CATÓLICA LISBON
BUSINESS & ECONOMICS

Innovation in Chronic Care Services

Designing a Diabetes Management Solution

Maria Inês Machado Pedras

Dissertation written under the supervision of Maria Inês Mendonça

Dissertation submitted in partial fulfilment of requirements for the MSc in Business, at the Universidade Católica Portuguesa, January 8th 2020

Abstract

Title: Innovation in Chronic Care Services – Designing a Diabetes Management Solution

Author: Maria Inês Machado Pedras

Diabetes is a growing burden on national healthcare systems, namely in Portugal, where 13.9% of the population aged 20–79 lived with the disease in 2015. Type 2 diabetes is acquired throughout life and is mostly related to poor lifestyles and it translates simply to prolonged high blood sugar levels. Increasing physical activity and improving diet are the cornerstones of treatment for these patients. Additionally, these people need to tightly monitor certain health parameters regularly in order to understand if there are decompensations. Providing greater guidance in between medical visits could help these patients to better understand, control and live with their disease, preventing cutisations and subsequent hospitalisations.

Basing on current trends, this research set out to understand needs and attitudes of both consumers regarding diabetes self-management and monitoring services, through interviews and patient testimonials collection; see how it compares with market offer, through the design of a market offer matrix; and, lastly, what is the main value such services provide. This research proposes an app-based platform that promotes self-management, similar to existent offer, whilst connecting patients to healthcare professionals, a component not as explored marketwise but that has been found in research to improve outcomes. To be successful, it should encompass a broad bundle of components beyond health parameters, such as community related features and activities, and nutrition tips.

A limited number of interviews was performed and so data are scarce. In the future, the cost-effectiveness and financing models of such services should be studied.

Key-words: *health service innovation; chronic care; value-based healthcare; self-management; telemonitoring; diabetes*

Resumo

Título: Inovação em Serviços de Cuidados Crónicos – Desenhar uma Solução de Gestão da Diabetes

Autor: Maria Inês Machado Pedras

A diabetes é um peso crescente nos sistemas de saúde, nomeadamente em Portugal, onde 13,9% da população viviam com a doença em 2015. A diabetes tipo 2 é adquirida ao longo da vida e está relacionada com fracos estilos de vida e traduz-se em valores prolongadamente elevados de açúcar no sangue. Aumentar a actividade física e melhorar a dieta são os pilares do tratamento destes pacientes. Adicionalmente, estas pessoas precisam de monitorizar os seus parâmetros biométricos regularmente para antecipar descompensações. Melhorar o acompanhamento destes pacientes entre idas ao medico poderá ajudá-los a melhor perceber, controlar e viver com a doença, prevenindo agudizações e hospitalizações.

Com base em tendências recentes, esta investigação destinou-se a perceber as necessidades e atitudes dos pacientes em relação a serviços de autogestão e monitorização da diabetes, a partir de testemunhos recolhidos e entrevistas; observar como se compara à oferta do mercado; e, finalmente, mostrar o principal valor que estes serviços providenciam. Esta investigação propõe uma plataforma móvel que promove a autogestão, tal como a oferta existente, ao mesmo tempo que faz a ligação entre os pacientes a profissionais de saúde, uma componente menos explorada pelo mercado, mas já demonstrada que resulta em melhores *outcomes*. Para ter sucesso, deve contemplar uma panóplia de componentes além dos parâmetros biométricos, como comunidade e o que esteja relacionado com actividade física e nutrição.

O número de entrevistas foi reduzido, pelo que os dados são limitados. No futuro, devem ser estudados a relação custo-efectividade e os modelos de financiamento destes serviços.

Key-words: *inovação de serviços de saúde; cuidados crónicos; value-based healthcare; auto-gestão; telemonitorização; diabetes*

Acknowledgements

I thank everyone that supported me throughout this journey and that participated in the writing of this thesis, both with content and with ideas, and my parents who kindly bore with me throughout.

Table of Abbreviations

APDP – Associação Protectora dos Diabéticos de Portugal

CCM – Chronic care model

CNTS – Centro Nacional de TeleSaúde

COPD – Chronic Obstructive Pulmonary Disease

HbA_{1c} – Haemoglobin A_{1c}

NHS – UK National Health Service

RQ – Research Question

SNS – Sistema Nacional de Saúde

T2D – Type 2 Diabetes

VBHC – Value-Based Health Care

Table of Tables

Table of Contents

1. Introduction

1.1. Service Innovation

Innovation. According to the Merriam-Webber dictionary, innovation is the introduction of something new or a new idea, method, or device. The Community Innovation Survey adds to this definition the introduction of a **significantly improved** product to the market or the introduction within the enterprise of a new or significantly improved **process**. Either way, it is a **core component** of economic growth, quality of life, and industrial competitiveness (Miles, 2010). Because services account for the greatest portion of value added in advanced economies, total economic activity and employment (OECD/EU, 2015), it is vital to look into innovation in services.

Service innovation is essentially about **change** and **renewal**. Changes in **processes**, **organisational arrangements** and **markets**. Changes that are mostly **small** and **incremental** (Jong, Bruins, Dolfsma, & Meijaard, 2003; Tamura, Sheehan, Martinez, & Kergroach, 2005).

1.2. Healthcare Today

Change and renewal is what the **healthcare industry** is in dire need of (Porter & Lee, 2013). Healthcare costs are on the rise; in the next three years, spending is projected to increase **5.4% per year**, globally (Deloitte, 2019). Yet, in the European Union, increase in life expectancy is slowing; there are more than 1.2 million premature deaths every year which could be avoided through **prevention** and more **effective care interventions** (OECD/EU, 2018); and, additionally, in 2022, the number of **people aged over 65** is expected to reach **11.6%** of the global population (Deloitte, 2019; Porter & Teisberg, 2006). In a nutshell, people are living worse, and costing more to society; healthcare systems are not working, and things are only bound to get worse.

A major contributor to these healthcare cost disparities is the rise in the prevalence of **chronic disease** (Deloitte, 2019; Ministério da Saúde, 2018), which is responsible for **63% of deaths** worldwide. This type of diseases share in common risk factors related to unhealthy and sedentary lifestyles. Chronic diseases are prolonged and usually they progress slowly, which entails continuous, long term engagement in care as opposed to acute, sporadic care (World Health Organisation, 2013). This needed continuous care also calls for people living with these conditions to adapt and make changes to their lifestyles, which requires an engagement on their part beyond their regular medical visits and examinations (Coulter & Ellins, 2007).

Chronic conditions, if not appropriately managed and looked after, will develop exacerbations and decompensations which can lead to hospitalisations or even death. It is possible to prevent many hospitalisations for patients with chronic diseases, giving them timely access to care in alternative ways to quickly address the signs and symptoms of decompensation of the disease, and by better self-management of their care by patients at home (J. Eapen & H. Jain, 2017; Ministério da Saúde, 2017b; Pearson, Mattke, Shaw, Ridgely, & Wiseman, 2007).

1.2.1. The Case of Diabetes

Diabetes is one of the most prevalent chronic diseases in the world, making it a priority to tackle with a new approach to care. This disease is characterised by prolonged **excess sugar** in the blood and it **kills one person every six seconds** around the world. In fact, in 2016 diabetes accounted for **10.7% of global** all-cause mortality in people aged 20 - 79, a rate higher than the combined number of deaths resultant from infectious diseases - HIV/AIDS, tuberculosis and malaria (Sociedade Portuguesa de Diabetologia, 2016; Whiting, Guariguata, Weil, & Shaw, 2011; World Health Organisation, 2013).

In **Portugal**, in 2015, **13.9%** of the population had diabetes, a prevalence greater than that of the world population. Almost 90% of these people living with diabetes were either overweight or obese, and the disease was responsible for **4% of deaths** in the country. These numbers keep rising every year, with the prevalence having **grown 2.8% annually** between 2008 and 2015 (Sociedade Portuguesa de Diabetologia, 2016).

There are three types of diabetes: type 1 diabetes, also called juvenile diabetes; type 2 diabetes (T2D), also known as adult-onset diabetes; and gestational diabetes. **Type 2 diabetes** is the most prevalent type of diabetes, making up 90% of the population living with the disease. The most common cause for its development is a combination of excessive body weight and insufficient exercise; it starts gradually, usually after 40 years of age, and it can take years for people to realise they have it, characteristics that coin it a **silent disease**. This makes it more difficult for people to feel the need to **actively engage** in its management and treatment (Brundisini, Vanstone, Hulan, Dejean, & Giacomini, 2015). Changing one's lifestyle with increased physical activity and the shift to a healthy diet can delay or prevent the damage done by the disease or even lead to remissions. In Addition, the harm of diabetes can be managed through a tight control of clinical markers, namely hyperglycaemia, hypertension and dyslipidaemia (Sociedade Portuguesa de Diabetologia, 2016; Whiting et al., 2011).

It is necessary to address the treatment of these conditions and find ways to improve care for people living with them.

1.2.2. A New Service for Chronic Patients

In the design of products and services, total quality management says that higher quality can be achieved by taking strategic actions at an earlier point-in-time. This principle can be applied to healthcare - ensuring adherence to medications or educating on lifestyle changes at an earlier point in time of the disease progression can achieve better outcomes, by avoiding deterioration of health conditions (Thompson, Whitaker, Kohli, & Jones, 2019).

Conversely, currently, focus is mostly on the moment the patient is at the clinic or the hospital, which happens sparsely and within reduced timeslots. **Care must change** for these patients and focus less on the presential moment and more on the ability of the patient to keep their condition managed in between clinical visits. Furthermore, as patients' role and influence in their health care become more prominent, providers are expected to establish more direct, personal relationships with them to give solutions that are convenient, customised, and accessible (Deloitte, 2019; Ministério da Saúde, 2018; World Health Organisation, 2013).

Because diabetes is a silent disease, people must make a **choice to address** it and be engaged in their care. **Non-compliance** is part of the issue in the lack of success of self-care. For instance, medication nonadherence in the United States is estimated to cost over USD 250 billion annually (Deloitte, 2018). Improving health literacy and patient engagement can improve care and, thus, outcomes (Deloitte, 2019; Ministério da Saúde, 2017b; Pearson et al., 2007; Whiting et al., 2011).

In the case of diabetes, people require access to a **comprehensive management plan**, systematic, regular and organized healthcare delivered by a team of skilled providers. This systematic care should include a periodic review of metabolic control and complications, a continually updated diabetes care plan and access to patient-centred care provided by a multidisciplinary team when necessary. Patients should, then, become educated to make informed decisions about diet, exercise, and weight; effectively monitor their blood glucose, lipids, blood pressure and cholesterol; access and correctly use medications; and regularly attend screening for complications (International Diabetes Federation, 2017; Whiting et al., 2011).

To make patients more engaged in their care and, consequently, more compliant with treatment, they must be provided with services that empower them with greater sensitivity for their condition and that allow them to feel more connected and in control. Services that should help them keep track of their health, to ensure compliance with therapeutics in between clinical

visits. It is necessary to have services designed with the patient in mind to help them throughout the journey of care outside the hospital.

Moreover, because remote access to patient actions has an effect on patient compliance (Staats, Dai, Hofmann, & Milkman, 2017), for a new service to be valuable, it should allow patients to be followed by a clinical team, remotely, while helping the patient to self-monitor and manage their health care. Self-management of the condition together with a constant connection to healthcare professionals (HCP) can trigger in people the need to comply and better care for themselves.

1.3. Managerial Relevance

An increasing prevalence of chronic disease, resultant from aging populations and poor lifestyles, is a growing burden on national health systems. People living with diabetes represent **2.5 times higher healthcare costs** than people that do not live with the disease. Global healthcare expenditure on diabetes is projected to reach USD 776 billion by 2045 in the 20 - 79 age group, which represents a growth of 7% (Whiting et al., 2011). With the impending demographic changes and the high obesity rates rampant in our society, if the costs of treating a patient with diabetes remain as they are, the overall costs of diabetes are still set to grow considerably over the next 20 years. Besides direct costs related to diabetes care, costs of social care are also impacted and therefore suffer an increase because if someone has an amputation, a common complication of diabetes, then their ability to look after themselves independently will be much reduced. This means the costs of diabetes to the health and social care systems will be even higher (Diabetes UK, 2014).

In Portugal, in 2014, diabetes had an estimated direct cost of 1300 – 1550 M€, of which 434.6 M€ resulted from preventable hospitalisations. This is equivalent to 0.7 - 0.9% of the Portuguese GDP in 2015 and signified **8 - 10% of healthcare expenditure** (Sociedade Portuguesa de Diabetologia, 2016). The top two medications that represent the highest expenditure by the Portuguese National Health Service (SNS) are anti-diabetic medications which, in the first semester of 2019, translated to 18.5% of total medication expenditure. This class of medication represents the greatest portion of total medication expenditure by 7pp to the next therapeutic group of medications (Infarmed, 2019).

Changing the way in which we take care of these patients will inevitably adjust the cost structure, benefitting the system. This looks to replace high-cost interventions (disease cutisation) with low cost interventions (monitoring service) before patient conditions deteriorate (Thompson et al., 2019).

As the shift to a healthcare system based on patient-centredness will imply substantial investment (Deloitte, 2019), it is paramount to understand what makes or breaks a service like this to design for success.

1.3.1. Problem statement

This research aims to understand which contours an innovative service destined to empower diabetes patients to better manage their condition should take. For that it is necessary to understand stakeholder needs, namely patient and physicians, evaluate what services already exist and how they answer those needs, in order to create a service to caters to those needs and evaluate its value proposition.

1.3.2. Research Questions

RQ1: What are the patients' and healthcare professionals' needs and attitudes regarding diabetes management?

RQ2: What features does the market of diabetes management programmes have to offer?

RQ3: How should a new T2D self-management service be like?

1.4. Dissertation overview

This dissertation will present a literature review of the research that has been carried out regarding the status of implementation of chronic disease management programmes, remote patient monitoring and patient self-management, what has been explored in regards to implementation of such innovative services and the moulds in which it can be done. Furthermore, it will be identified where this research fits in within the existing research.

Next, the methodology of the dissertation will be described; the detailed methods used to carry out this research, describing the type of research, and how the data were analysed.

Then, the gathered results will be explained so that in the discussion section, they can be discussed in depth and conclusions may be drawn. Also, the limitations of this research will be described and what future research can be carried out from here.

2. Literature Review

2.1. Value-Based Health Care

Healthcare today is deteriorating. It has been happening for some time now. The concept of **Value-Based Health Care (VBHC)** arose as the way to redefine healthcare and combat this decline. A redesign of healthcare is crucial so that we can improve value for patients and shift to a model based on competition for value of outcomes instead of volume, which translates to **improving outcomes whilst reducing costs**. VBHC causes the focus to be put on patients: on value delivered, on results obtained and on the medical conditions (Porter & Teisberg, 2006).

Professor Michael E. Porter explored the concept of VBHC in depth in his 2006 book "Redefining Healthcare" and has been building up on it ever since (Porter & Lee, 2013; Porter & Teisberg, 2006). The concept's core is improving outcomes relative to costs. However, only working on one part of this fraction is not enough, focusing on cutting costs is not feasible. This means that we also need to **focus on outcomes**. Since outcomes are condition specific, the benefits of an intervention for ultimate outcomes will depend on the effectiveness of other interventions throughout the care cycle. It is necessary to study the approach to specific conditions individually and the benefit of an intervention in the outcomes of that condition (Erichsen Andersson, Bååthe, Wikström, & Nilsson, 2015; Porter & Teisberg, 2006).

The VBHC model is composed of 6 elements: Organise care around medical conditions; Measure outcomes and cost for every patient; Align reimbursement with value; Systems integration; Geography of care; Information technology (Porter & Teisberg, 2006). In the Portuguese SNS several actions are being taken in this sense, including synergies with other sectors to empower citizens in the control of their own health care, programmes of integrated domiciliary care, and others (Ministério da Saúde, 2017b).

The adoption of VBHC brings about a **paradigm shift** in the approach to care. That shift has also been taking place in care for chronic illnesses. Many of the main elements of VBHC have been in the genesis of research aimed at improving chronic care management, namely the organisation of care around medical conditions, organisation of care around matching the correct provider, treatment, and setting, changing geography of care, and the use of information technology (Elf et al., 2017; Wagner, Austin, & Korff, 1996; Wootton, 2012).

2.2. Chronic Disease Management

The main challenges of chronic disease management have been a lack of time for clinicians to see patients, insufficient care coordination and lack of resources for patient self-

management (Compton-phillips et al., 2019). Therefore, chronic patient care redesign has been discussed for over 20 years, to try and understand what can be changed in the approach to treatment and guidance for these diseases and overcome the aforementioned hurdles. Research pertaining to chronic care redesign is aimed at integrating care, to achieve seamless and continuous care, tailored to the individual patient's needs, improve outcomes for patients, lessen utilisation of acute care, and prevent development of complications (Wootton, 2012).

In 1996 the **chronic care model (CCM)** emerged as the need to alter chronic care became more and more evident (Wagner et al., 1996). The research that birthed it looked to analyse and gather the elements present in past initiatives dedicated to improving care for chronic patients. Before the design of the CCM, research did not evaluate care in a holistic way, focusing on specific elements of the overall care. Some programmes had been developed with structured teaching sessions and treatment, which emphasized group patient education and financial incentives; also, clinics dedicated to chronic care had been trialled. All these endeavours shared certain elements in common, based on the needs of chronic patients, that were found to be effective:

- **Explicit plans and protocols** – applying standardised guidelines for patients with similar clinical profiles to ensure systematic care;
- **Reorganisation of care to meet patients' needs** - delegating key tasks to the appropriate members of the practice team, namely nonphysicians, such as nurses; ensuring regular follow-up after consultations;
- **Support for patient self-management and behavioural change** – allowing contribution by both patient and physician to set the issues that need to be addressed; Targeting, goal setting, and planning; continuous self-management training and support service; Active and sustained follow-up;
- **Ready access to necessary expertise** – providing clinical teams with experience in the disease, specialists that have greater knowledge of effective therapies.
- **Supportive information systems** – facilitating proactive strategies from providers.

Essentially, multidisciplinary care, care coordination, patient self-management and provider education are the core of the chronic care model, and therefore of chronic management, having the most consistent effects on clinical outcomes (Scott, 2008; Wagner et al., 1996). This model continues to be explored and enhanced, for example with the application of technology for patients to use in their self-management (Coleman, Austin, Brach, & Wagner, 2009; Gee, Greenwood, Paterniti, Ward, & Miller, 2015; Van Lieshout, Goldfracht, Campbell, Ludt, & Wensing, 2011).

2.3. Telehealth

Alongside this research of how to improve care for chronic patients, the use of **technology enabled remote access** in overall patient care has also been extensively explored. In short, telemedicine, used to mean **medicine practiced at a distance**. Research in this field takes several forms, starting by the name used to refer to it – virtual care, telecare, telemedicine, telemonitoring, eHealth, telehealth (Brettle, Brown, Smith, Radcliffe, & Smith, 2013). Different names that all seek to describe a means to **connect patients and providers at a distance**, from simple video consultations to text-message reminders, to real-time access to patient data. This opens doors of opportunity for interaction between patient and provider, greatly improving patient access and involvement in their care.

The current perception of telehealth is, overall, positive among physicians: they see telehealth as a way to improve patient access to care, improve patient satisfaction and connect with patients and caregivers. Despite this seemingly positive outlook on virtual care, currently, rates of adoption are still low (Deloitte, 2018). Even so, the use of telehealth is becoming more prevalent and attractive to physicians. A 2019 survey in the US showed that the willingness to use telehealth by physicians increased from 57% in 2015 to 69% in 2019. As it is becoming a more commonplace practice, physicians who were unsure of the technology in 2015 have since become more acceptant (American Well, 2019). In Portugal, a 2017 study showed that at least 60% of healthcare institutions would like to be part of projects or services related to telehealth (CNTS, 2017).

Actually, in Portugal, the pursuit of telehealth-related ventures has been in motion for a little over 20 years. It started with simple “televisits” in 1998 until the creation of the National Centre of TeleHealth (CNTS) in 2016, as seen in Figure 1.

Nevertheless, there is a lack of consensus regarding what telemedicine encompasses, with widely varying definitions filling the research pool. Both the medium of interaction between patient and provider and the timing of the interaction vary: from phone calls and text messaging to constant, real time feedback. This makes research in this field more disperse, difficult to understand and organise and thus be able to build upon. In turn, the evaluation of results and which results to measure becomes more difficult. Is it truly beneficial, in what way, and where should we keep developing? Additionally, most studies lack conditions to enable drawing any conclusive evidence. From such a diverse collection of research, result a wide range of conclusions; different studies have different features, use different measurements of

success and report on different outcome (Brettle et al., 2013; Ferrante, Balasubramanian, Hudson, & Crabtree, 2010; Gee et al., 2015; Wootton, 2012).

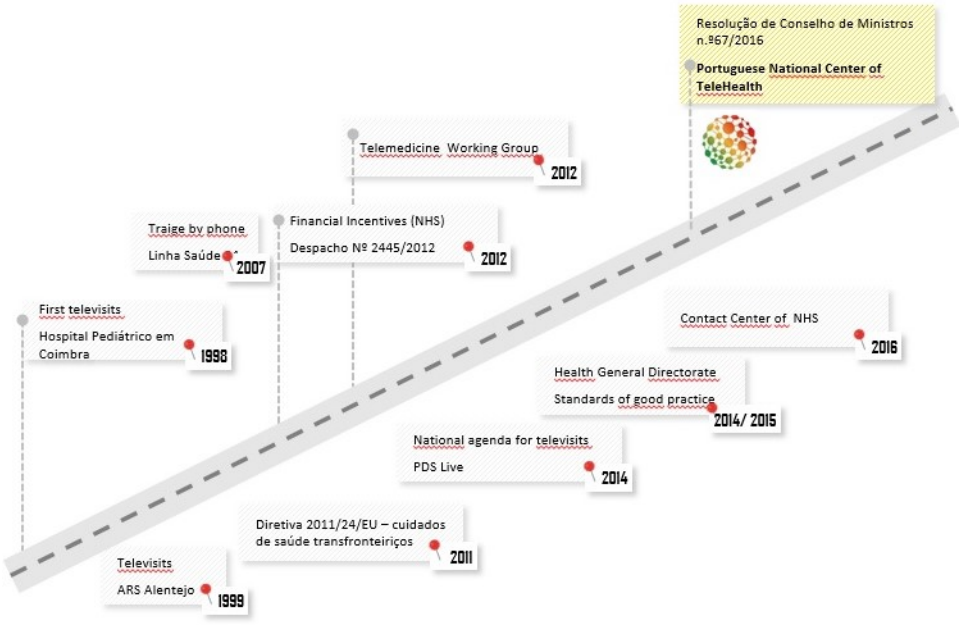

Figure 1 - Timeline of Telehealth in the Portuguese SNS (CNTS, 2019)

2.3.1. Remote Monitoring for Chronic Care

Strategies of delivering care at a distance can be incorporated in chronic disease management in order to **facilitate patient self-management and improve outcomes**, the core components of the CCM (Gee et al., 2015; Wootton, 2012). This combats overuse of healthcare resources, by mitigating the need for extra appointments, and assists in behavioural change, leading to better care, greater compliance and fewer emergency visits, and resulting in improved disease outcomes (Peikes et al., 2012; Wagner et al., 1996; Wootton, 2012).

Patient knowledge is not enough to adjust behaviour. Factors such as motivation, emotional adjustment, self-management skills and the existence of follow-up contribute to behavioural change. Therefore, self-management is essential for improved outcomes and interventions, being the most frequently used primary CCM element in studies (Reynolds et al., 2018). Patient self-management goes beyond patient knowledge, encompassing having the confidence to deal with medical management, role management, and emotional management of one's condition (Grady & Gough, 2014; Pearson et al., 2007). It is important that patients participate in their own care, which includes making informed choices about providers, participating in reaching diagnoses, and deciding on treatments (Pearson et al., 2007).

One of the ways of enacting this integration of telehealth and chronic disease management is through the remote monitoring of patients (Wootton, 2012), which is, according to the Portuguese Health Ministry, a tool comprising communication technologies to monitor biometric parameters at a distance that are transmitted to healthcare providers (Ministério da Saúde, 2019). Patients have a good perception of introducing telemonitoring to their usual care because it reduces the need to go to healthcare facilities (Dario et al., 2016).

Several interventions using telehealth for chronic disease management have been piloted. In 2013, the Portuguese association for diabetic patients (APDP) partnered with Vodafone Portugal to offer patients a simple remote monitoring programme where patients could send blood glucose readings and insulin intake through SMS, e-mail or voice message to a platform accessible to a clinical team at any time, continuously (Vodafone Portugal, 2013, 2019). In 2014, the Portuguese health ministry launched a project dedicated to remote monitoring in public hospitals of patients with chronic obstructive pulmonary disease (COPD) using a mobile phone application. The project included different units across the country, and small samples of patients in each unit (15-20 patients) were treated. The patients selected had had at least 2 cutisations in the previous year. These patients would insert their health parameters, which were measured daily, such as blood pressure and oximetry, on their phoens and these data were being monitored remotely by a clinical team which would evaluate what was the necessary follow-up. This follow-up could be scheduling an appointment or sending the patient to the emergency room. It has had success, with hospitalisations going down significantly (>70%) after 12 months, as well emergency visits and time of internment decreasing (Gonçalves, Castelo-branco, & Campanella, 2018).

A similar programme had been launched by the UK National Health System (NHS) three years earlier, in 2011, with similar outcomes: a pilot telehealth programme was launched for patients with COPD in two care units, with remote monitoring managed centrally by the NHS. The patients had devices to measure temperature, weight, oxygen level, and blood pressure, which were provided by the programme, according to patient needs. Patients also received educational messages. After around 200 days, there was an decrease in the number of hospital admissions and of length of stay (Clarke, Fursse, Connolly, Sharma, & Jones, 2018).

These programmes shared in common a telemonitoring platform where patient health data were aggregated and sent to nurses for triage. When serious enough, the case was then forwarded to doctors. Health data were gathered from devices provided by the programme institution.

Part of the success of these trials was due to the existence of feedback. A complete **feedback loop** is needed to impact chronic illness outcomes: transmission of the consumer's health data; interpretation of the data with previously established knowledge; address specific need of the consumer; feedback to the consumer according to requirements; repeat loop regularly (Gee et al., 2015).

2.3.2. Diabetes Management

As for T2D, patient education should not be limited to a single intervention, as it is not enough for patients to become independent in the management of their condition or to sustain the gains made in education; it is important that the education is continuous for effective self-management (Beebe & Schmitt, 2011). That can be enabled by mobile health tools and remote monitoring as well.

Numerous studies exist using mobile-enabled self-management interventions together with remote monitoring and feedback. One of them (Quinn et al., 2011) used WellDoc, a diabetes management system composed of a mobile application and a web portal where patients insert their diabetes self-care data such as blood sugar, carbohydrate intake, medications, and physical activity. The platform, then, returns feedback with automated real-time educational, behavioural, and motivational messaging based on professional treatment guidelines, as well as personalised messages sent by the HCP. It also had remote monitoring and a messaging centre to contact HCP. Such an intervention resulted in a significant decrease in **glycated haemoglobin ($\mathbf{HbA_{1c}}$)** after the 12-month period of intervention in a population aged between 18-65 years old (Quinn et al., 2011). HbA_{1c} is the lab examination that measures average blood glucose over the past three months and the standard measure for improved diabetes management. The elements of glucose monitoring, healthy eating, and medication adherence were found to have the greatest impact on outcomes (Quinn et al., 2018).

The same system was used on a sample of people over 65 years old. It was shown that older adults also adhere to mobile-enabled self-management interventions and are able to make use of them successfully, even the ones with lower technology literacy (Quinn, Khokhar, Weed, Barr, & Gruber-baldini, 2015). This finding helps mitigate the idea of some physicians that there might be difficulty of use and of adopting such technologies (Seto et al., 2010).

The element of personalisation is also important in these programmes. Needs vary greatly between people, as is the case of people suffering from anxiety who may have more difficulty in dealing with their diabetes. Therefore programmes should be adaptable accordingly (Brettle et al., 2013).

Many of these mobile applications for self-management are very much focused on the patient management component and seem to lack HCP intervenience (Cui, Wu, Mao, Wang, & Nie, 2016). The most effective interventions use the feedback loop components, with 2-way communication, analysed health parameters, tailored education, and personalised feedback (Greenwood, Gee, Fatkin, & Peeples, 2017; Hou, Carter, Hewitt, Francisa, & Mayor, 2016). Additionally, patients in these interventions gained improved knowledge about their own health conditions, became more confident in self-management, and saw improved convenience, efficiency, quality of care and comfort (Lee, Greenfield, & Pappas, 2018).

Overall, **mobile-enabled self-management** solutions seem to lead to **clinically significant changes** in signs and symptoms of the disease and reduce the need for hospitalisation. But there is still **uncertainty** in these conclusions, given the possibility of biased research or publishing, different standards between programmes and different features and types of intervention (Hou et al., 2016; Walker, Tong, Howard, & Palmer, 2019). So, what should these programmes really encompass? It is necessary to **talk to the users**, to design programmes that answer to what they feel they need to better live with their disease.

3. Methods

The first step of the research process is to identify a problem to address. This was done by looking into current trends in health and services in need of reform. Then, research questions were formulated to better understand the problem.

Grounded theory methodology was used to carry out the present research, as data were gathered from several types of sources. The present research is qualitative in nature as it gathers non-numerical data. Using qualitative methodology, it is possible to understand why or how a phenomenon occurs, as opposed to how often it occurs. In this case, as we are not looking to explain or describe a phenomenon, there are no hypotheses to be tested and the research will be exploratory, to understand what the service should encompass and what value it brings. Inductive reasoning was used to formulate theories as to what answers to what is needed regarding T2D management and monitoring (Saunders, Thornhill, & Lewis, 2009).

Because the issue under study is related to a specific health condition, the sample included medical professionals and people suffering from the disease, for a more complete understanding of the problem. Research was based on interviews and testimonials, to understand in a detailed way the needs associated with the treatment T2D and priorities from the ones dealing with the condition daily. An examination of secondary data was executed for an unbiased evaluation of the services available to people living with diabetes for disease management.

To understand healthcare professionals' perspective of patients' needs and attitudes, semi-structured and informal interviews were conducted. In diabetes, nurses play a rather relevant role in dealing with the patients and spend the most time with them (Grady & Gough, 2014). Since of this they have a greater contact and awareness of patients, and so, a semi-structured interview with a nurse that has worked with diabetic patients for a long time, including paediatric patients, was conducted. The professionals in question have been exposed to very different types of patients, which has provided them with a broad view of patient experiences. An informal interview with a physician specialised in diabetes was also conducted to have a more varied overview of treatment needs. As for the patients' perspective, testimonials were gathered at a diabetes congress. This way, the data was unbiased by the research views, and it was possible to obtain a more honest insight of patient priorities regarding living with and managing there T2D. These data can be found in the appendices. This overview of perceptions was complemented with additional secondary data retrieved from literature research.

In order to assess the current market offer of diabetes management services, an internet search was conducted for the market of services related to disease management and remote monitoring. For this search, the entries “diabetes management programme”, “diabetes management services”, diabetes management software” and “diabetes remote monitoring” and the same expressions in Portuguese will be used. The results found were divided in categories and the services were described accordingly in terms of duration, if there is a time limit, what elements of treatment they touch upon, if there is a connection to HCP and how they are delivered. As the objective is not to see what exists in Portugal, but rather evaluate what in the market can be useful, the analysis was not limited to the offer accessible in Portugal.

Also, to better analyse mobile-based self-management services, a “Play Store” search was performed to evaluate the possibilities of offer to build the patients’ side of the service. As the offer is varied, a matrix was designed to help describe these apps in terms of features and understand what the most common components are. The matrix was designed using the main needs and attitudes in T2D management previously identified, namely data insertion, connection to devices, educational content and community, and also who is the target market of such services, if the patients or the HCP, and financing. This matrix facilitates the organisation and the visualisation of the data to extract valuable information.

The data gathered from these searches were then related to healthcare professionals’ and patients’ needs and attitudes, and what they are missing to be able to deliver to those stakeholders.

Lastly, using the data collected, features for the service were suggested in order to address the identified necessities.

4. Results and Discussion

4.1. RQ1 – Qualitative Assessment of Patient and Provider Needs and Attitudes

People with T2D usually visit their physician every three months or so for check-up, eye screenings and regular foot checks, and lab tests to measure HbA_{1c}, kidney function and others. At home, these patients must measure their blood sugar (glycaemia) daily, before and after meals, and, ideally, other health parameters such as blood pressure, due to the risk of developing other conditions. They must also monitor their overall sugar (carbohydrate) intake, as it affects blood sugar, and should maintain a healthy lifestyle including physical activity and healthy eating. In addition, many patients need to take medication for diabetes, often for other conditions simultaneously, and ,eventually, possibly move on to insulin (International Diabetes Federation, 2017).

Both patients and providers were sought in order to understand what is necessary to address not only what is perceived to be a patient need but also patient and provider attitudes toward the management of the disease. The data collection, found in the appendices, resulted in the identification of two categories of ideas: the needs of patients and the attitudes towards those needs and treatment. The several needs and attitudes identified were organised in clusters.

4.1.1. Needs

Vigilance & Education

One patient testimonial indicated vigilance as key for T2D management. Vigilance implies being aware of current health status, of variations in health, of arising symptoms of disease decompensation… For many patients, their system for recording their **daily measurements**, of keeping vigilant, is to write them down on paper. They then show up at the doctor's office with little pieces of paper with **scattered data** on them. Sometimes they forget to write down the values or even, as this is too cumbersome a process, they may not take their measurements at all. This makes it difficult for them to keep track of the values but also to communicate to their physician how they did in between appointments, if there was any evolution or if their blood sugar varied substantially throughout the day.

Besides the need to keep track of variations, patients need to **understand their readings**, if they are within the established limits. They need to be able to make connections between their blood sugar and what they eat and understand triggers and the variation patterns.

Consequently, talking to HCP, it is evident that **education** is the most critical element to provide to patients in diabetes management. Education about the disease itself, how it progresses, what it affects, the consequences of not treating it, and also about how to best manage and live with it, the lifestyle alterations necessary, and medication. Moreover, nurses try to gather what patients know of the disease before they give them additional information and recommendations, as, sometimes, they may hold misinformed views which wouldn't be exposed otherwise.

Furthermore, this education should be tackled with a **hands-on approach**, because it creates engagement and offers tools for patients to be able to act and react to different situations in their daily lives. One example of this approach is a programme that was related by a nurse, in which nutritionists and dieticians took patients in groups to the supermarket *Continente* to help them shop for groceries and to interpret food labels and be able to tell the difference between different foods and ingredients. This is the type of activity that endures in people and helps to create change in one's life.

In addition to these initiatives, the nurse also talked about **group sessions** to clarify any doubts about therapeutics management and where an effort is made to explain the natural progression of the disease.

Nutrition & Physical Activity

Both patients and HCP pinpointed **nutrition** as a key component of care and as one of the greatest struggles for people with diabetes. Since T2D is a disease greatly affected by lifestyle, nutrition is one of the most important modifications to make and one of the most difficult ones. Even when patients know that they must eat more healthily and what the basics of eating better are, it is difficult to **change the pattern**, to change habits and routines, as pointed out by a surveyed doctors.

Patients also feel very **insecure** in this regard because of the vast sources of **conflicting information** regarding diets. Nurses play a role in this by demystifying the major myths regarding diet and a nutritionist or dietician is always necessary to guide patients.

Physical activity is another major lifestyle-related component needed in diabetes care. It is vital to maintain the lifestyle necessary for better diabetes management and requires a **mind-set adjustment**. In fact, it is considered a critical element of change by patients and HCP, and patients consider it one of the hardest things to modify. It does not require education per se, although it might be necessary to make patients realise that physical activity is broader than

organised sports or gyms and that small changes are enough to start (Geneva: World Health Organisation, 2018). Indeed, over 40% of the Portuguese population does not consider simple daily tasks such as walking up the stairs as physical activity. Likewise, over 30% of the population is uninterested in physical activity, which might indicate the lack of understanding regarding the reach of its benefits (Ministério da Saúde, 2017a).

Community

Patients highlighted the **sense of community** as fundamental and an actual **trigger to change**. HCP attest to this and consider peer communication and exchange to be pivotal, and something the HCP cannot offer. Patient testimonials show that the group spirit is essential to them as it helps to lessen the **emotional load** the diagnosis brings on. The disease ceases to have only a negative component and, instead, becomes a link between individuals.

Access to Care & Communication

The interviewed nurse also mentioned improving the **access to care,** namely **proximity and ease** of access. Patients need people of reference, that they are familiar with, and they ought to know where to go when in need, a service they know they can turn to. This is important to HCP as well (Hiratsuka, Delafield, Starks, Ambrose, & Mau, 2013). Patients also refer HCP guidance as an important tool in their disease management.

Telehealth consultations might facilitate access to care but patients do not do without the face-to-face visits (Dario et al., 2016). Patients and HCP agree that their relationship is crucial for effective and satisfactory healthcare delivery (Brundisini et al., 2015; Hiratsuka et al., 2013).

Individuality

HCP all call attention to the variability between needs and states of condition and the individuality of patients. A “one-size fits all” type of service could never work. Clinical needs vary, as do the strategies that work and engage patients in the management of the disease and collaboration in treatment design.

A summary of the described needs can be found on **Error! Reference source not found.**.

Table 1 - Summary of the needs of patients with T2D

Vigilance & Education	• Organised healthcare data • Health metrics tracking • Trends • Understand readings • Hands-on approach • Group sessions
Nutrition & Physical Activity	• Mandatory • Lack of information consensus • Misinformation • Averseness to change
Community	• Emotional support • Trigger for change • Peer exchange
Access to Care & Communication	• Familiarity • Comfort and trust
Individuality	• Variation in therapy • Variation in motivations • Variation in overall needs

4.1.2. Attitudes

Resistance to Change & Therapy Non-adherence

Resistance to change regarding lifestyle is the greatest barrier patients and physicians face initially. It is a mind-set change, above all. Changes in lifestyle include changing diet and physical activity. Patients testify resistance to adhere to better nutrition and difficulty in introducing physical activity in their lives.

Indeed, one patient offered that when he was first diagnosed, instead of going through the trouble of changing his lifestyle, he preferred to go on medication instead. Only after feeling **fear** brought on by an **extreme experience**, the death of a very dear friend in similar circumstances, did this patient decide to "**embrace the diabetes lifestyle**", as he put it. He has since stopped taking any type of medication and has his diabetes under control. Another patient admitted to not being able to lose any weight and feeling it was too lonely to have to start exercising and was only able to do it after finding a group of people that was going through the same experience.

This lack of compliance happens despite the efforts HCP put into explaining everything about the disease to patients and the consequences of not following through with therapy, albeit

sometimes they do not even entirely realise the consequences of therapeutic non-adherence. **Therapy nonadherence** is affected by factors **beyond lack of knowledge**. To patients, diabetes and medication self-management is a complex experience, comprising of **practical aspects** like daily routines and the need for instrumental support, and **emotional aspects** as health beliefs and emotional impacts. Given this, they point to providers' lack of collaboration, lack of interest in the patient's life and context and poor communication as contributing factors to therapy nonadherence. Likewise, other feelings such as **shame** affect adherence: a patient reported feeling stigmatised by measuring blood glucose in front of other people.

HCP often fail to recognise these potential barriers to adherence and from their point of view, though, the barriers lie in the system, for instance short consultations and lack of inter-professional collaboration, which prevent prioritising patients' medical and psychosocial needs. There is a mismatch of focus that needs addressing (Brundisini et al., 2015).

(Lack of) Accountability

When asked about the possibility of remote monitoring, the interviewed nurse feared patients might feel too dependent on it, instead of seeing it only as a safeguard, and **lose the sense of responsibility** of managing their disease. Still, patients must be **accountable for their care**, the ones responsible for it. Whatever remote access there is to patients, it must be balanced and leave enough room for patients to care for themselves and have the autonomy to manage most situations. Otherwise, they may try to shift the responsibility of managing the condition to the HCP, which is not the purpose of improving self-management. That said, research shows that many patients viewed telehealth only as a monitoring service and that telehealth helps them feel secure and confident, empowered (Lee et al., 2018). Therefore, finding the right balance is crucial for patient independence, and possible.

A summary of the described attitudes can be found below, on Table 2.

Table 2 - Summary of the attitudes of patients with T2D

Resistance to Change & Therapy Non-adherence	Accountability
• Mind-set change • Fear and shame • Support • Mismatch between patients and providers	• Sense of responsibility • Sense of empowerment • Patient independence

4.2. RQ2 – Market Offer Analysis

Patient self-management is in vogue. Mobile applications flood the market. Here is presented a summary of the main features of some of the most popular diabetes self-management services that connect patient and provider.

After seeing what patients need and how they feel about the management of their condition, we look into what type of programmes exist, their features, and what they might be missing. Four types of services were identified: self-management applications that allow patients to send data reports to their physician, diabetes device manufacturers' applications, coaching programmes based in clinics and corporate wellness programmes.

Looking at **self-management mobile applications** (Table 3), it is possible to see they rarely incorporate HCP in the disease management, serving mostly the purpose of **facilitating data tracking**. Only one of the analysed services offered a community and educational component, aspects we have found to be vital for successful diabetes management. Feedback is also lacking in these services, which might hinder long-term engagement (Gee et al., 2015). Some allow recording **health indicators** besides blood sugar, such as blood pressure, and all of them allow keeping records of lifestyle, namely **physical activity** and **food or carbohydrate** intake. Additionally, some have food a photo diary or even a food database, just like the nurse suggested. Most of them also allow recording the medication taken. Most of them have reminders to check blood sugar and some also allow to set reminders for medication. The most popular ones can **connect directly with medical devices** to upload health data automatically. Only one of the applications could be used for remote monitoring as well, as HCP can adhere to it and access patient data. All of them are free of charge, although most offer a paid version with extra features.

On the other hand, **glucose meters manufacturers** have also started offering mobile applications of their own to **manage blood sugar levels**. They also allow to send reports to HCP or offer an HCP front-end as well. In fact, they are marketed towards providers, as well, not just to patients, as they are the ones potentially promoting the brands to patients. However, physicians having to toggle between numerous brand applications might be a nuisance, as is for patients it they need to have other applications besides the one to track blood sugar, making it more difficult to follow therapy in the long run. These services are mostly dedicated to analysing blood glucose levels over time, to find patterns and changes, and so, they are **not holistic** and counteract integration of care (Abbott, 2020; Dexcom, 2020; Menarini, 2020).

Table 3 - Top T2D self-management apps and their features

	Glucose Buddy (Glucose Buddy, 2020)	**OnTrack Diabetes** (OnTrack Diabetes, 2020)	**Diabetes:M** (Diabetes:M, 2020)	**mySugr** (MySugr, 2020)	**OneDrop** (OneDrop, 2020)
Therapy data	Blood sugar Paid Estimated HbA_{1c} Blood pressure	Blood sugar Estimated HbA_{1c} Blood pressure	Blood sugar	Blood sugar Estimated HbA_{1c}	Blood sugar
	Food Weight Physical activity	Food Weight Physical activity	Food	Carbohydrates Weight Physical activity	Food Carbohydrates
	Medication		Medication Insulin & injection sites	Medication	Medication Insulin
Manual / automatic data input	Manual and BT integration	Manual	Paid BT integration	Manual and BT integration	Manual and BT integration
Device / brand limitation	Connects with limited brand apps		Connects with several brand apps	Connects with several brand apps	Connects with one brand
Platform Feedback		Value outside specified range		Value outside specified range	Coaching after value insertion
Educational content					Educational content and news Coaching messages
Community					Community to share health parameters and activity
Communication with healthcare professionals	Send reports via e-mail Possibility of referral		Send reports or paid remote monitoring if HCP participates	Send reports via e-mail	Possibility of referral
Reminders	Blood sugar reminders		Blood sugar reminders	Paid blood sugar reminders	Medication reminders Blood sugar
Customer	Patient	Patient	Patient and HCP	Patient	Patient
Financing	Free / Paid	Free	Free / Paid	Free / Paid	Free (Pay for device subscription)
Other features	Photo diary		Food database Nutritional advisor	Paid challenges Paid photo food diary	Food database

The use of these applications would require the use of different tools to be able to access more elements important to self-management, which people don't want to spend mental energy on (Catlin, Lorenz, Nandan, Sharma, & Waschto, 2018).

As for **educational programmes**, they are usually of short duration, many aimed at "inaugural diabetics". They mostly encompass a limited number of **training sessions or workshops** (6 – 9 weeks) to learn about the disease and living with it. Most incorporate the **community component**, since part of the sessions are given in groups (Healthcare, 2020; Princeton HCS, 2020). More robust solutions add other resources such as **exercise videos** and a mobile application much like the already evaluated self-management applications (SelfHelpWorks, 2020). These programmes have proven fruitful in improving diabetes management and lowering HbA_{1c}, however they may not be enough to engage patients in the long-run, as after a while it ceases to have an effect (Beebe & Schmitt, 2011). Therefore, it is important that education is on-going for a longer period of the patient's life rather than for just a year, at most. Nevertheless, the group classes and personalisation of care are always present in these services, an important feature to retain.

Lastly, **Corporate wellness programmes** are programmes sold to companies and aimed at improving **employee health** and preventing chronic diseases resulting from an **improved lifestyle**. Supposedly, this should decrease employee absenteeism and increase productivity. These programmes may go so far as to offer rewards for healthy behaviours, for completing challenges and achieving goals, including reimbursements. They sell improved business performance and company culture. Overall, these corporate wellness programmes are mobile application based programmes that allow tracking of basic health data, such as weight and physical activity, and promote the adoption of healthy habits (Virgin Pulse, 2020; Vitality, 2020).

Looking at the ones that offer chronic disease related features, some of them allow to, on top of the regular features, **track some diabetes related data** such as blood sugar (Virgin Pulse, 2020). Other such programmes have chronic disease specific offers which are more complete (HealthCheck360, 2020). It works with **to-do lists** for the different health checks needed (eye exams, lab tests, office visits) and tracking of **progress with reports**. The application has the possibility to set reminders for the different tasks and of connecting devices. These programmes offer a somewhat holistic view of the disease and have a greater **focus on engagement and lifestyle change**, more than on tracking. Nonetheless, like the diabetes self-management applications, they lack HCP intervention and guidance.

Similar to the corporate wellness programmes, there are programmes sold to health plan providers, specifically. By having clients well-controlled, health plans have fewer costs. The main programme found focuses on keeping blood sugar under control, providing a kit with a device to measure it and a guide. It then tracks when the person needs more strips to measure blood sugar and sends it to them. They also have access to HCP by phone and educational materials, and receive phone calls when not complying (Envolve, 2020). While highly facilitating patients' life regarding blood sugar monitoring, it diminishes self-management greatly by reducing it to blood sugar measurements.

Constructive elements can be taken from this analysis, namely the tracking of health data beyond basic biometric indicators, like weight management and physical activity. Also, the ubiquitous use of group sessions in diabetes education confirms our testimonials. Finally, from corporate wellness programmes we can take the engagement created from the existence of challenges and goals.

4.3. RQ3 – New T2D Self-Management Service

A new T2D Self-Management Service is needed to fully answer patients needs, accounting for their attitudes and what is available in the market. This new service proposition is triggered by a clinical need rather than by a technological push. Remote patient monitoring and disease self-management are driven by the clinical need to alter patient behaviour in regards to their chronic disease. There is a need to get these patients to better manage their condition in order to prevent further deterioration of health. Technology enables patients to keep better track of their health and to feel secure with the remote monitoring component.

Our issue at hand: the rise in costs stemming from preventable complications from diabetes in Portugal. This service aims to prevent cutisation of the disease, less trips to healthcare facilities, less emergency visits and change patient behaviour in the process. Clinical benefits for patients have been demonstrated with the use of similar services, namely decrease of HbA_{1c} and better weight management. A summary table of the suggested features can be found at the end of the chapter (Table 4).

4.3.1. Platform Basics

Remote monitoring involves two main components: **patient front-end** and **HCP front-end**. The data inserted by the patient are sent to a cloud where response is generated, back to the patient and alarms to HCP according to a clinical protocol of action. HCP can access individual patients' data, which is continuously transmitted to the platform, and the alarms from all their patients.

Given that knowing the doctor that is caring for the patients is important, the familiarity (Hiratsuka et al., 2013), these programmes must have **medical endorsement** from the doctor they know, a prescription of sorts. Hence, the enrolment in the programme should be done by the HCP, and the protocol for the patient is set.

There being constant monitoring **incentivises patients** to monitor themselves and be more careful, they may feel the need to show results, because it disenables patients to lie or sugar-coat their status, giving them greater consciousness of the severity of the condition and the impact on overall health (Lee et al., 2018; Walker et al., 2019). On the other hand, there is the lack of accountability to consider, and so the platform must not alert HCP for every given value outside of the established range and instead send **coaching or recommendations** to the patient and only alert HCP if values remain outside the range for prolonged periods. For example, if a patient accuses elevated blood pressure, without remote monitoring, the patient

would just wait for the next consultation with the physician and comment on the elevated value, which could be too late.

There is also a sense of **security, comfort and confidence** associated with the existence of remote monitoring, with patients becoming more certain of when it was necessary to seek medical attention. Patients, then, feel like equal partners in their care (Coulter & Ellins, 2007; Lee et al., 2018; Walker et al., 2019) These emotions subsequently improve adherence to therapy (Brundisini et al., 2015).

4.3.2. Needs & Attitudes

Vigilance & Education

Making this service **mobile-based** is convenient and allows for constant connection, as people carry their mobile phones with them most of the time. The use of internet on mobile phones is also high, being as broadband penetration rate in Portugal is fairly high (75.9% in the first semester of 2019) (ANACOM, 2019), and so a mobile-based application dependent on **internet connection** makes sense, allowing for data transfer "on the go" to HCP and access to content we might want to make available. This unlocks unnumbered possibilities of features and elements to include in the service.

Since patients need to take readings regularly, a service where their **health data can be aggregated** and its communication to HCP facilitated is in order. Also, the application must be able to **receive data automatically** from the devices as already happens with most self-management mobile applications. A single mobile-based service enables these patients to **keep records** of all their measurements in one place, and the automatic upload of health data from the measuring devices to the mobile application prevents mistakes and makes the process simpler. Patients being able to take their own readings at home with the telehealth equipment increases patient confidence in managing their own condition and it also helps them come to terms with facing the reality of their condition (Lee et al., 2018). This helps minimize therapy nonadherence (Brundisini et al., 2015).

Moreover, because patients need help knowing if their readings are good, they need **immediate feedback** on them. The application must easily convey whether the values are over or under their established limits and how severe the deviation is. Also, some coaching should be triggered lest the values be undesirable, containing positive encouragement or advice to retake readings soon.

Given that it is important to **track variations** over periods of time, the application must generate **graphs** for the different parameters and for blood glucose taken before and after meals. Supporting self-care with telehealth system's health **trend analysis** displayed as a graph, providing an overall picture of the patient's health over time, encourages them to self-reflect and take control of their own health (Lee et al., 2018). In addition, it is important to associate certain events to the readings, to **understand patterns** of causality, for example between physical activity and variations in blood sugar. For this reason, it is important that the application allows for the use of labels to describe occurrences.

Because education is a pillar of diabetes management, **access to educational content** is pivotal in this service. Given that on-going education is needed (Beebe & Schmitt, 2011), it is important that they have it on them to consult whenever they feel it is necessary. Also, this content should be tailored to the stage of development of the disease, meaning, for instance, that there should not be content about insulin administration if they do not use insulin at all. The HCP should be able to trigger new content according to changes in treatment, if the patient changes medication, new content should be available accordingly. Additionally, it could be interesting if patients were able to deem the content useful or not, helping the application to adapt to their needs and preferences. Educational content could be delivered in the form of interactive surveys, educational videos and motivational messages and tips, and questions tailored to their diagnoses (Lee et al., 2018).

Nutrition & Physical Activity

Despite HCP efforts to transmit all the information patients need regarding nutrition, doubts often can arise during the day, making it a need to have access to content, on hand. This means that it is important to have easy access to food related content and that it is regular. This can happen in the form of **periodic tips and recipes**.

One nurse suggested that it would be very valuable for patients to have access to a **food database** where they could scan their meal, or insert it into the database, and have a carbohydrate estimate, which was found in one of the evaluated self-management applications. Alternatively, as a simpler version, she suggested a feature in which patients could just have the possibility to upload photo of their meals and crate a **food diary**. This would help them associate the variations in blood sugar to different meals.

Due to the resistance to change, it is important to keep patients committed and engaged to the change. This could be achieved by asking for **daily check-ins** of what they ate, with

feedback for **encouragement and suggestions** for improvement when needed. There must be a **meal plan** when necessary, as well, designed by a nutritionist or a dietician specifically for the patient.

That same engagement must be triggered for physical activity. This should both come from the HCP and from the platform, with periodic incentives and positive reinforcement strategies. It should **integrate with other healthcare mobile applications**, the phone's operating system applications and other activity apps so that patients can have a choice in how to measure their activity (through the phone or a device). Basic activity data from the device, such as number of **steps and time of activity**, should be able to load directly to the T2D management service without the need for an extra application.

For patients to be more involved in their activities, there should be daily goals and weekly or monthly challenges. Since we've seen that exercising in group is an encouragement, there should also be a presential component, with recurrent meets to exercise such as nature walks, and they should be able to see how they **compare** to other people of similar characteristics (same age group and gender) and participate in virtual challenges (weekly steps, e.g.) with other people that are using the service as well. Patients should also be able to view their **physical progress**, trend graphs of their physical activity and their goals for different periods.

Community

Besides facilitating the initiation of physical activity, the existence of community increases adherence to programmes and self-management (Gee et al., 2015). Therefore, it is important to have a component of **peer interaction** in this service. This service should include **group sessions**, which are used commonly in diabetes care and considered fruitful. In these sessions anything pertaining to diabetes is discussed, from medication to simple exchange of tips between patients. These are mediated by the HCP who launches the topics and then let the patients work out the rest. It enables the exchange of ideas between peers and tips they pick up with experience. This should go together with the "hands-on" approach, to provide **workshops and learning activities** on a periodic basis. The application could have a **schedule of upcoming events** near the patient, and the possibility to enrol for them.

In addition to educational activities and exercise related meetings and challenges, there should be a place for the exchange of ideas, such as a **message board** or a **forum,** where HCP regularly launch a topic and then patients contribute and interact much like the in-person periodic group sessions. Patients should also be able to share accomplishments and other

content related to condition management, as found in the OneDrop application previously described (OneDrop, 2020). This sharing of experiences addresses the shame some patients feel as well, and seeing other people succeed improves motivation and hence adherence to therapy (Lee et al., 2018).

Access to Care & Communication

Concerning remote monitoring in general, patients value the reduced need to travel to see a doctor or wait for a doctor's appointment to have their health status confirmed (Lee et al., 2018). Given this, and because facilitated access to care was referred as being important by HCP, the service should enable patients to talk to their HCP for smaller matters that should not require a face-to-face visit, either through a **delayed messaging service** with their care team (nurses and physicians), or through the possibility of making **teleconsultations** appointments.

This, however, must not replace **face-to-face contact with the HCP** and the quarterly or yearly consultations remain essential, to discuss more serious health concerns or because of the need for medical advice or a physical examination (Lee et al., 2018). Therefore, there should be the possibility for the doctor to set the periodicity of visits and that information being available for the patient to see in their mobile application, in the form of tasks or in a calendar. Then, HCP can associate notes from the consultations to the corresponding entry in the platform for the patient to access.

A **multidisciplinary team** is important, as pointed out by the interviewed nurse. Doctors from the different specialties that care for a patient should have access to the platform and their patient's data. In the HCP front-end there should be the possibility for communication between physicians to a quicker access to changes to therapy in other specialties for true integration of care.

Individuality

As evidenced, needs vary greatly between patients and types of patients. Therefore, objectives should be customisable to different patients, such as the healthy range of certain health parameters. The patients doing it creates the possibility of error, as it is a medical input, so it should be the doctors who have the ability to establish thresholds for patients and the individualised clinical protocol for platform feedback (Lee et al., 2018).

Furthermore, as **treatment varies** greatly from person to person and people deal differently with the disease, it is important that education is not completely standardised, as

previously mentioned. Personalisation of content requires that the service, namely the mobile application, has the ability to learn and **adapt its content**, the same way the nurses appoint different devices to different patients according to their limitations.

To facilitate the personalisation of the service, it should be modulable. The concept of delayed differentiation in supply chain management advises designing processes so that the point of differentiation is delayed as much as possible, which is achievable with standardisation and **modularisation** of products. This provides greater product availability and efficiency. In chronic disease management, this may translate into a standard management programme that becomes more personalised to adapt to patient behaviour (Thompson, Whitaker, Kohli, & Jones, 2019). That said, the service should be designed in such a way that it has different modules, for different needs, that can be **put together according to different requirements**. For example, for older, more illiterate patients, a simpler version could be more effective, with less functionalities. As the nurse pointed out, if there are too many functionalities, patients might not explore them and get lost, so HCP should perceive patients' capabilities regarding the use of technology and their autonomy.

4.3.3. Other Facilitating Features

There can be concern for ease of use of the technology due to the prevalence of the disease in older and less literate people. Nevertheless, research shows that those patients who expressed initial concerns about using telemonitoring, generally related to their lack of familiarity with technology and also the ability to use the equipment correctly, overcame them through continued exposure to the technology and individualised training and support (Lee et al., 2018; Walker et al., 2019). HCP should be the ones enrolling patients in the programme and guide them through it in an **introductory session**. These sessions of **individualised training** should encompass downloading the application, registration in the platform, setting alarms and tasks according to preferences, going through the use of the platform and the connection of the devices.

This service dedicated to the management of diabetes must have the possibility to set different types of **reminders**, for **medication** and to ensure patients take the **necessary readings**. In place of reminders, there could be an engagement feature that asks people if they took their medication and why. These setting should be **easy to change** because people might find notifications helpful at first, but, depending on other life circumstances and overall state of mind, they may eventually tire of them, as revealed by the nurse.

Table 4 - Summary of suggested features for a T2D management service according to needs & attitudes

Vigilance & Education	• Automatic data upload • All health data • Data records • Feedback on results • Trend graphs
Nutrition & Physical Activity	• Tips & recipes • Food database & reader • Food photo diary • Meal plan • Integration with fitness apps • Group exercise • Performance comparison with peers • Physical progress • Goals and community challenges
Community	• Group session • Workshops & learning activities • Event schedule • Message board/ forum
Access to Care & Communication	• Messaging service • Teleconsultations scheduling • Face-to-face consultations scheduling • Access to doctor notes • Multidisciplinary care and communication between professionals
Individuality	• Modularisation of service • Adapt to patient needs and capabilities
Individual Training	• Registration • Settings • Device connection • Platform usage
Reminders	• Medication • Readings • Easy to adjust • Data input request
Mental Wellbeing	• Questionnaires • Emotions diary

Finally, as there is a high emotional load brought one by living with diabetes, there should be a feature that engages patients in dealing with their **mental wellbeing**, like questionnaires and a daily diary of emotions.

5. Conclusions, Limitations and Future Work

5.1. Conclusions

Healthcare costs are becoming unsustainable (Deloitte, 2019), and so healthcare needs to change, including how care is delivered (Porter & Lee, 2013). Part of the problem is the rise in prevalence of chronic diseases (Deloitte, 2019; Ministério da Saúde, 2018). The problem involves rising costs from badly managed diseases (J. Eapen & H. Jain, 2017; Ministério da Saúde, 2017b). Type 2 diabetes is one of those diseases and has a high prevalence in Portugal (Sociedade Portuguesa de Diabetologia, 2016).

Care for people living with the disease is changing and needs to keep changing. More and more services are available with the aim of improving disease management (Grady & Gough, 2014; Pearson et al., 2007).

Despite numerous efforts to create solutions to facilitate disease management, they oftentimes fail to offer the holistic support these patients need, as found in the present research, and much of the research in this field focuses on inconclusive and inconsistent outcomes rather than on the composition of the services (Hou et al., 2016).

We set out to find what the service should be like to really address demand. Remote monitoring is well received by patients and presents advantages to treatment such as improved compliance and confidence (Lee et al., 2018). Nonetheless, it was found that it is important that contact with HCP is regular and not substituted by the monitoring. Constant vigilance of health data can be helped by a mobile-based application that can keep data aggregated and generate graphs for an overall view of health status. Also, it is important to tackle the necessary lifestyle changes and enable them, by promoting community activities beside educational group sessions, and generate engagement with coaching, daily content and goal setting.

5.2. Limitations

The way this research was conducted presents some **limitations**, namely the amount of primary data collected. Primary data collection was constrained by the availability of HCP to take part in the research and of patients as well. Furthermore, public and private hospitals have different concerns, different exposure to different types of patients. Having said that, for a more varied set of experiences, a more complete set of interviews could have been pursued, with HCP from different specialties and that practice in different types of healthcare facilities.

5.3. Future Work

For **future work**, it would be interesting to study patients' **willingness to pay** for this service and subsequently the financing of the service. The analysed self-management applications all charge for certain features. Which ones are more valuable and how valuable are they?

Still, as the proposition is that the HCP are the ones bringing the service to patients, some sort of **financing** is expected. In the **public system**, should the system pay the entirety of the programme for all patients as it does in pilot programmes? Or perhaps just to a few people, based on income or other limitations like the severity of their condition.

On the other hand, as the escape from the public system increases (Instituto Nacional de Estatística, 2018), the private sector gains more and more relevance and, in this case, the **health insurer** is part of financing. In such a situation, insurers could decrease the price of health insurance to patients well controlled and enrolled in the service, or enact discounts to patients that show positive results in the programme, as done by the Vitality product, an insurance wellness programme available in several countries around the world (Vitality, 2020).

6. References

Abbott. (2020). Prepare for Your HCP Visit | Diabetes Care | FreeStyle Libre. Retrieved January 6, 2020, from https://www.freestylelibre.co.uk/libre/discover/preparing-for-a-medical-appointment.html

American Well. (2019). *Telehealth Index: 2019 Physician Survey*.

ANACOM. (2019). *Mobile services: first half of 2019*.

Beebe, C. A., & Schmitt, S. (2011). Engaging Patients in Education for Self-Management in an Accountable Care Environment. *Clinical Diabetes*, *29*(3), 123–126.

Brettle, A., Brown, T., Smith, N. H., Radcliffe, J., & Smith, C. (2013). *Telehealth: The effects on clinical outcomes, cost effectiveness and the patient experience: a systematic overview of the literature*. Retrieved from http://usir.salford.ac.uk/29392/

Brundisini, F., Vanstone, M., Hulan, D., Dejean, D., & Giacomini, M. (2015). Type 2 diabetes patients' and providers' differing perspectives on medication nonadherence: a qualitative meta-synthesis. *BMC Health Services Research*, *15*, 516. https://doi.org/10.1186/s12913-015-1174-8

Catlin, T., Lorenz, J., Nandan, J., Sharma, S., & Waschto, A. (2018). *Insurance beyond digital : The rise of ecosystems and platforms*. *McKinsey & Company*.

Clarke, M., Fursse, J., Connolly, N., Sharma, U., & Jones, R. (2018). Evaluation of the National Health Service (NHS) Direct Pilot Telehealth Program: Cost-Effectiveness Analysis. *Telemedicine and E-Health*, *24*(1), 1–10. https://doi.org/10.1089/tmj.2016.0280

CNTS. (2017). *Auscultação aos Stakeholders*.

Coleman, K., Austin, B. T., Brach, C., & Wagner, E. H. (2009). Evidence on the Chronic Care Model in the new millennium. *Health Affairs*, *28*(1), 75–85. https://doi.org/10.1377/hlthaff.28.1.75

Coulter, A., & Ellins, J. (2007). Effectiveness of strategies for informing, educating, and involving patients. *BMJ*, *335*(July), 24–27.

Cui, M., Wu, X., Mao, J., Wang, X., & Nie, M. (2016). T2DM Self-Management via Smartphone Applications: A Systematic Review and Meta-Analysis. *PLoS ONE*, *11*(11). https://doi.org/10.1371/journal.pone.0166718

Dario, C., Luisotto, E., Pozzo, E. D., Mancin, S., Aletras, V., Newman, S., … Saccavini, C. (2016). Assessment of Patients' Perception of Telemedicine Services Using the Service User Technology Acceptability Questionnaire. *International Journal of Integrated Care*, *16*(2), 1–11. https://doi.org/http://dx.doi.org/10.5334/ijic.2219

Deloitte. (2018). *What can health systems do to encourage physicians to embrace virtual care?*

Deloitte. (2019). *2019 Global health care outlook: Shaping the future*.

Dexcom. (2020). CLARITY - Portugal | Dexcom. Retrieved January 6, 2020, from https://www.dexcom.com/pt-PT/clarity-portugal

Diabetes:M. (2020). Diabetes:M – Your Diabetes Management App – Keep Diabetes Under Control. Retrieved January 6, 2020, from https://www.diabetes-m.com/

Diabetes UK. (2014). *The Cost of Diabetes*.

Elf, M., Flink, M., Nilsson, M., Tistad, M., Von Koch, L., & Ytterberg, C. (2017). The case of value-based healthcare for people living with complex long-term conditions. *BMC Health Services Research*, *17*(1), 1–6. https://doi.org/10.1186/s12913-016-1957-6

Envolve. (2020). Diabetes Management Solutions | On.Demand Diabetes Management Program. Retrieved January 6, 2020, from https://www.envolvehealth.com/our-solutions/diabetes-management.html

Erichsen Andersson, A., Bååthe, F., Wikström, E., & Nilsson, K. (2015). Understanding value-based healthcare – an interview study with project team members at a Swedish university hospital. *Journal of Hospital Administration*, *4*(4), 64–72. https://doi.org/10.5430/jha.v4n4p64

Ferrante, J. M., Balasubramanian, B. A., Hudson, S. V., & Crabtree, B. F. (2010). Principles of the patient-centered medical home and preventive services delivery. *Annals of Family Medicine*, *8*(2), 108–116. https://doi.org/10.1370/afm.1080

Gee, P. M., Greenwood, D. A., Paterniti, D. A., Ward, D., & Miller, L. M. S. (2015). The eHealth Enhanced Chronic Care Model: A Theory Derivation Approach. *Journal of Medical Internet Research*, *17*(4). https://doi.org/10.2196/jmir.4067

Geneva: World Health Organisation. (2018). *Global action plan on physical activity 2018-2030: More active people for a healthier world*.

Glucose Buddy. (2020). Glucose Buddy. Retrieved January 6, 2020, from https://www.glucosebuddy.com/

Gonçalves, L., Castelo-branco, M., & Campanella, N. (2018). *e-Saúde - livro de ensino para estudantes de cursos de ciências da saúde e para profissionais de saúde*. (Tipografia da Unidade da Beira Interior, Ed.). Covilhã.

Grady, P. A., & Gough, L. L. (2014). Self-Management: A Comprehensive Approach to Management of Chronic Conditions. *American Journal of Public Health*, *104*(8), 25–31. https://doi.org/10.2105/AJPH.2014.302041

Greenwood, D. A., Gee, P. M., Fatkin, K. J., & Peeples, M. (2017). A Systematic Review of Reviews Evaluating Technology-Enabled Diabetes Self-Management Education and Support. *Journal of Diabetes Science and Technology*, *11*(5), 1015–1027. https://doi.org/10.1177/1932296817713506

Healthcare, E. (2020). Diabetes Management Program. Retrieved January 6, 2020, from https://www.emoryhealthcare.org/centers-programs/diabetes-management-program/index.html

HealthCheck360. (2020). Disease & Chronic Condition Management. Retrieved January 5, 2020, from https://www.healthcheck360.com/chronic-condition-management

Hiratsuka, V., Delafield, R., Starks, H., Ambrose, A. J., & Mau, M. M. (2013). Patient and provider perspectives on using telemedicine for chronic disease management among native Hawaiian and Alaska native people. *International Journal of Circumpolar Health*, *72*. https://doi.org/10.3402/ijch.v72i0.21401

Hou, C., Carter, B., Hewitt, J., Francisa, T., & Mayor, S. (2016). Do Mobile Phone Applications Improve Glycemic Control (HbA1c) in the Self-management of Diabetes? A Systematic Review, Meta-analysis, and GRADE of 14 Randomized Trials. *Diabetes Care*, *39*, 2089–2095. https://doi.org/10.2337/dc16-0346

Infarmed. (2019). *Monitorização do Consumo de Medicamentos*.

Instituto Nacional de Estatística. (2018). *Os hospitais do sector público continuam a assegurar a maior parte dos cuidados de saúde, mas o setor privado tem evidenciado um forte crescimento*.

International Diabetes Federation. (2017). *Recommendations for Managing Type 2 Diabetes in Primary Care*. *Diabetes Research and Clinical Practice*. https://doi.org/10.1016/j.diabres.2017.09.002

J. Eapen, Z., & H. Jain, S. (2017). Redesigning Care for High-Cost, High-Risk Patients. *Harvard Business Review*, *368*(2), 100–102. https://doi.org/10.1056/NEJMp1212324

Jong, J. P. J. De, Bruins, A., Dolfsma, W., & Meijaard, J. (2003). *Innovation in service firms explored: what, how and why? EIM Business & Policy Research*.

Lee, P. A., Greenfield, G., & Pappas, Y. (2018). Patients' perception of using telehealth for type 2 diabetes management: A phenomenological study. *BMC Health Services Research*, *18*, 549. https://doi.org/10.1186/s12913-018-3353-x

Menarini. (2020). Diabetes Remote Control. Retrieved January 6, 2020, from https://www.menarinidiag.pt/en-us/home/diabetes-care-products/diabetes-remote-control

Miles, I. (2010). Service Innovation. In *Handbook of service science* (pp. 511–533). https://doi.org/10.1007/978-1-4419-1628-0_22

Ministério da Saúde. (2017a). *Barómetro da Actividade Física*.

Ministério da Saúde. Regulamento do programa de incentivo à integração de cuidados e à valorização dos percursos dos utentes no serviço nacional de saúde para 2017 (2017). Retrieved from http://www.acss.min-saude.pt//wp-content/uploads/2017/04/Regulamento-PIIC.pdf

Ministério da Saúde. (2018). *Retrato da Saúde*.

Ministério da Saúde. (2019). *Plano estratégico nacional para a telessaúde 2019-2022*.

MySugr. (2020). mySugr - Make Diabetes Suck Less! Retrieved January 6, 2020, from https://mysugr.com/en

OECD/EU. (2015). *OECD Compendium of Productivity Indicators 2015* (OECD Compendium of Productivity Indicators). OECD Publishing. https://doi.org/10.1787/pdtvy-2015-en

OECD/EU. (2018). *Health at a Glance: Europe 2018: State of Health in the EU cycle*. OECD Publishing. https://doi.org/10.1787/f222b050-mt

OneDrop. (2020). One Drop: The Best in Diabetes Management. Retrieved January 6, 2020, from https://onedrop.today/

OnTrack Diabetes. (2020). Type1 and Type 2 Diabetes, Prediabetes, Recipes, Lifestyle Tips - OnTrackDiabetes.com. Retrieved January 6, 2020, from https://www.ontrackdiabetes.com/

Pearson, M. L., Mattke, S., Shaw, R., Ridgely, M. S., & Wiseman, S. H. (2007). *Patient Self-Management Support Programs: An Evaluation. Final Contract Report (Prepared by RAND Health under Contract No. 282-00-0005)*.

Peikes, D., Zutshi, A., Genevro, J., Smith, K., Parchman, M., & Meyers, D. (2012). *Early Evidence on the Patient-Centered Medical Home. Final Report (Prepared by Mathematica Policy Research, under Contract Nos. HHSA290200900019I/HHSA29032002T and HHSA290200900019I/HHSA29032005T)*.

Porter, M. E., & Lee, T. H. (2013). The Strategy That Will Fix Health Care. *Harvard Business Review*, (October).

Porter, M. E., & Teisberg, E. O. (2006). *Redefining Health Care: Creating Value-based Competition on Results*. Harvard Business Press. Retrieved from http://books.google.com/books?hl=en&lr=&id=cse2LOAndNIC&pgis=1

Princeton HCS. (2020). Diabetes Management Program. Retrieved January 6, 2020, from

https://www.princetonhcs.org/care-services/diabetes-management-program

Quinn, C. C., Butler, E. C., Swasey, K. K., Shardell, M. D., Terrin, M. D., Barr, E. A., & Gruber-baldini, A. L. (2018). Mobile Diabetes Intervention Study of Patient Engagement and Impact on Blood Glucose: Mixed Methods Analysis. *JMIR MHealth and UHealth*, *6*(2), e31. https://doi.org/10.2196/mhealth.9265

Quinn, C. C., Khokhar, B., Weed, K., Barr, E., & Gruber-baldini, A. L. (2015). Older Adult Self-Efficacy Study of Mobile Phone Diabetes Management. *Diabetes Technology and Therapeutics*, *17*(7), 455–461. https://doi.org/10.1089/dia.2014.0341

Quinn, C. C., Shardell, M. D., Terrin, M. L., Barr, E. A., Ballew, S. H., & Gruber-Baldini, A. L. (2011). Cluster-randomized trial of a mobile phone personalized behavioral intervention for blood glucose control. *Diabetes Care*, *34*(9), 1934–1942. https://doi.org/10.2337/dc11-0366

Reynolds, R., Dennis, S., Hasan, I., Slewa, J., Chen, W., Tian, D., … Zwar, N. (2018). A systematic review of chronic disease management interventions in primary care. *BMC Family Practice*, *19*(1), 1–13. https://doi.org/10.1186/s12875-017-0692-3

Saunders, M. N. K., Thornhill, A., & Lewis, P. (2009). *Research Methods for Business Students*. *Pearson Education Limited* (5th ed.).

Scott, I. A. (2008). Chronic disease management: A primer for physicians. *Internal Medicine Journal*, *38*(6 A), 427–437. https://doi.org/10.1111/j.1445-5994.2007.01524.x

SelfHelpWorks. (2020). LivingWell - SelfHelpWorks. Retrieved January 6, 2020, from https://corp.selfhelpworks.com/programs/livingwell/

Seto, E., Leonard, K. J., Masino, C., Cafazzo, J. A., Barnsley, J., & Ross, H. J. (2010). Attitudes of Heart Failure Patients and Health care Providers towards Mobile Phone-Based Remote Monitoring. *Journal of Medical Internet Research*, *12*(4). https://doi.org/10.2196/jmir.1627

Sociedade Portuguesa de Diabetologia. (2016). *Diabetes: Factos e Números – O Ano de 2015 − Relatório Anual do Observatório Nacional da Diabetes*. *Observatório da Diabetes*.

Staats, B. R., Dai, H., Hofmann, D., & Milkman, K. L. (2017). Motivating Process Compliance Through Individual Electronic Monitoring: An Empirical Examination of Hand Hygiene in Healthcare. *Management Sciencce*, *63*(5), 1563–1585. https://doi.org/10.1287/mnsc.2015.2400

Tamura, S., Sheehan, J., Martinez, C., & Kergroach, S. (2005). *Promoting Innovation in Services*. https://doi.org/DSTI/STP/TIP(2004)4/FINAL

Thompson, S., Whitaker, J., Kohli, R., & Jones, C. (2019). Chronic Disease Management: How IT and Analytics Create Healthcare Value Through the Temporal Displacement of Care. *MIS Quarterly*, (February). Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3415199

Van Lieshout, J., Goldfracht, M., Campbell, S., Ludt, S., & Wensing, M. (2011). Primary care characteristics and population-orientated health care across Europe: An observational study. *British Journal of General Practice*, *61*(582), e22–e30. https://doi.org/10.3399/bjgp11X548938

Virgin Pulse. (2020). Technology to Replenish the Modern Worker - Virgin Pulse. Retrieved January 5, 2020, from https://www.virginpulse.com/our-products/

Vitality. (2020). How the Vitality Wellness Program Works - Vitality. Retrieved January 5, 2020, from https://www.vitalitygroup.com/how-vitality-works/

Vodafone Portugal. (2013). Gerir a Diabetes através do telemóvel. Retrieved December 30, 2019, from https://www.vodafone.pt/press-releases/2013/4/gerir-a-diabetes-atraves-do-telemovel.html

Vodafone Portugal. (2019). Monitorização de Diabetes. Retrieved December 30, 2019, from https://www.vodafone.pt/a-vodafone/fundacao/programas/monitorizacao-diabetes.html

Wagner, E. H., Austin, B. T., & Korff, M. Von. (1996). Organizing Care for Patients with Chronic Illness. *The Milbank Quarterly*, *74*(4), 511–544. https://doi.org/10.2307/3350391

Walker, R. C., Tong, A., Howard, K., & Palmer, S. C. (2019). Patient expectations and experiences of remote monitoring for chronic diseases: Systematic review and thematic synthesis of qualitative studies. *International Journal of Medical Informatics*, *124*, 78–85. https://doi.org/10.1016/j.ijmedinf.2019.01.013

Whiting, D. R., Guariguata, L., Weil, C., & Shaw, J. (2011). IDF Diabetes Atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Research and Clinical Practice*, *94*(3), 311–321. https://doi.org/10.1016/j.diabres.2011.10.029

Wootton, R. (2012). Twenty years of telemedicine in chronic disease management – an evidence synthesis. *Journal of Telemedicine and Telecare*, *18*(4), 211–220. https://doi.org/10.1258/jtt.2012.120219

World Health Organisation. (2013). *2008-2013 Action Plan for the Global Strategy for the Prevention and Control of Noncommunicable Diseases*.

Appendix

Appendix I – Nurse Interview

1. What are the main needs of a person living with diabetes for their management of the disease?

The most important need is nutrition. What patients ask the most is "what can I actually eat?". There are a lot of trends in food, and what is considered best is always changing. Patients are always in doubt because they don't know what they can eat and think they can't eat anything. Making the right food choices is a major need.

It's all about lifestyle change. There's also the physical activity, and then therapeutics management.

We actually had a programme recently for cardiac rehabilitation where the great majority of patients had diabetes. We led group sessions for therapeutics management clarification and we always made an effort to explain the natural evolution of the disease, that even if don't need insulin right now, they might eventually because that is how the disease progresses, they need to understand that. Demystify therapeutics needs.

One time, the nutritionists and dieticians took patients in groups to *Continente* to help them shop for groceries and to interpret food labels and be able to tell the difference between foods. We make an effort to teach them by doing. That is how they learn.

They also had group sessions with physical activity.

1.1. Would you consider the community component to be relevant?

Peer communication is very powerful. Hearing from me what is happening with them and how the disease is going to progress is not the same as hearing it from someone who has been there. That is why the conversational maps are so important, we have a series of topics we want to address and let them do the rest.

2. What is missing for these patients in terms of disease management, if you were to create a service to help them self-manage, what would it be?

What they need is proximity, ease of access. They need to know where to go when in need and have people of reference, they are familiar with. It would have to be a service that the patients know they can go to in case of doubt. It would have to have group sessions, always.

Patients feel that they don't have the power. It is necessary to improve their self-confidence regarding disease management. There are several types of glucose meters, some that are smaller, some are less visible, etc. We try to choose the equipment for each person, if they have big hands and have some difficulty, we try to give them a bigger device with bigger

buttons, if they have poor vision, then we give them a device with greater contrast and a bigger screen.

My proposition is a service that gathers a patient front-end where they have access to several tools to self-manage and a healthcare professional front-end that gathers patient data and receives patient information in real-time.

3. **Would you recommend such a solution to patients?**

Sure, but needs vary greatly between patients and types of patients. There needs to be guidance. Also, if it has too many functionalities a person might end up not exploring everything. A great tool for patients would be something that could tell them what they are eating, where they can take a picture of food and have information about what's in it. It would be interesting to have functionality for them to upload pictures of what they eat and have a food diary.

4. **Do you think that continuous remote access to patients' clinical data is necessary? With alarms that less healthcare professionals know that clinical values are off?**

There has to be patient accountability. They must feel the responsibility is on their side. We shouldn't make it too easy to access the healthcare professionals because otherwise the patients lose the sense of responsibility of managing their disease. It has to be a balanced access; patients have to be able to fend for themselves and have the autonomy to manage most situations. Maybe if a system sends alarms to the nurses only after several instances where values were outside the desired thresholds.

Additionally, people might find it helpful to have notifications and alarms at first, but they eventually get tired of them and ask the nurses to turn them off. And not all people respond well to alarms, we don't turn them on for everyone. Nurses manage that, they adapt this type of functionality to the person, and to the moment as well.

Treatment varies greatly from person to person.

5. **Some patients would rather be medicated than go through the trouble of changing their life. What is your experience with these patients?**

It's important to give people knowledge and tools to make treatment decisions. In the end it's their decision, but we try to explain everything and the consequences of not following through. There are patients that, when told they might have to have their leg amputated, prefer to do whatever they feel like and make the best of everything before losing their leg than to try and slow the lesion progression. We have to ensure that they fully understand the circumstances.

When patients have just been diagnosed, before we talk to them about the disease, we first try to understand what they already know, because they have gone to google and gotten some wrong ideas that we won't be able to demystify unless we ask directly.

6. **What are the basic characteristics a service for people with diabetes would need to have in order to add value to patients?**

Education is the pillar of diabetes management. A multidisciplinary team, where everyone has sensibility to the needs of diabetic patients. Also, direct contact with the patients is important.

Appendix II – Doctor

1. **How do patients convey to physicians their daily health tracking?**

Patients have a hard time keeping records of their blood sugar. They come in with a bunch of papers with the values written on it and the time they took them. Many a time they forget to save them at all. During consultations it becomes difficult to understand what really went on in between visits. This makes it difficult for them and for us, the physicians.

2. **How do you feel about the nutrition aspect in T2D management?**

Us telling patients that they must eat more healthily does not work. People know that eating healthily is eating more vegetables and what not, but the hard part is getting them to act on it.

An initial evaluation is crucial to understand patient needs and to adapt the plan to patient literacy, availability and disposition to follow a dietary regimen. It also depends on patients' specific goals like weight loss or just becoming healthier or learning to count carbohydrates.

3. **What about other lifestyle related changes patients might need to tackle?**

Physical exercise might be even more important than nutrition because it is the hardest to change. Patients know somewhat how to change their diet but introducing physical activity is a greater change and it is more difficult to elicit any change bust just telling them they have to exercise.

4. **Do you have an opinion on using technology to engage these patients?**

Patients are all very different. Gamification is being widely used to change behaviour but, truth is, it does not work with everyone. No solution is universal. There is no one-size-fits-all solution in diabetes management. There are also programmes in the United States that have initial intensive coaching and then let patients go and just give them a phone app to keep data in order and nothing else; results are mixed, and this is not enough to prompt change long-term.

Appendix III – Testimonials

There are four key aspects to manage diabetes: vigilance, medication, nutrition and physical activity.

When I was first diagnosed, I was ashamed of having to measure glycaemia openly, I felt stigmatised, I felt people looking at me and I tried to conceal it. I was also told that I would have to go on a diet and start exercising. I was never able to lose any weight; I never caught on to the exercising thing, I tried at first, my wife tried to encourage me, but eventually I quit, it felt too lonely and I couldn't keep it up. My health wasn't great during this time and I didn't feel well.

Eventually, I received an invitation from the Spanish diabetic society to take part in a group activity – walking the Santiago de Compostela way – and, since then, I have been exercising regularly, with a group. We go for nature walks weekly, and we have group sessions to clear any doubts we may have with doctors and nurses as well.

I have found that the group spirit is crucial, it reduces the emotional load of the disease; that and the clinical guidance and support. The collective is of utmost importance and is very strong, it transforms the disease into a connection link between people.

When I was first diagnosed and was told I needed to make changes in my life, I didn't really pay much attention. I had always been fairly active, I did some sports, so I didn't really feel like changing. I just took the medication they prescribed, went to my quarterly consultations and never changed my lifestyle. I also had a normal HgA_{1c} level, so I assumed there were no consequences. I didn't feel the need to change.

After years of smoothly navigating the disease management, an injury made me have to stop exercising at all, I continued eating the same way, and my HgA_{1c} started increasing and my health took a turn for the worse. However, I had a long-time friend who was in similar circumstances to mine and he started getting worse. And it was all very quick, the way the disease developed, and, in no time, he died. After that, I took a hard look at my life and the way I was going, and I decided I needed to change. That is when I finally embraced the "diabetes lifestyle".

I joined a group with other people with diabetes, we have weekly meets, we go for runs, participate in races. I have since got my HbA_{1c} down to normal levels again and have actually stopped needing medication altogether. What is most important, the keys to living with diabetes are a physical activity plan, constant coaching, nutrition and information.