee valtavia heittoja ja tällä se pysyy tasasempana.." (Interview 5)

> "olennaistahan tietysti on tosiaan se koko jatkumo, että se potilas itse tietää, että ja sit toinen et ku se mittaa itse jotakin niin se tieto menis myös ammattilaisille joka tavallaan tietää joka pystyy sit identifioimaan ne tietyt aukot myös. et hei nyt tältä potilaalta ei ole jotakin tietoa tai se ei ole käynyt seurannassa tai sille on tapahtunut jotain kummallista tai sen sokeritasapainot yllättäen nousee. … järjestelmät on silleen systemaattisia ja helppoja et ne jotankin ns hälyttää sulle jos jotakin hoitosuosituksesta poikkeavaa tapahtuu." (Interview 4)

> "…ja kustannustehokkain tapahan on se et ihmiset oppii hoitamaan itseään oikein. … se on seuraavaks kustannustehokkain tapa on se että siellä on on sitten ohjelmistoja jotak seuraa mitä sä teet ja sitten ohjaa sua automaatin avulla." (Interview 1)

> " Teknologi.. att de sku behövas naturligtvis tror ja nog att ..tror ja nog på teknologin på de vise att sku man få stöd från teknologin och undervisning genom teknologi" (Interview 2)

> "Technology...I do think there's a need for it. I believe in technology in that sense that one could get teaching and support through technology." (Free transaltion)

Also, as previously mentioned, it was considered useful as a tool for the healthcare professionals, e.g. managing patients more efficiently.

> "Man kan snabbt se enligt de här molnresutatena att de här mänskor behöver så pass mycke hjälp o de här behöver int alls hank an ju komma efter ett års tid till mottagning o de här mänska måst.. sköterskan måst ringa honom att komma ti mottagning i moron på moron. så där man kan direkt på de viset allokera pengarna till de va de behövs o ta ut ur såna som int alls behöver komma ti mottagningen.." (Interview 2)

> "According to the results in the cloud service one is quickly able to see what amount of support which patients need, e.g. the nurse has to contact this patient's, he or she needs to come in tomorrow. And this way one can allocate the

> money where they are really needed and remove from the ones who don't need to come in." (Free translation)

Although the interviewees saw very good possibilities with technology in supporting patients and healthcare professionals, they did acknowledge that on one hand it doesn't necessarily suit everybody and on the other hand the fact the healthcare system in Finland need to have quite big changes both in structure and atmosphere before these kinds of services could be used on a national level. Plenty of technical and legal issues also remain to be solved regarding standards, systems and data security.

# 6 Discussion

Chapter 6 aims to present the results of this Master's thesis in relation to the theoretical background, covering the pros and cons, the process behind the research. in this chapter, reliability and validity is also addressed, as well as ethical aspects of the research.

## 6.1 Cause, Pros and Cons

Within the process of this Master's Thesis, I had expected to find that technology could be used for monitoring and automatizing the care in a way that helps patients reach their care goals. However, it was interesting to see that the interviewees to a great extent highlighted the need for more holistic care, focusing especially on the encounters between patient and healthcare professionals and that this is in fact, something that both parties wish. Overall, technology opening up for better and more efficient communication among and between healthcare professionals and patient seemed to be where interviewees saw the greatest potential of technological use, enhancing, not replacing, the physical relationships and empowering all parties.

Although the use of technological solutions is increasing in the field of healthcare, it is important to keep in mind that it is not necessarily every patient's choice. Not everybody wants - or need - constant overview and monitoring of how one's doing, especially not all the time.

> "osalle riittää se et ne käy joka toinen vuosi. jos siihen on yhdistetty jotain muuta seurantamahdollisuutta,et hyödynnetään teknologian tuomia mahdollisuuksia, ja ei kaikki koe sitä tarpeelliseksi." (Interview 5)

> ”For some [patients] it’s enough to come in every second year. If it’s linked to some other type of follow-up, taking advantage of the possibilities brought by technology, and not everybody feels that it’s necessary.” (Free translation)

Results also suggested that there is experience of especially parents getting exhausted over the constant information they are provided with regarding their child’s blood sugar fluctuations and medical dosages, if they have all the data transferred to mobile applications in their own phones.

> “niin nähtiin se et miten vanhemmat on ihan lopussa sen takia et niille tulee joka ikinen lapsen verensokerimuutos kännykkään ja sitten sitä koko ajan seurataan ja .. et ainoa mikä on jäänyt pois on se et lasta ei pistetä enää kahta kolmee kertaa yössä et seurataan mihin se menee mut ei vanhemmat nuku yhtään sen paremmin itte.” (Interview 5)

> ” we saw how parents are exhausted because they get every single notification of their child’s blood sugar changes to their mobile and then they are constantly following it. … the only thing that’s left out is that you don’t have to measure the blood sugar twice or trice a night by taking a blood sample in order to follow where it’s going but parents doesn’t sleep any better.” (Free translation)

However, from the healthcare system’s point of view, it would be very beneficial and more cost-effective for the healthcare professionals to get an overview of their customer-base, being able to see how the patients are doing and where the help and support needs to be allocated. This way care and support can be better targeted. For example, could a system detect trends in the HbA1c-balance over time, small changes that could be difficult to spot even for experienced healthcare professional.

> “se tieto auttaisi myös siihen miten kohdennetaan sitä hoitoa ja seurantaa että kaikki tietää et jos sokeritasapaino on aina hyvä, niin eihän sellaisille potilaille tule vaikka retinopatiaa... et sitä pitäis satsata ne resurssit niiden kuvaamiseen joilla on enemmän sitä vaihtelua ja oikeeta riskiä. jolloin sit säästettäis sitä työaikaa johonkin muuhun .. motivointiin, neuvontaan ja muuntyyppiseen toimintaan. et tavallaan myöskin semmoseen oikean hoidon oikean kohdentamiseen voitais satsata paljon enemmän jos tollasta informaatiota olis online saatavissa koko ajan.” (Interview 4)

> ”the information helps in allocating care and follow-up, everybody knows that if your blood glucose balance always is good, you don’t get e.g. retinopathy. Resources should be focused on photographing the ones with big fluctuations [in blood sugar balance] and real risk. And this way work time is saved for something else… motivation, guidance, other types of activity. There could be more effort on targeting the right care if that kind of information was available all the time.” (Free translation)

Also, from the patient’s point of view, the patient should at least have the opportunity to gain access to technological care support. Then it is up to him or her to decide, whether to use it continuously.

The access to currently available high-quality BGM technology, giving patients the choice of using it or not, was also considered important by the British IDEAL group in July 2018 (IDEAL 2018). In United Kingdom, diabetes care faces similar challenges as the Finnish system and a need to "*rethink treatment and management strategies*" has been acknowledged. The IDEAL (Insights for Diabetes Excellence, Access and Learning) group was formed in order to tackle these challenges. The aim of the group is to have "*a positive impact on both health and economic outcomes for people living with diabetes*", and they have developed guidelines for improving care results and ensuring equal support and diabetes education for both patients and healthcare professionals. As glucose monitoring is a highly important part of diabetes management, the need for individually executed care plans was highlighted, as well as engagement. In order to ensure high standards and accuracy, established appropriate regulations for blood glucose monitoring was also suggested. (IDEAL 2018.)

Especially when considering technological solutions and aids in diabetes care, it is important to keep in mind that not one single app makes all the difference. This was clearly found in the results of this Master's thesis and was also stated by Kaufman et al (2016), as most apps available have limited functions and doesn't impact or support the patients enough to truly change their behaviour.

As results showed, the interviewees found it important to invest in supporting the self-treatment of patients, as happy patients are healthy patients. It makes sense also from an economical perspective, as good glycaemic control (treatment balance) decreases the risk of complications, which in turn lowers the cost. This was demonstrated e.g. in the DCCT study (1993) and current guidelines like Käypä hoito (2018) rely on it. All interviewees also stressed the importance of a good treatment balance. Also, research shows that outpatient costs as well as medication for diabetes is significantly cheaper compared to inpatient costs. This is due to the fact that it's less expensive to maintain good glycaemic control with regular monitoring and medication. (Kanavos et al, 2012)

Results also showed a growing concern regarding the availability of skilled healthcare professionals and it was considered important to make sure that there are enough trained diabetes nurses and diabetologist in the future. As presented earlier, the national diabetes survey Diabetesbarometri (2017) has also been concerned with the lack of sufficient resources in the Finnish healthcare sector.

Despite the fact that diabetes care has developed greatly during the past decade especially in a technical sense, the care results have, especially when it comes to self-care, decreased. The results of this Master's Thesis support this. Interviewees suggested that the problem lies in the self-treatment of the patient (lack of know-how and support) but also in the system, as it is perhaps not being able to address e.g. type 2 diabetes cases early enough to avoid complications. Based on the results, the main input for investment in diabetes care should be put on encouraging all parties to do an even better job, giving them tools and supporting them to use them in order to reach the individual care goals, that patients and healthcare professionals have set together in mutual understanding.

## 6.2 Process and Methods of work

The process of the research has been described in detail in chapter 4, providing a comprehensive description of sampling, data collection and data analysis. The sample size was only five persons, representing different fields of expertise in different geographic areas. Saturation was reached after these five interviews as no more interviews were expected to provide any new information to this particular research topic. Data was collected using semi-structured theme interviews, and the interviewees were provided with the themes of the interview in advance. During one interview I had the feeling that the interviewee preferred more specific questions, and it was slightly challenging not to lead the conversation to certain topics. However, I found it important to maintain the conversational atmosphere and listening to the recordings afterwards I consider I managed to do it quite well. All interviewees gave me permission to contact them afterwards, had there been any questions regarding the content of the interview, but I felt no need for that during the analysis process.

## 6.3 Reliability and Validity

Representativeness and generalizability in qualitative research can be problematic (Seale et al, 2007: 421-422). A theme I chose interviewees based on their experience and expertise in respective field and it is possible that a different sample could have provided different angles to the problem. My sample did not e.g. cover the whole of Finland, although three different geographical regions where represented. Although I

felt five interviews provided me with enough information for this Master's thesis, the sample size is indisputably small. As the results are reflecting the thoughts and feelings of individuals they are therefore by no means generalizable (Jacobsen 2007: 93). However, they provide an important insight to the current situation in the diabetes care field in Finland and also indicate the direction of where we are heading.

In qualitative research and context analysis one needs to consider whether collection and/or analysis of data have influenced the results to any extent, as the interviewees and the interviewer undoubtedly are affected by each other (Jacobsen 2007:169-173) As said, data collection and analysis procedure is described in detail in chapter 4, which gives an opportunity to objectively evaluate how I succeeded in the process.

When addressing the reliability and validity of a research it is important to consider the role of the interviewer as well (Jacobsen 2007: 174-175). I am very familiar with diabetes as a condition and with the field of diabetes care both from a patient's and healthcare professional's point of view. I acknowledge the risk of my experience or opinion affecting the outcome of this research. However, I consider it rather to be an asset in this research context, especially interpreting collected data, and I have focused on maintaining an as objective approach as possible. Although keeping this in mind at all times of the process, I cannot completely exclude the possibility of my personal beliefs or opinion influencing the interviewees or the analysis of data at some stage.

## 6.4 Ethical Aspects

When conducting research, there are also ethical aspects to consider, such as informed consent, confidentiality and correct presentation of data. (Jacobsen 2007: 22-27) Regarding informed consent, all interviewees were informed of my background and purpose of the research as well as why they had been chosen. All interviewees were informed of the fact that participation was voluntary, that they could withdraw from the research at any time and that all information including identity would be handled confidentially. An informed consent form was also signed at the point of interview. Correct presentation of data refers to data and results being described completely and in context, meaning e.g. that quotations are not taken from their original consent (Jacobsen 2007: 26-27) I have openly described the process of analysis and the choices made during the process and have presented the results accordingly.

# 7 Conclusions

The aim of this study was to explore how the current diabetes care practice in Finland could be improved by using technology in a way that decreases both the amount of complications and the healthcare expenditure. As said, the field of healthcare in general, and diabetes care in particular, is facing big changes and technology is playing an important role. However, many of the technological solutions and tools discusses earlier cannot be incorporated or implemented in the system at its current state, rather are big structural shifts needed.

When considering where to make investments in order to cut complications and healthcare expenditure, the obvious answer was presented by one of the interviewees:

> ”Kysymykseen yksinkertainen vastaus on tietysti se että pitää investoida siihen että hoidetaan diabetesta. elikkä autetaan ihmisiä hoitamaan itseään.” (Interview 1)

> “The simple answer to the question is of course that we should invest in treating diabetes itself. Helping people to take care of themselves that is.” (Free translation)

This is of course easier said than done. However, technology could help making everyday decisions, serve as a reminder system and a channel for mental support. It can bring visibility to and increase knowledge about what and how the patient is doing, providing the same data for healthcare professionals. In the longer run this will most likely lead to a shift towards a more preventive care model. As healthcare professionals gain better overview of patients’ care, resources can be allocated in better ways.

As said, in order to implement this new kind of technology-based and data-based care model, there needs to be big structural changes in the current healthcare system. A shift towards more preventive and need-based care is essential, and common standards for proper management of the quality of care play an important role. It also calls for changes in atmosphere and mindset, how healthcare professionals encounter and react to patients with diabetes and how the patients feel about themselves. Based on the results of this research and what seems to be the current opinion in the field, these changes are likely to happen even though it will take time. The new head of HUS hospital district, Juha Tuominen, recently suggested in an article in Helsingin Sanomat that also specialized care should take on a bigger role in preventing diabetes in cooperation

with basic healthcare. Also, he stressed the importance of having the time to properly encounter the patient, as well as having the tools for measuring the quality of work. (Aalto 2018). This is completely in the line with my research findings, and I would say a step in the right direction.

This Master's thesis has focused on the bigger picture of diabetes care in Finland, which is a very vast field. The research has been concerned with gathering information from different aspects; technological, clinical and administrative. The Finnish Diabetes Association has also been heard. Some research has been done regarding patient's thoughts about mobile applications in diabetes care (Elonen 2015) but research focusing especially in the diabetes nurses and their feelings and experiences with technological solutions in their daily work, would be of great importance. They are the ones working closely with the patients, and therefore their opinions and thoughts should be strongly considered, especially in the times of structural and organizational changes. As this research focuses on diabetes in general and does not distinguish between type 1 and type 2 diabetes, and as the two patient groups have different needs, further research could be concerned with further exploring the need for and benefits of technology in respective patient group.

Clearly, technology can and most likely will play an important role in the future healthcare system. However, it is important to acknowledge that technology in itself is no answer to the question of how to cut complications and costs, rather how it is used, for what purpose and by whom.

In order to reach better care results and less complications, the bigger picture also needs to be taken into consideration. In early 2017, the Finnish government made significant changes regarding the reimbursement of diabetes medication, leading to notably higher medication costs for especially patients with type 2 diabetes. As low-income patients don't necessarily can afford to buy the medicines they need, they are forced to quit or change their medication. In the long run, this may show to be counter-productive and have severe long-term consequences, as research shows that low-income patients are more prone to developing complications (Ora 2017). This shows that the right political decisions as well as an understanding of the big picture are crucial when working to handle the diabetes situation in Finland.

According to my research findings, technology can be a both useful and powerful tool, eventually changing the way we look at and treat diabetes in Finland. Technology gives the opportunity to make a shift from problem-solving to preventive actions, decreasing the amount of complications as patients - and healthcare professionals - gain even better and more holistic understanding of diabetes and the individual needs of the patients.

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## Structure of Interview

**Cutting Complications and Costs in Diabetes Care**
Exploring the possibilities of technology in diabetes care practice in Finland

Master's degree, Health Business Management, Metropolia AMK
Henrika Wiitakorpi
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**Teemahaastattelun runko**

- Mitkä ovat kustannustehokkaat tavat vaikuttaa hyvään diabetes hoitotasapainoon lyhyellä ja pitkällä tähtäimellä?

- Mitkä ovat tämän hetken suurimmat (kustannus-)ongelmat diabeteksen hoidossa?

- Komplikaatiot moninkertaistavat diabeetikon sairaanhoitokulut. Mihin tulisi investoida, jotta voidaan vähentää komplikaatioita?

- Nykybudjetin lisäksi, millaisia rahoitusmalleja voisi soveltaa diabeteksen hoidossa?

- Millä tavalla teknologiaa voisi hyödyntää ja implementoida, ja mitkä ovat esteet sille, ettei sitä käytetä enempää tällä hetkellä?

# Letter to interviewees

**Cutting complications and costs in diabetes care**

**Exploring the possibilities of technology in diabetes care practice in Finland**

Master's degree, Health Business Management, Metropolia AMK

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Diabetes on maailmanlaajuinen ongelma, joka aiheuttaa suuria kustannuksia. Suomessa diabetesta sairastaa yli 500 000 henkeä ja määrä on ennustettu kaksinkertaistuvan seuraavien 10-15 vuoden aikana. Tämänhetkiset hoitokustannukset ovat 15 % Suomen terveydenhuollon kokonaismenoista ja siitä jopa 60 % kostuu vältettävistä komplikaatioista.

Teen Metropolia Ammattikorkeakoulussa Helsingissä ylempiin ammattikorkeakouluopintoihin liittyvää opinnäytetyötä diabeteksen hoidosta ja sen kustannuksista. Tutkimuksen tavoitteena on selvittää, miten hyödyntämällä teknologiaa ja digitalisaatiota voitaisiin parantaa Suomen tämän hetkistä diabeteshoitoa tavalla, joka vähentää sekä diabeteksen aiheuttamia komplikaatioita että hoitokustannuksia. Tarkemmin tutkimus pyrkii ymmärtämään, millaisia investointeja tulisi tehdä komplikaatioiden määrän pienentämiseksi. Tutkimuksen tuloksia voidaan hyödyntää diabeteshoidon kehittämisessä suuntaan, joka tukee ja parantaa diabeetikoiden hoitotasapainoa sekä elämänlaatua.

Pyydän Teitä osallistumaan tutkimukseen, koska saamieni suositusten mukaan Teillä on kokemusta ja tietämystä kyseisestä aiheesta. Tutkimukseen osallistuminen on täysin vapaaehtoista ja halutessanne voitte perua osallistumisenne missä vaiheessa tahansa tutkimuksen aikana. Henkilöllisyytenne ei tule muiden kuin minun tietooni.

Mikäli haluatte osallistua tutkimukseen, pyydän Teitä ottamaan yhteyttä minuun puhelimitse tai sähköpostitse (yhteystiedot yllä). Tutkimusaineiston keruu tapahtuu noin tunnin kestävässä henkilökohtaisessa haastattelussa, ellei toisin sovita. Haastattelut on tarkoitus järjestää kesä-elokuun 2018 aikana. Haastattelu nauhoitetaan ja nauhoitukset sekä niistä kirjoitetut kirjalliset versiot säilytetään luottamuksellisesti salasanan takana. Ne tuhotaan vuoden kuluttua opinnäytetyön julkaisemisesta. Kiitos etukäteen!

# Informed Consent Form

TUTKITTAVAN SUOSTUMUS

**Cutting complications and costs in diabetes care**

**Exploring the possibilities of technology in diabetes care practice in Finland**

Minua on pyydetty osallistumaan yllämainitun tieteelliseen tutkimukseen ja olen saanut sekä kirjallista että suullista tietoa tutkimuksesta ja mahdollisuuden esittää siitä tutkijalle kysymyksiä.

Ymmärrän, että tutkimukseen osallistuminen on vapaaehtoista ja että minulla on oikeus kieltäytyä siitä sekä perua suostumukseni, milloin tahansa ilmoittamatta syytä. Ymmärrän myös, että tiedot käsitellään luottamuksellisesti.

| **Suostun osallistumaan tutkimukseen:** | **Suostumuksen vastaanottaja:** |
|---|---|
| _____ | _____ |
| tutkittavan allekirjoitus | tutkijan allekirjoitus |
| _____ | _____ |
| nimenselvennys | nimenselvennys |
| _____ | _____ |
| aika ja paikka | aika ja paikka |