Exploring Needs and Designing an Interactive Service to Empower Home Dialysis Patients in their Everyday Life

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Abstract

The average life expectancy for people around the world is higher than ever before. Older people are at higher risk of suffering from chronic diseases, including chronic kidney disease. Patients with dysfunctional kidneys need dialysis. The main function of the kidneys is to clean the blood from waste products and excess water. In 2018, Sweden had 4101 dialysis patients of which 1026 had home dialysis. A dialysis patient has many things to keep track of regarding treatment, diet, and medication. The aim of this project is to investigate if an interactive product could empower home dialysis patients to make them more involved in their treatment and increase their quality of life.

To investigate this, twelve home dialysis patients and seven healthcare providers were interviewed. The data was analyzed using a thematic approach and based on the needs identified, concepts were generated. Personas and customer journey maps were used to evaluate them. Through an iterative design process using sketches, lo-fi and hi-fi prototypes, the final concept, *The Dialysis Master*, was created. *The Dialysis Master* is a health application which aims to help dialysis patients become, and motivate them to remain, a master of their own health. The hi-fi tests showed promising results regarding the concept and design, though it needs further testing by primary users.

In conclusion, there are many needs among home dialysis patients and there are many ways of empowering them. *The Dialysis Master* is empowering them in their everyday life by making them more involved in their treatment, give them a sense of control, and increase their quality of life.

Keywords: dialysis, empowerment, interaction design, user experience, thematic analysis

Sammanfattning

Medellivslängden för människor runt om i världen är högre än någonsin. Äldre personer löper högre risk för att drabbas av kroniska sjukdomar, inklusive kronisk njursjukdom. Patienter med dysfunktionella njurar behöver dialys. Njurarnas huvudfunktion är att rena blodet från restprodukter och överflödigt vatten. År 2018 hade Sverige 4101 dialyspatienter av vilka 1026 hade hemdialys. En dialyspatient har många saker att hålla reda på gällande behandling, diet och mediciner. Målet med det här projektet är att undersöka om en interaktiv produkt skulle kunna ge hemdialyspatienter egenmakt för att göra dem mer involverade i sin behandling och öka deras livskvalitet.

För att undersöka detta intervjuades tolv hemdialyspatienter och sju vårdgivare. Data analyseras på ett tematiskt tillvägagångsätt och baserat på de identifierade behoven genererades koncept. Personas och kundresor användes för att utvärdera dem. Genom en iterativ designprocess där skisser, lo-fi och hi-fi prototyper användes, skapades det slutgiltiga konceptet *DialysMästaren*. *DialysMästaren* är en hälsoapplikation som syftar till att hjälpa dialyspatienter att bli, och motivera dem till att förbli, en mästare över sin egen hälsa. hi-fi testerna visade lovande resultat gällande koncept och design, även om den behöver vidare testning av primära användare.

Avslutningsvis, det finns många behov bland hemdialyspatienter och det finns många sätt att ge dem egenmakt. *DialysMästaren* ger dem egenmakt i deras vardag genom att göra dem mer involverade i sin behandling, de får en känsla av kontroll och deras livskvalitet ökar.

Nyckelord: dialys, egenmakt, interaktionsdesign, användarupplevelse, tematisk analys

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Lund, June 2019

Ebba Ahlberg and Paula Carlsson

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List of acronyms and abbreviations

aAPD	assisted automated peritoneal dialysis
APD	automated peritoneal dialysis
ApoEx	ApoEx AB is a company which delivers medicines and consumable materials to clients in the private and public sector, for example hospitals [1].
AV	arteriovenous
CAPD	continuous ambulatory peritoneal dialysis
CKD	chronic kidney disease
ESRD	end-stage renal disease
HD	hemodialysis
HHD	home hemodialysis
Hi-fi	high-fidelity (prototype)
IHD	in-center hemodialysis
Itachi	Itachi is a computer system used for communication between medical staff and PD patients. The system monitors, for example, the patients' weight and blood pressure. This data can be viewed by the nurses in the system. Information about Itachi was obtained during an interview with a PD nurse.
Lo-fi	low-fidelity (prototype)
NxStage	NxStage System, developed by NxStage Medical, Inc., is a portable hemodialysis machine which can be used both during the day and at night. The machine was designed to be used in the patient's home, and is small enough for the patient to bring the machine with them when traveling [2].
PD	peritoneal dialysis
UX	user experience

1 Introduction

As of today, the average life expectancy for people all over the world is higher than ever before. With an aging population comes the challenges for the healthcare systems to meet the rising needs [3]. Older people are at higher risk of suffering from chronic diseases [3], including chronic kidney disease (CKD) [4]. As the work load increases for the hospitals, the economic challenges in meeting the rising demands become more difficult to address. About 10% of the world population are affected by CDK, and each year, millions of people die since they cannot afford the treatment needed [5].

The main function of the kidneys is to clean the blood from waste products and remove excess water [6]. People who suffer from dysfunctional kidneys or even renal failure need to undergo dialysis treatment. Their blood needs to be cleaned artificially since the kidneys are no longer capable of performing this task [7].

At the beginning of 2018, Sweden had 4101 chronical dialysis patients [8]. Of these patients, 3209 people had hemodialysis (HD) of which 134 performed home-hemodialysis (HHD) and 3075 performed hemodialysis at a dialysis unit [8]. There were 892 patients performing peritoneal dialysis (PD) [8].

People that suffer from chronical kidney failure will always be bound to treatments unless they get the opportunity to undergo kidney transplantation [6]. These treatments are time-consuming and the patient will also experience other restrictions in their life such as special diet due to their condition. Furthermore, if the treatment is performed at home, the patient alone is responsible of handling the treatment [9]. Though, by making patients more involved in their treatment, it gives them a sense of control which can increase their quality of life.

As of today, the healthcare sector faces many challenges such as high expenses, the incapability to provide healthcare for all citizens, and care of equal quality. Internet-based technologies have the potential to solve at least two of the major challenges - cost and patient latency [10]. The increased usage of internet could be utilized to reach more people to provide healthcare and education. It is also believed that these techniques can be used to reduce expenses in the healthcare system [10].

A major trend seen today, is the increased use of technology and digitalization. It is used in a wide range of industries. Statistics from 2018 show that about 90% [11, p. 8] of all Swedes has a smartphone and 98% [11, p. 9] of the population have internet access at home. Worldwide, the number of internet users has almost reached 3.9 billion [12, p. 2] people which corresponds to about half of the world's population [12, p. 2].

Due to the digitalization trend, patients' role in the healthcare system has changed in the last few years. These days, many patients can search for more information regarding symptoms, diseases, treatment, etc. on the internet. It gives them an opportunity to become more enlightened. However, it requires that the provided information is trustworthy, accurate, and sufficient, which is not always the case. It is therefore important that patients are introduced to reliable sources relevant to their level of knowledge and needs [13]. With more reliable techniques, patients can acquire more knowledge and be empowered. By taking an interaction approach and designing healthcare products with the users in the center, the products are more likely to deliver a good user experience and become more engaging and efficient to use [14, pp. 1-2]. If the developed product deliver services of good quality, it is more likely to be used. In addition, such a product will probably have the potential to stay on the market for a longer time period.

1.1 Project purpose

The main purpose of this master's thesis project is to investigate how dialysis patients can become more involved in their treatment with an interactive product. The focus will be on patients that perform their treatments at home. With the possibilities that interaction design and user experience offers, this project will have a user-centered approach. The process will be iterative with an early focus on the users. The aim of this project is to find a good answer to the following question:

How can an interactive product empower dialysis patients in their treatment and everyday life?

To answer the question, needs and requirements among the dialysis patients will be identified. Based on these needs different concepts will be generated to facilitate *patient empowerment*. The concepts will be evaluated and improved. They will be used to generate one or a few prototypes. These prototypes will also be tested and evaluated. The final design process can be seen in Figure 1.

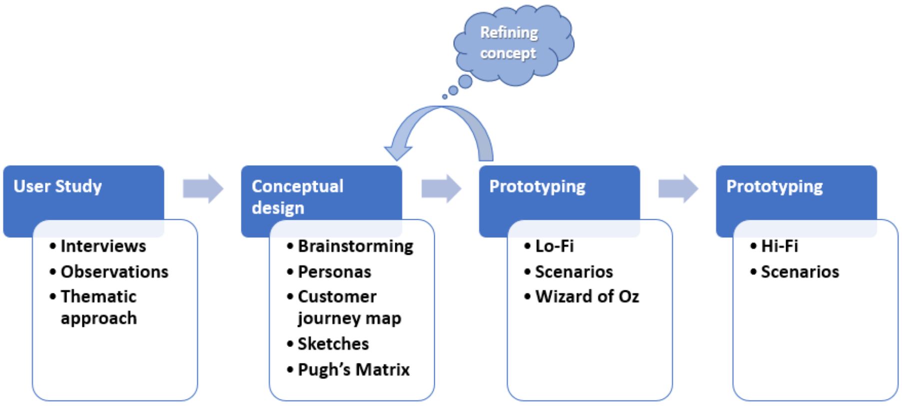


Figure 1. The blue boxes symbolize the different phases of the design process for this project and the white boxes include the used methods. These methods are described in the report. The arrows show the steps taken to reach the result.

1.1.1 Project limitations

In this project, the goal is to create a prototype of a product which could help empower home dialysis patients. Due to limited time, the aim is to create a prototype to test the overall concept and initial design ideas. All functionalities will not be tested and a final product will not be implemented in this project. Furthermore, the prototypes will not be tested by the primary users. This is one limitation of the project since, with more functions implemented and tests performed by primary users, the evaluation of the concept and design would be more extensive.

Due to the limited amount of people with home dialysis and regulations and legislations, such as patientdatalagen [15], that ensure patient protection, the primary target group is hard to reach. In this project, only people from the southern parts of Sweden will be interviewed. With more time and resources, more interviews could be performed, both in the south and in other parts of Sweden. More needs could then be identified and the final prototype may then look different.

1.2 About Baxter

This master's thesis project is conducted in collaboration with Baxter, at the office located in Lund, Sweden. More specifically, it is done in collaboration with the human factors team in Lund. On this site, the focus is on research and development of products for dialysis treatment. Baxter has products in many different healthcare areas such as nutritional care, surgical care, and renal care. The company has its headquarters in Deerfield, Illinois. It is a global healthcare company with a presence in more than 100 countries [16].

1.3 Report structure

At the beginning of the report, relevant background information for the project is provided to give the reader a solid knowledge base for the research. The structure of the report then follows the conducted design process, see Figure 1, which is divided into three phases: *User study*, *Conceptual design*, and *Prototyping*. Each phase follows the format of a method, a result, and a discussion. The design process is an iterative process, see Figure 1. Therefore, two iterations are presented in the phases *Conceptual design* and *Prototyping*. Towards the end, the major conclusions drawn are presented.

Methods and theoretical frameworks, that are already from the start evidently a need for this project, are presented in the following background section. The other methods, seen in Figure 1, are methods that were found to be necessary to use along the way of the process. A short description and a motivation for each choice of these methods will be provided later in this report.

1.4 Work distribution

During the project, the work has been divided equally between the two authors. Both authors have been involved in all parts of the project and have had continuous discussions to make progress. When writing the report, both authors have contributed equally.

2 Background

The background introduces the reader to the medical terminology and design methods that will be used later in the report. The aim is to help the reader gain an insight into what it means to be a dialysis patient, how they might differ from each other, and what some patients might have in common. Firstly, a short overview of the different treatment options for dialysis patients will be presented. Secondly, the expression "patient empowerment" will be explained. Thirdly, the background covers typical experiences, lifestyles, attitudes, and behaviors seen in patients with dialysis. Lastly, different theoretical frameworks for interaction design will be covered.

2.1 Treatment options

Patients with chronical kidney disease have several different treatment options. The patients can either receive a dialysis treatment or undergo kidney transplantation. In relation to the need, few kidneys are available, and most patients, therefore, have to receive dialysis treatments [17] [6]. In this report, the main focus will be on the patients performing dialysis at home. Two main techniques are used for dialysis treatments, hemodialysis, and peritoneal dialysis. These techniques will be described more in the following sections.

2.1.1 **Hemodialysis**

Hemodialysis (HD) is a technique used to clean the blood. To allow for a good blood access, the patient needs to have an arteriovenous (AV) fistula, a graft or a central catheter. From one of these access points, blood can be transported to a dialysis machine and be cleaned before entering the body again [9].

In the dialysis machine, the blood is filtered from waste products. The machine has a filter that contains a big number of capillaries through which blood passes. The capillary walls work as semi-permeable membranes. Waste products, such as urea and creatinine, diffuse over these membranes into the dialysate that flows on the other side of the membrane. Similarly, required substances can be added to the dialysate and diffuse over to the blood. To speed up the process, the dialysate and the blood flows in the opposite direction to each other [9].

HD treatments can be performed either at home (HHD) or in-center (IHD). Electricity and water are needed for both alternatives. When HHD is used, the patients are responsible for their treatments. They need to practice before they can do their treatments by themselves but they will become more flexible in when and how to do their treatments [9].

2.1.2 **Peritoneal dialysis**

Another way to clean the blood is though peritoneal dialysis (PD). In this technique, the patient's peritoneum is used as a filter. The patient needs to undergo a surgery where a catheter is put into the abdominal cavity. Through the catheter, dialysate can be led into the abdominal cavity. The waste products from the blood are filtered through osmosis [18].

When the dwell time is over, the concentration of waste products is similar on both sides of the peritonea which makes the filtration slow and inefficient. The old dialysate should then be drained through the catheter and replaced by fresh dialysate. The dialysate can have different concentrations of dextrose which is a form of sugar. Different individuals use dialysate with different dextrose concentrations. With very little or no dextrose, blood sugar will be withdrawn from the body. High dextrose concentrations in the dialysate will result in a higher blood sugar level. With a higher concentration level of sugar, more fluid can be withdrawn from the blood due to the osmotic gradient [18].

Two types of PD exist, continuous ambulatory dialysis (CAPD) and automated peritoneal dialysis (APD). Both are performed in the patient's home. In the former treatment, the patient manually has to change dialysate bags several times during the day. In latter treatment, the patient connects the catheter to a machine that automatically drains and refills dialysate. One form of APD is assisted APD (aAPD), where the dialysis is performed by a caregiver in the patient's home [18].

2.2 Patient empowerment

Patient empowerment is a central expression that will be used quite frequently in this project. WHO [19, p. 190] defines *patient empowerment* as:

> *"A process in which patients understand their role, are given the knowledge and skills by their health-care provider to perform a task in an environment that recognizes community and cultural differences and encourages patient participation."*

The concept aims to help the patients gain control over their lives by improving their decision-making and self-management. Several studies have been made in this field, for example, those described by Hung and Tsaya [20] and Ebrahimi et al. [21]. Empowerment programs have been tested on patients with several different chronic diseases and have indicated to be effective. The programs have also been specifically applied on end-stage renal disease (ESRD) patients and resulted in both mental and physical improvements [20] [21].

ESRD patients need to be aware of their health all the time. It requires a lot more than to just undergo dialysis treatments a few times a week. Compared to healthy people, these patients are much more restricted when it comes to what they eat and drink and how they live [9]. Studies suggest that *patient empowerment* can help patients feel like they have greater control over the health and help them stay motivated to maintain a healthy lifestyle [20] [21]. In general, empowered patients know much about their disease, and themselves.

Patient participation is another well-known term in the healthcare sector. According to WHO [19], this concept is being used to help patients get more involved in the decision making regarding their treatments. It allows patients to take more responsibility and it is concerned with the communication between the healthcare staff and the patients. Oftentimes *patient empowerment* is needed to achieve *patient participation* [19].

Internet and internet-based interventions have been used more and more in recent years to facilitate *patient empowerment*. Some benefits with the technique are that it is easily accessible both for the patient and healthcare workers and the interfaces can be interactive. Aaronson et al. [22] compare several studies to evaluate its effectiveness. Different studies have measured *patient empowerment* in different ways, yielding in results that are difficult to compare. Furthermore, Aaronson et al. [22] conclude that many studies face difficulties in establishing proper control groups. Sometimes both the test groups and the control groups have been given an intervention making it difficult to systematically produce accurate results when evaluating empowerment. However, there are several reports that support internet-based interactive interventions and its possibilities in empowering users [22].

2.3 Experience of starting with dialysis

People suffering from ESRD need dialysis for different reasons. Some of them have had enough kidney function for years before having to start with dialysis, while others need dialysis immediately, often as a result of trauma or acute illness [23]. In the ideal case, the decision to start with dialysis treatment should be made by the patient in consultation with nephrology healthcare professionals. If the situation is more acute, no such planning is possible and the dialysis treatment has to start right away. Unplanned dialysis starts can be described as a suboptimal start [23]. This means that these patients will not have the opportunity to mentally prepare for what it means to be dependent on dialysis and how it will impact their lives. About 50% of all dialysis initiations have a suboptimal character [23]. People starting dialysis treatment in a suboptimal way are more probable to experience stress, anxiety, and depression. This may also affect their choice of dialysis modality [23].

The number of training sessions for HHD is individual. According to Eggers et al. [24], the number of training sessions varies between 11 to 59 days. The article written by Bourbonnais et al. [23], describing the transition between having dialysis in-center to having it at home, reports that the average length of in-center dialysis is 5.6 months before transitioning to home dialysis. Initially, the participants that choose home dialysis treatment face many challenges in order to adapt to their new treatment. Bourbonnais et al. [23] identify five themes: living with loss, managing fear, needing support, getting informed, and living with hope. Living with loss includes the loss of health and kidney function, but also the loss of time and activities due to the treatment and everything around the treatment. Some patients also get a changed body image. Casey et al. [25] state that the need for vascular access when doing HD can be emotionally confronting for the patient. The vascular access is a visual reminder of the permanency of dialysis and a symbol of being sick.

Bourbonnais et al. [23] claim that when transitioning into home dialysis, many patients fear that their body might get harmed or that they will make mistakes managing their treatment. It is important that the patients have support throughout their home dialysis treatment, emotional support from people around them as well as functional support from healthcare professionals [23]. Another important source of support is other patients since they are all in the same situation and know what they are going through [26]. The quality of support during the first six months of home dialysis will influence whether the patient will continue with home dialysis or not [23]. The way of getting informed about their condition and how to treat it, needs to be clear and understandable. Bourbonnais et al. [23, p. 15] describe it as:

> *"In times of crisis, the delivery of information plays a great role in the patient's ability to understand, process, and use what is provided to make an informed decision".*

Finally, Bourbonnais et al. [23] claim that the possibility to get a transplant and to be able to live a normal life is a motivation for the patients.

2.4 Patient lifestyle

In home dialysis, the patients perform their treatment themselves at home [7]. With home dialysis, it is easier to fit the treatments into the patient's individual schedule and lifestyle [7]. Both HD and PD can be performed at home. In CAPD, one has to carry out three to five treatments per day, placing cleansing fluid into the belly and later drain the fluid [27]. APD treatment is commonly performed at night while sleeping and no treatment is needed during the day [27]. HHD treatment can be performed three to seven times a week, depending on the length of the treatment [7]. It can also be performed at night while sleeping. Every or every other month, the home dialysis patients visit the hospital to meet with their doctor or nurse [9].

When having home dialysis, the equipment needs to be stored at home [28]. This includes the machine as well as the non-recyclable products, such as dialysate. For convenience, some patients designate a specific room for dialysis. This can also be a way of avoiding a complete medicalization of the home. The impact of the dialysis treatment is not only evident from inside a patient's home, but also from the outside. The products needed for the treatment generate a lot of medical waste bags and empty cardboard boxes, which need to stored somewhere [28]. It can cause trouble depending on how often waste is disposed and how many people that share the same bins.

In general, it is easier to adapt the treatment into one’s life with home dialysis. Since dialysis cannot fully replace the function of the kidneys, it is important for people with renal disease find a balance between food, fluid intake, and medication to feel well [9]. It will be necessary to eat more high protein food since proteins in the blood transfers to the dialysis solution when on dialysis [9]. People performing dialysis need to eat less high salt, high potassium, and high phosphorous foods [29]. The daily fluid intake is restricted and how much the patient can drink is advised by a nurse or a doctor [9]. By reducing the amount of salt in the food, the patient will not be as thirsty. Potassium is needed for the muscles and nerves in the body to function properly, but too high levels of potassium in the blood can cause heart problems [9]. Phosphorous is an important component for the bone structure. Though, high levels of phosphorous in the blood may over time make the skeleton fragile [9]. A healthy kidney produces red blood cells, containing hemoglobin. If the blood does not contain enough red blood cells, medication is needed as a complement [18].

The benefits of HHD are the opportunity for a more frequent treatment which leads to improved blood pressure control, fewer diet restrictions, and less need for medication [30]. Apart from eating well, exercising is another key to obtain a healthier lifestyle. To exercise regularly is good for our body, which is applicable for people depending on dialysis as well [9]. Lighter exercise can be performed during the treatment such as bed gymnastics or bed cycling [9].

2.5 Patient attitude and behavior

Many renal patients have in common that they want to be involved in forming the outline of their treatment and not just simply follow professional advice [31]. They want to make sure that the treatment will fit into their everyday life to maintain their normal lifestyle. Polaschek [31] describes that when patients first start with home dialysis, they push the boundaries to see the effects of not following their treatment. They must learn their need for treatment to accept it and make the treatment part of their everyday life. Polaschek [31] also reports that, for patients to be able to control the symptoms caused by dialysis or to make the treatment fit into their regular life activities, they modify the treatment. In the end, they know their body best. The modifications could be due to the fact that the patients feel frustrated when they are not being consulted about therapy by healthcare professionals. Motivation from the individual life situation of the renal patient, such as close relationships, work, and personal attitude, have an impact on whether they will continue to perform their dialysis treatment carefully or not. When life is going well, dialysis is not a problem. General life situation influences the motivation of performing dialysis carefully [31].

For long-term dialysis survivors Curtin and Mapes [32] stress that:

> *"Successful self-managers are strongly motivated to act positively in their own best interests, to make decisions for themselves, to negotiate with healthcare professionals, and to exercise control over their own care and treatment."*

People choose home dialysis since it allows them to maintain a normal life where they do not have to travel to the hospital every week. Being responsible for the treatment improves the patients' physical and mental well-being. The independence gives them a sense of empowerment [33]. When they can control their own lives by managing their own treatment, they will feel less like patients which improves their quality of life [30]. Having support throughout the treatment is the most important aspect for people with home dialysis [33].

Bourbonnais et al. [33] state that the most common barrier to home dialysis is the burden of care. Other barriers with HHD could be the fear of needles and of feeling unqualified. The older people get, the more negative attitude they tend to have toward home dialysis and they tend to prefer in-center treatment. This negative attitude may be due to the decline in cognitive and physical abilities and the burden of care. Younger people tend to adjust to home dialysis more quickly compared to old people [33].

There are many benefits with home dialysis. To improve the collaboration between home dialysis patients and healthcare professionals, the communication needs to improve [31]. Patients will need to discuss alterations with their nurse or doctor to make sure that it does not affect their treatment in a negative way. Healthcare professionals need to be better at understanding patient attitudes and the interaction between treatment and lifestyle. The nurses interact with the patients extensively, which should make them able to identify the needs of each patient and help them in the way they need [31].

2.6 User experience (UX)

User experience (UX) plays a central role in interaction design [14]. UX is the experience the user gain from interacting with a product. The UX determines the overall perception the user will get about a product [34]. It is important to integrate the physical product with the digital ones in the best way possible to create a good UX [34]. In UX design, the focus lies on the quality of the UX, to ensure that the products created are meaningful to the users as well as being pleasant to use [14]. UX is a very wide term that covers many different aspects of design. To ensure a good UX, this report will focus on usability goals and well known design principles.

2.6.1 **Usability goals**

To create a good UX, interactive products need to be usable, meaning they should optimize the interactions between the user and the product to enable them to carry out different tasks [14]. According to the official ISO standard ISO 9241-11 [35], usability is defined as:

> *"The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."*

Usability can be broken down into six goals which will be reviewed in the following paragraphs. The goals are quite general, but they could be helpful as a starting point when generating questions about the product to be evaluated. These usability goals can also be used as a tool when designing for UX [14].

Effectiveness

The first goal aims to attain effectiveness. It is important that a product helps the user succeed with the intended task and purpose of the interaction. The product must provide the user with the right information and operations that result in high accuracy [14].

Efficiency

Another important goal is efficiency. The main purpose of this goal is to make sure that the product provides the user with operations that help them perform the task rapidly and remain productive. When using this goal for evaluation, it is important to consider the fact that some products take time to learn. Therefore, the initial interaction of a product might not be efficient. However, as time goes and the user gets comfortable the product might provide the user with more efficiency [14].

Safety

For good UX, the product needs to be safe to use. For higher safety, the design should prevent users from making mistakes, and if they do it should be easy for them to correct them [14].

Utility

Utility is another important goal when designing. When a product has good utility, it provides all functions the user needs to perform desired tasks [14].

Learnability

The fifth usability goal is learnability, which involves whether the design of a product makes it possible for the user to quickly learn how to use it. Learnability is an important factor to consider while designing a product since most people want to spend as little time as possible to learn new products. If there are functions in the product which are very time consuming to learn, there is a risk that those functions will not be used [14].

Memorability

The aim of the sixth goal is to design a product which supports the user so they do not have to memorize how to use it. If a product is not used continuously, it could be hard for the user to remember how to use it and the cognitive load on the user could be high which is why this goal is necessary to fulfill [14].

2.6.2 Norman’s design principles

The goal when designing an interactive product is to create a good UX. This can be accomplished by applying design principles [14]. There are many design principles and Donald Norman provides the following six: visibility, feedback, affordance, mapping, constraints, and consistency [36].

Visibility

It is important for the designer to help the user see all the options and possibilities the interactive product provide. Important operations should not be hidden to the user. Instead, it is important that the user with ease both see the functionality and understand how to use it. Donald Norman [36] describes it as:

> *“The mapping between the intended actions (what you want to do) and the actual operations (what is possible to do).”*

Feedback

When the user interacts with the product and executes operations (for example, pressing a button), it is important that the system provides the user with relevant system outputs. With feedback, such as audio, verbal, or visual feedback, the user will know the result of their action [14].

Affordance

With affordance, the user is given clues about how to use an object. For example, a door handle invites to be pushed down [36].

Mapping

Mapping refers to the design of controls to make sure that they reflect the results achieved when using them. One example is the controls on the stove. With good mapping, the user will easily understand which button controls which stove plate [36].

Constraints

Constraints are restrictions in the design which decides the interactions the user can and cannot do using the interface. Constraints will reduce the risk for the user to make mistakes, by not presenting improper options. One example is to only be able to use numbers, and not letters, when filling out the weight of something [14].

Consistency

In a consistent design, the same action should always give the same response. For example, when pressing the “back” button, the user should always return to the previous page. When the user recognizes the consistency in the design, it will be easier for them to know how to use the product [14].

2.6.3 Nielsen’s heuristics

Using Nielsen’s heuristics, user interfaces can be evaluated to find out whether they conform to existing design principles [14]. The ten usability heuristics for user interface design cited below are developed by Jakob Nielsen and his colleagues [37].

> ***Visibility of system status***
>
> *The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.*
>
> ***Match between system and the real world***
>
> *The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.*

User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing.

Error prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

Recognition rather than recall

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Flexibility and efficiency of use

Accelerators - unseen by the novice user - may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information

> *should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.*

2.7 Customer journey map

According to Bitner MJ et al. [38], customer journey mapping can be used to extract interactions, known as touchpoints, between the customer and different channels, such as an organization or a service. The goal is to generate a visual representation of all the interactions a customer has. A map can then help the designers gain a better understanding of their customers and the customers' needs can then more easily be recognized. It can help designers to see what changes they can do in their design to correct their services accordingly [39].

A disadvantage with the customer journey map is that while creating it, there might be an insufficient focus on the customer. Experts might not fully understand the issues a customer has [40]. To make a good map, it is therefore important to involve the customer when creating it. It is the customer's perspective that should be in focus. From a user study, information about the potential users can be collected. This information can typically be utilized to identify important touchpoints between the user and different stakeholders or products. Another way to discover the touchpoints is by asking the users themselves. After extracting the touchpoints, the map can be formed. One way to create a map is in a graph. The x-axis will present the past time of the journey and the different channels that the user interact with will be lined up on the y-axis. In the graph the different touchpoints will be marked out and by generating a story different lines can be drawn between the touchpoints [34].

Customer journey and customer experience are two closely related expressions. By optimizing a customer's journey, the overall customer experience can be increased. Depending on what the different touchpoints look like over the customer journey, the customer will have different experiences. A trend among many companies today is to focus on customer experience. It is thought that a good customer experience, will result in a stronger relationship with the customer. The interest in creating momentous experiences for the customer is big. The traditional physical products may not deliver enough customer value. Instead, companies develop additional intangible products such as surrounding services. To understand and evaluate customer experience it is important to work systematically and use robust and reliable techniques and methods [38].

Many different definitions of customer experience are used. It makes it difficult for different companies and designers to fully understand and evaluate it. Furthermore, the complexity of customer journeys is increasing. These days, customers are getting involved with an increasing number of touchpoints [40]. In addition, many new customer channels have been introduced in the society today [40]. Depending on what channel the customer decides to use, their journeys might take very different turns. Since many different channels exist, it might make it difficult to plot the correct customer journey and to find the most optimal one. However, to generate promising ideas of products or services, it is of great importance to map good customer journeys. This can be done by working systematically and utilize reliable methods [38].

3 User study

A user study was made to get more familiar with what it means to be a dialysis patient. In this part of the project, data was gathered about the potential users' needs and experiences. The aim was to find common needs and trends among the users that would be of value when establishing requirements for the interactive design later in the project. The user study in this report is divided into three main sections. These are the method used in the user study, the derived result and discussion about the data gathering method.

3.1 Method

3.1.1 **Research design**

To gather enough data, semi-structured interviews [14, pp. 234-35] were carried out. Main questions had been prepared to gather qualitative data from the interviews. In case the interviewees were to give narrow answers, sub-questions had been prepared as well. Both the main and the sub-questions were pilot tested. Most of the questions asked were of exploratory character and can be seen in Appendix A. If unexpected and interesting topics arose during the interviews, a few unprepared questions were asked. The goal was to gather rich data about the interviewees' experiences and views on the topics.

Before the interviews, the participants were asked to sign the informed consent form seen in Appendix B. Both the primary users i.e. home dialysis patients and potential secondary users i.e. nurses and doctors were interviewed. To further understand the users and get an insight in their daily environment, observations [14, p. 252] were made in the patients' homes. The second part of the research design includes how the data was analyzed. Thematic analysis [41] was used in this study to analyze the qualitative data. This method was used to get an objective analysis of the data and to eliminate the influence of the writers' own opinions. With this method, the data from the interviews were segmented. Similar data were gathered and formed themes. By reviewing the data and the themes in an iterative yet systematic way, representative themes were established in a bottom-up approach.

3.1.2 **Participants**

During the data gathering, twelve patients, five nurses, one assistant nurse, and one senior physician in nephrology were interviewed, see Figure 2. Eight male patients and four female patients were interviewed and the age of them varied from 41-85 years (mean = 63.6 years old). Eight patients lived together with someone else, and four patients lived alone. Seven patients lived in houses and five patients lived in apartments. All patients lived in the southern region of Sweden. The time it takes for the patients to travel to the hospital varied from seven minutes to one hour. Five patients had HHD. Seven patients had PD, of which three patients had APD, two had CAPD, and two had both CAPD and APD.

Three nurses and one assistant nurse working with HHD patients, one nurse working with PD patients, and one nurse working with IHD patients were interviewed. They had between 4-39 years of experience with dialysis care. The HHD nurses and the PD nurse had between 1.5-14 years of experience with home dialysis patients. A senior physician who had been a specialist in nephrology for 32 years was interviewed. The senior physician had been working with home dialysis patients for eight years. All healthcare professionals interviewed were females.

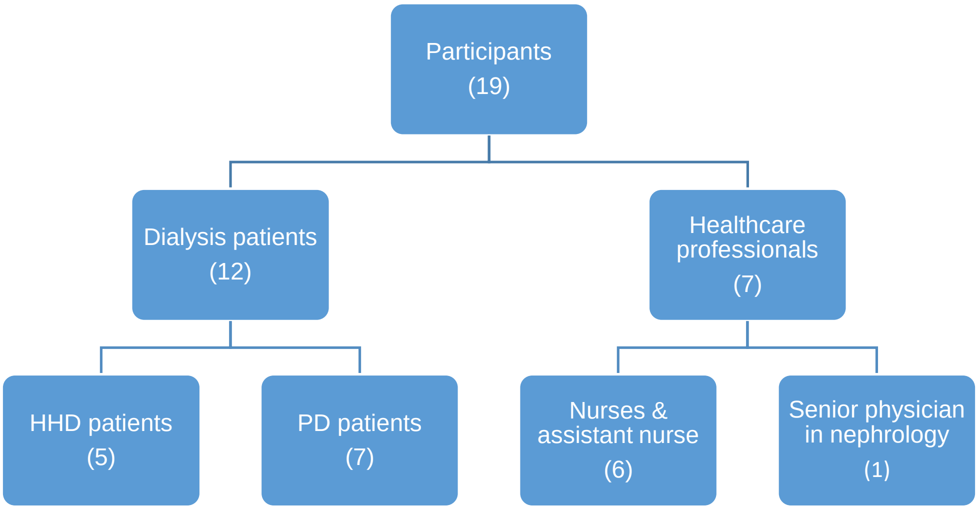


Figure 2. Hierarchy diagram visualizing the participants in the user study. The numbers in the brackets represent the number of participants within that category.

3.1.3 **Data collection**

The average interview time for the patients was one hour. For the nurses and senior physician, the average interview time was 40 minutes. For ten of the patients, the interviews took place in the user context i.e. their homes, and two patients had phone interviews. For the interviews made in the user context, observations were made and photos were taken. The interviews with three of the nurses and the senior physician took place at a university hospital, and interviews with two nurses and one assistant nurse at a local hospital. Both hospitals are located in southern Sweden. The interviews were conducted in 2019 from the middle of February to the beginning of March. The main topics discussed were: treatments, relationships, experiences, lifestyles, and techniques.

3.1.4 **Data analysis**

A thematic approach was used to analyze qualitative data [41]. All the interviews were recorded. These audio files were used to transcribe the interviews, see Figure 3. All the interviews were thereafter re-read and initial codes were generated from the transcripts. The coding was made by highlighting important parts of the texts. All interviews and questions were given the same amount of attention. In the same phase of the data analysis, reflections were written down and attached to those parts of the text they referred to.

Figure 3. One step in the process of establishing themes from the data. The theme names are written on the big yellow notes, the highlighted parts are the codes, and the small yellow notes are reflections made during the analysis.

The codes were then further analyzed. Common subjects were identified from the codes. The answers in the transcripts were divided into different segments. Data concerned with similar topics were gathered and placed in the same bundle. The bundles represented potential themes. It was an iterative part of the analysis. When the initial themes were established, the themes were reviewed. Data within the theme was re-read and compared but data was also compared and re-viewed inter-themes. By using this method, the data was divided into consistent and distinctive themes, see Figure 3. Some data segments had to be moved into other themes, themes were combined, and some themes were divided. The names of the themes were then reviewed and refined and the content of the themes was finalized.

3.1.5 **Ethical considerations**

Before the interviews were performed, the participants were informed about the study, that they could withdraw from the study at any time, without being asked any questions. The participation was voluntary which also meant that the interviewees could skip questions. The participants signed an informed consent form, see Appendix B. In the informed consent form, the patients were informed that the interview would be a freer conversation about their perceived problems and needs in everyday life. It also said that if the patients agree, the interview would be audio recorded to ensure a correct interpretation of the conversation. If they gave their consent, photos would also be taken of their dialysis equipment in their home environment. The data was handled confidentially which meant that only the ones involved in the study had access to the gathered data. The patients were also promised to remain completely anonymous. After the project, the audio files and transcripts will be deleted.

3.2 Results

In the data collected from the interviews, 17 themes were identified, see Table 1. Each theme is described in the following text as well as general comments about them.

Table 1. Themes identified from the data collected in the user study.

Theme	***Description***
Travel	Describes limitations and restrictions dialysis patients experience concerning traveling.
Ordering Dialysis Equipment	This theme expresses the experience of ordering dialysis equipment, both from the patients' and healthcare workers' perspective.
Waste and storage	Reports the problems concerning the large amount of waste generated and storage needed for home dialysis.
Physical and mental limitations	Exemplifies the physical and mental limitations of the patients which must be considered when designing.
Exercise	Describes the level of exercise among the patients interviewed.
Diet	Expresses what dialysis patients need to have in mind concerning what to eat and drink.
Medication	This theme describes what kind of medication dialysis patients have.
Tests	Outlines which tests patients take to monitor their health and treatments.
Work	Reports the experiences patients gain when continuing working after starting with home dialysis.
Relatives and friends	Covers the involvement and understanding of the patients' relatives and friends concerning the dialysis treatment.
Contact network	Involves the patients' private network and whether they want to expand it.
Hospital	Describes which services the hospital can and cannot offer for dialysis patients.
Noise from the machine	Includes noise coming from the dialysis machine, such as alarms.
Treatment decision	Exemplifies factors which can affect the patient's decision of treatment.
Training	This theme describes the training process needed for the patients to learn to manage their treatment themselves.
Quality of life	Expresses the quality of life of home dialysis patients and how it has been affected by the treatment.
Technology	Clarifies what kinds of technologies the patients are currently using and familiar with.

3.2.1 **Travel**

Dialysis patients need their treatments to survive and therefore they must adjust their lives accordingly. One of the common topics discussed during the interviews was traveling and the patients' different experiences related to this. The theme includes opinions regarding both short trips and longer ones.

Nine of the patients saw it as a freedom to have the treatment in their home since they do not have to travel to the hospital as often. One argument was the flexibility of being able to decide when to perform the treatment. If the patients want IHD they need to adjust their schedule to the appointment they are given. At home, they can be more flexible in when, both regarding the time and the day, to start the treatment. Another argument was the time they save on not having to travel to the hospital. One patient said:

> *"I get more dialysis compared to when I have to travel to the hospital where a lot of time is spent to get there. That time, I now use on my dialysis instead."*

Data show that the patients who have the flexibility to choose the time and place for the treatment, help them in daily activities. One HD patient said:

> *"Now I run it yesterday, which is normally a free day, but it is because there is a board meeting tonight. I realized that it is better to skip it tonight so that is why I ran it yesterday and I will run it tomorrow."*

Another benefit extracted from three different interviews, is that by having the treatment in their home, the patients' do not need to plan, book and wait for taxi services. One patient said:

> *"It is not sure that you will arrive at home at the time you think or that a car will come".*

The comment gives a view of distrust in the taxi systems. Furthermore, another patient said:

> *"…however, you are so tired afterward, so it is not very suitable for you to drive".*

This patient was referring to how tired they can be after a dialysis treatment and how patients might be dependent on the taxi services.

Six patients mentioned the inability to travel spontaneously. One of the patients even said:

> *"Yes, the lifestyle is that you do not travel anywhere. You stay close to home, at least in Skåne, further than that is not so fun to travel."*

The same patient used to travel before starting with dialysis. When it comes to longer travels one common problem identified for patients is the need for thorough planning. The planning includes much contact with the hospital since they, for instance, need certification papers to travel. The patients need to take blood tests before and after the trips to check for contagions. Patients with HD need to find dialysis units that offer guest dialysis. In these interviews, it also became clear that depending on the different locations, the difficulty in finding available guest dialysis seats varied. Two nurses mentioned that it is easier to find available seats for guest dialysis in foreign countries. They said that in Sweden, there is a lack of seats, especially in the tourist towns. PD patients are, on the other hand, more flexible when it comes to where they can perform their dialysis since they can perform their treatments at many different places. One patient said:

> *"If you are the one organizing the trip, and that you are driving in Sweden, then it is just to load the car."*

However, a PD patient might have to order equipment and medicine to the address they are going to visit, especially if they are going to stay there for a longer time period. They also need to make sure that there is enough space for these boxes. It requires another form of planning. HD patients who use NxStage machines face similar problems. This machine is considered mobile and can be used together with dialysate bags like those used for PD. One patient who just recently got a NxStage machine was talking about traveling abroad:

> *"I think there are some restrictions… haha… to dare to take a chance… What if the stuff does not reach the destination. No, I would rather order guest dialysis."*

Another well experienced patient, with positive experiences traveling with the NxStage, said:

> *"I rather stop traveling than to go on vacation and have in-center dialysis there."*

3.2.1.1 Comments

The major need identified in this theme was the need for making it easier for dialysis patients to travel. Six patients mentioned that they found it hard to travel spontaneously since it requires a lot of planning. Some patients experienced that they were traveling less compared to before starting with dialysis. By providing a service which facilitates for dialysis patients to travel, they would not feel as restricted which could increase their quality of life.

3.2.2 **Ordering dialysis equipment**

This theme expresses the patients' and healthcare workers' experience of orders for treatment equipment and medicine. There are several problems around the subject "order" expressed in the data. One patient makes orders every week, nine of the patients make orders every 14th day and two patients do it less often. Seven of the patients said they order from the computer, one patient makes the orders by phone, and another patient said the healthcare workers make the order. Five patients mentioned that they need to be at home when the delivery comes. One patient arranged so that the delivery men can place it in another building if the patient is not at home, and another patient orders every 3rd month to decrease the amount of times the patient needs to be at home to receive the orders. One patient mentioned that it takes time to receive the delivery. The patient was not able to go on a work trip to Germany since it was decided on short notice.

The senior physician in nephrology thinks the new ApoEx system is more troublesome than the previous one. Before, the nurses made the orders. However, with the new system, the doctors now need to write prescriptions before the order can be made. Two nurses pointed out that it also can be difficult for the patient. One said:

> *"Sometimes they forget to order something. Then they have to call us so that we can deliver it to them".*

Two patients have expressed the difficulty of keeping track of all the articles that need to be ordered. One of them mentioned that the difficulty lays in that the boxes do not contain the same number of articles. During the interview, the patient said:

> *"It makes it so that when you must order, it is difficult. You need to stand and think. How many are there left at home? How many is there in a new box? What do I need then? And that calculation you need to do every time you shall make an order since it does not match."*

A third patient also brought up the number of articles in the boxes does not even out with the treatment.

Two patients were displeased with the webpage from which you make the orders. They said that the page was not mobile- and iPad-friendly. Three patients also said that some of the equipment cannot be ordered from the webpage. Instead, they need to pick it up at the hospital.

3.2.2.1 Comments

It was noticed that patients found it to be unnecessarily hard to place orders. Most of the patients order every 14th day, and a simpler system could, therefore, make a lot of difference. Furthermore, the patients need to be at home to receive deliveries which limit them. This is a touchpoint in a customer journey that needs to be changed and improved.

3.2.3 **Waste and storage**

This theme covers the problems home dialysis patients face considering the waste produced from the treatment and storage of the machine, disposable products, and waste. The theme was recurring in many of the interviews for both patients and nurses, and was identified as an overall disadvantage with home dialysis.

Five patients identified the amount of waste and storage as the worst part of having dialysis at home. Other patients also saw this as a problem. One patient said:

> *"Yes, the waste! It is true! You have no idea about how much plastic there is from the dialysate bags and the cardboard boxes and… You have no idea, there is a lot of waste!"*

Two of them mentioned that they take care of the waste themselves even though it could be taken cared of for them. One of them had a son that found it easier to drive to the rubbish dump instead of having to fold the cardboard boxes and glue them together for them to be picked up. The other one felt sorry for the people delivering goods to have to take care of it.

All the patients interviewed see the benefits of having home dialysis. Though, eleven out of twelve people said that it requires a lot of space. Two nurses pointed out that one of the reasons for patients not wanting to have home dialysis is due to lack of storage space. One patient was appalled about all the cardboard boxes to store. Two patients assess that it requires about half a room to store all the equipment needed. Two patient mentioned, and it was observed in other patients' homes as well, that they found it necessary to store extra equipment such as dialysate at home, to prevent them from running out if there would not be a delivery.

Home dialysis is not suitable for everyone and one patient said:

> *"But if you live in the city maybe it is as easy to go to the hospital or to get there and then you do not have to have all of this at home. It does require a lot of space".*

One of the nurses pointed out that it could be hard to find a solution if the living space is very small, but the technicians are good at finding solutions.

3.2.3.1 Comments

One of the major issues about home dialysis is that it requires a lot of space to store the equipment needed. There is a need for reducing the amount of equipment that the patients must store at home. Baxter is currently working on a solution to solve the storage problem, and will therefore not be further explored within this project. Many of the patients keep extra supplies of equipment at home, in case something about the order will go wrong. They might forget to order, or the delivery might not arrive. With a better ordering system, the patient will not have to worry as much.

3.2.4 **Physical and mental limitations**

This theme shows the similarities and dissimilarities between the different patients when it comes to their physical and mental limitations. One nurse said that a common limitation for several patients is the memory. The nurse specifically talked about the difficulty for people to remember in which order to do things regarding the treatment. Two of the interviewed patients mentioned that they had mental limitations. In both cases, these limitations had appeared due to other diseases and medical complications.

Many patients mentioned week muscles. Three patients specifically felt restricted in lifting heavy objects such as dialysis machines. One patient said:

> *"Even if it is classified as portable (handheld), it is more draggable. If you do not have an elevator it does not work to carry it in the stairs."*

One patient experienced a strength loss in the hands. This was something one nurse also mentioned, that sometimes patients can experience difficulties in performing certain steps in the treatment due to hand weakness. Two nurses mentioned that patients might have issues with certain steps of the treatment due to poor dexterity. An aAPD patient mentioned that quivery was the main reason why the patient had not practiced to perform the dialysis. Six patients mentioned that they had experienced difficulties in walking. The reasons were both muscle weakness and balance. However, two of them had improved their walking significantly by exercising. Five patients said they feel more tired these days. Another restriction commented on was the body temperature. Two patients said that they often tend to get cold these days, both perform HD treatments.

Two nurses said that, for the APD patients, the catheter could be a problem. One patient missed being able to move around when sleeping. One of the nurses said:

> *"Is it a younger patient then they say: "No, never ever that I will have a machine at night." Then, some of the patients are probably thinking - and now I am prejudiced when I say the younger generation but it is usually the younger ones who say this - then they think about sexuality. When you connect yourself to the machine, then you become fixed with a tube."*

3.2.4.1 Comments

It was realized that many of the dialysis patients are not only having problems with their kidneys, but often suffer from other diseases as well. The most common physical limitations identified was less energy, trouble walking, and weak muscles. These limitations, as well as mental limitations, need to be taken into consideration when generating concepts. Many of the patients are older, which should also be taken into account in the design process.

3.2.5 **Exercise**

This theme describes whether people performing home dialysis are exercising to some extent. Questions were asked to find out the degree of exercising performed and why some patients were not exercising.

One patient out of the twelve patients interviewed, was playing badminton and taking five kilometers walks regularly. A senior physician in nephrology stated that exercise is very important for dialysis patients for them to get more energy and to feel normal. All people can go to the gym, including people with kidney diseases. Two patients said they felt better and had more energy when exercising. Every time the senior physician meets the patients, physical activity is encouraged. It was suggested that a workout program when sitting down could be a way of encouraging patients to exercise more during dialysis.

Six patients explained that they tried to exercise as much as they could, considering their condition. One patient who was taking long walks regularly mentioned that during winter time, hands and feet got cold which made the patient less willing to take walks during this time of the year. Another patient was unmotivated to exercise during winter time when the weather is not good.

Five patients said they were barely exercising due to different reasons. Three patients had trouble walking. Another patient was not exercising due to weak leg muscles. This patient had a stationary bike at home, and was planning to start using it since the physiotherapist at the hospital had said that two minutes on the bike each day was enough to start with. One patient felt limited due to the PD catheter and had stopped going to the gym because of it. Nurses were helping to change the bandage for the catheter two times a week, and the patient could only shower before these two visits.

3.2.5.1 Comments

A trend identified within this theme is the fact that many dialysis patients are exercising less compared to before starting with dialysis. Dialysis is an energy draining treatment, which together with physical limitations, contribute to a less active life. A need would be to motivate more physical activity.

3.2.6 **Diet**

This theme describes what a dialysis patient need to think about concerning what to eat and how much to drink. Some substances are toxic for them and many of them have restricted fluid intake. The advantage with home dialysis is that the patients can do dialysis more often and longer treatments compared to at the hospital, and are therefore not as restricted in what they eat and drink. One nurse said:

> *"They know that, "I can drink some extra today and then I run dialysis thirty minutes longer, then it will be fine"."*

Eight patients said that they have a diet. For at least two of these patients, they had trouble remembering exactly what not to eat and why they should not eat it. One of them said:

> *"Yes, I should not eat nuts. And I should not eat too much pea soup for example. But sometimes I forget why. I have just adjusted my lifestyle."*

One patient also mentioned that the diet restriction could look different depending on your current treatment. Four patients stated that they had no diet to follow, but three of them then said that they had some restrictions in for example fluid and salt intake. Five patients said that they should eat enough protein. Five patient found it a bit hard to follow the restrictions of food and fluid intake. One patient said:

> *"And not to drink milk, milk products, I have to minimize this intake. And I am having a hard time doing that. So, that test result is usually high on me."*

Three of them said that if their blood test results were good, then they could eat what they wanted.

Two patients and one nurse said that the surrounding people can have an impact on how likely a patient is to follow the restrictions. The nurse said:

> *"Well, it is really important that the patient has a family, wife, husband, children or friends who understand that the patient should not be tempted to eat soups and drink a lot all the time. You could, if you invite a dialysis patient to your home, offer some more solid food."*

One patient said:

> *"The hardest part is this drinking culture we have here in Sweden, that you should always sit down and drink something every time you meet…"*

At the same time, two patients said that they adjusted their diet because if they eat certain things, such as a big pizza, then they will not feel good.

3.2.6.1 Comments

Eight patients said that they had a diet and four patients said they did not. This raised some questions about whether it is the word 'diet' that the patients do not want to use, or they do not have a diet. Are they not aware or not sure that they have a diet? Some of the data indicate that they are not sure, and hence need more information. It could also be that the patient might associate diet to unhealth and then the kidney disease becomes more apparent. It was found that some of the patients had trouble adapting to restrictions, and that these restrictions could vary depending on the treatment. A service could possibly make this easier as well as motivating the patients to follow the restrictions. Test results, such as blood tests and blood pressure, could be used to increase the understanding of how food and fluid intake affect the test results.

3.2.7 **Medication**

This theme describes what kind of medication dialysis patients have. Two APD patients who ran the machine nighttime said that they took a sleeping pill to fall asleep easier. Three PD patients mentioned that they took diuretic tablets to remove excess fluid from the body. Two patients said they used a pill organizer box to keep track of what pills to take. These two patients were 79 and 85 years old and the pills were organized by a partner or nurse. One patient mentioned that it was hard to keep track of the expiration date of all medical prescriptions and that a nurse helped with this.

Two patients and one nurse pointed out that dialysis patients must take a lot of pills as part of their treatment. A senior physician in nephrology said:

> *"There will be about 20-30 pills plus your blood pressure medication. And then I think it is natural that you, so to say, cut down that amount."*

Therefore, the senior physician said that it is important for the patients to understand why they should take all the pills. It was suggested that if the patient could see the connection between a symptom, the test results, the treatment, and a pill, then it would be easier for the patient to understand the effect of their medication. If the patients could see the connection, they would become more motivated to take all the pills. For example, some pills must be taken in connection to meals. Then it is important for the patients to understand the importance of bringing the pills with them since they have no effect if taken one hour after the meal. One patient often forgot to bring these pills. Both nurses and the physician point out how important it is for the patients to understand the effect of medication on their well-being.

3.2.7.1 Comments

Dialysis patients must take many pills as part of their treatment. Diet, exercise, and dialysis treatment could influence the number of pills the patients must take. By motivating the patients to follow recommendations and information about diet, exercise and dialysis treatment, the number of pills could be decreased. Though, some of the medication is necessary, and therefore they need to be motivated to take those pills. There could also be a need for patients to be reminded about taking their medicine.

3.2.8 **Tests**

This theme shows the degree to which patients utilize different tests and test results to monitor their health and treatments. Occasionally all patients are sent an invitation to visit the hospital. During these visits, the patients meet their doctors to discuss their health and treatments. A senior physician in nephrology said that blood tests are checked together with the patients during the visits. The physician said:

> *"It is far from all places where they do this. It is something that I have introduced here because I think they should get this feedback."*

Beyond these meetings, the patients do not have access to the test results and this feedback. It was also mentioned that doctors also observe the tests in between the visits. If the values are normal, they do not contact the patient, which is something the physician thinks is wrong. Instead, the senior physician would like to see reactions to all the tests studied.

One patient said:

> *"I might not have been able to understand this myself without my doctor's inspection of the tests. Even if the normal values and what I have is written on these notes, there are some values that are allowed to backfire. Those are values that do not have much importance for me and my dialysis. That is something I am not aware of."*

Three other patients have specifically said that they think the doctors keep a better track of their treatment results. One of them said:

> *"It is, of course, the doctor who is more aware, I have not really familiarized myself in all these tests and such. That is something that I could become better at. I could adjust myself to the test results if I get too high values."*

Other patients have shown more interests in their test results. Four patients said that they have good values which makes it okay for them to skip treatment or be more flexible regarding their food consumption for special occasions. One patient monitor the test results to meet the requirements for transplantation.

Three patients let healthcare providers take blood samples. Another patient switch between the two options of doing it oneself and letting healthcare workers do it. The same person tended to forget taking these tests. Two patients mentioned that they take blood tests by themselves. Both then drive on their own to the healthcare center to deliver the tests. One of these patients said:

> *"I do not really trust the mail service."*

The patients monitor their health in other ways too. Some of the mentioned parameters are their weight, blood pressure and more specific parameters related to their treatments (dialysate concentrations, filtration rates etc.).

3.2.8.1 Comments

As described in Section 2.5, home dialysis patients are in greater control of their lives compared to patients at the hospital. They are usually more motivated to maintain a healthy lifestyle and since they can perform more frequent treatments compared to at the hospital, they are less restricted. From the interviews, it was found that patients with more knowledge about their test results can be more flexible with their treatment. They can, for example, skip one treatment if necessary, and they can eat and drink with fewer restrictions. Four patients said that their doctor has better knowledge about test results than the patients do. This indicates that there is a need for the patients to gain more insight into their test results, to become empowered and be able to be more flexible.

3.2.9 **Work**

This theme involves the experiences patients gain when continuing working after starting with home dialysis. Three patients were working, one CAPD patient worked full-time, one CAPD patient worked two days a week and one HHD patient worked one day a week. The patient working one day a week said that the colleagues do not mind about the dialysis and that they do not seem to know what it is. The patient working two days a week feels like the closest colleague understands the situation, whereas the boss does not seem to understand. For the patient working full-time, the colleagues are not bothered by the dialysis and have adapted their work to allow for dialysis treatment. The patient said:

> *"Some meetings take place in my room instead. Since I cannot leave when I am connected…".*

This patient also mentioned that the advantage of continuing working is the social part. One patient answered the question about what he or she missed the most from the time before dialysis as following:

> *"My work. Working."*

The experience of a nurse working with PD patients was that they are usually able to do dialysis at work without trouble. In the nurse's experience, many dialysis patients only enlighten their boss about their disease and treatment, and not colleagues.

One senior physician in nephrology and four nurses said that it is quite common for home dialysis patients to continue working after starting with their treatment. Two of the nurses pointed out that it is not always full-time. A nurse said that dialysis is like a part-time job. It was also mentioned that if a patient lives close to a hospital, it could be more time efficient to have IHD since nurses will prepare the machine which will save some time. One nurse working with IHD patients said that it is not common for patients to continue working since they get so tired from the treatment. A nurse working with PD patients pointed out that many of the PD patients are older than 65 years, and are therefore not working.

One patient faced some challenges when wanting to work 60%. The patient said:

> *"I started working half-time. Then I wanted, when I was doing hemodialysis I was there three times a week. I went there on Tuesday, Thursday, and Saturday, which meant I could work three full days per week. But you cannot work, you cannot work 60%. You can only work 50, 75 or 100, or well 25 as well. It was not possible."*

The patient said this was due to regulations. Another patient mentioned having problems with sickness compensation. One nurse, one patient, and one senior physician also said that in their experience there could be problems with health insurance and sickness compensation. The senior physician said:

> *"…the Swedish Social Insurance Agency can be troublesome sometimes, they do not understand that there is a new law that says that you have the right to be on sick leave full-time if you have dialysis treatment. And they are bothering some people."*

3.2.9.1 Comments

From this theme, it was found that more information needs to be provided for work colleges and bosses for them to better understand the needs of a dialysis patient.

3.2.10 **Relatives and friends**

This theme covers the involvement and understanding of relatives and friends to home dialysis patients. Dialysis is a time-consuming treatment and the entire family is affected by it to some extent. One nurse said:

> *"If the family does not - wife, husband, children - understand that mom or dad has a kidney disease and need their treatment, then it can be hard to fit the treatment into their spare time. The family may not accept the time the treatment takes."*

Another nurse said:

> *"If the relatives resist, the patients will not come home."*

Another nurse added:

> *"It is teamwork. They have to be on the same page."*

Five nurses and one senior physician said that they try to involve the relatives in the treatment, and are positive when they want to participate.

Five patients said that their relatives were involved in the decision to have home dialysis. For six patients, the relatives were not involved in the decision. Ten patients felt like they had supportive and understanding relatives and friends. One patient felt supported by friends but not by family. Another patient felt supported by the partner, but was not sure if other relatives and friends fully understood what it means to be a dialysis patient. Four other patients mentioned that usually their family understands, but it is harder for others. One of them said:

> *"I think it is harder outside of the family, with non-relatives and friends. They do not see me in my everyday life. They meet me for a short while and think that "but you look very lively, you are super healthy!" Yes, but today I had to sleep for about three hours to be able to do this."*

One patient took photos of the machine and all equipment to make it easier to explain what dialysis means. The same patient has some experience with people not understanding the dialysis treatment. The patient had once tried to explain to a friend that there is a need of one hour before the treatment for preparation, and one hour after to finish off. The following quote states the friend's response and the patient's reaction to it:

> *"Yes, that is only in the beginning until you get used to it".*
>
> *"So, after two years I am still not used to it? But then you have to shrug and think that they do not know any better."*

Five patients said that their family was involved in their treatment, and helped them with practical issues such as throw away waste and help with the dialysis treatment. One patient said:

> *"My youngest son, he is eight, when he sees that I am tired he starts preparing my machine. That says a lot about my family."*

On the contrary, another patient said:

> *"Like I said before, I have two children who are eight and thirteen years old, and they have no idea about how sick you are when you need dialysis. The never see me doing dialysis."*

3.2.10.1 Comments

This theme also identifies the need for more information to be provided to people surrounding dialysis patients, to contribute to higher awareness about what it means to be dependent on dialysis. In both the interviews and in Section 2.3, it was found that support from relatives and friends is very important. A nurse pointed out that it needs to be a teamwork, both the patient and the family have to be on the same page for the home treatment to work.

3.2.11 **Contact network**

One theme found in the data is the contact network. It includes the network the patients have other than with the healthcare system.

Nine patients did not feel like they wanted to expand their network. Although, about five patients were positive to get in touch with other patients. One of the patients that were positive in meeting other patients is currently active in the Swedish kidney foundation, Njurförbundet. The same person also made an active choice to take blood tests at the hospital to get in contact with the patients there. There was another patient who mentioned that due to the treatment this patient tends to avoid new contacts. Six patients were not interested in getting in touch with other patients. One of the patients said:

> *"No, not really. There are a lot of people in there but you only see that they lay down. Many get also hemodialysis there."*

Two of the patients mentioned that they currently share information and talk with other patients about their lives and experiences. A third patient shortly mentioned that one of the patient's goals is to find new ways and make it easier for other dialysis patients in the future.

3.2.11.1 Comments

This theme shows mixed opinions considering expanding the patient's contact network. Five patients were positive about the idea to get in contact with other dialysis patients, and six were not. Three patients want to inform others and share their experience with home dialysis. By analyzing the data obtained, it is unclear if there is a need for the patients to get in contact with other patients since they have opposing opinions. When the question was asked, it was not specified how the patients would get in contact with other patients. If the question would contain a specific proposal about how they would get in contact, the answers might have been different.

3.2.12 **Hospital**

This theme contains information about what the hospital can and cannot offer the patients. It also involves information about how the patients interact with the hospital. The interview data indicate that the contact between the patient and the doctors mostly occur through hospital visits. The nurses are in contact with the patients through phone, hospital visits, and home visits. The nurses that have PD patients in Lund also use the computer system called Itachi. Four patients said they visit their doctor approximately once every month. One patient visits the doctor every 14th day. Another four patients said these visits occur once every third month. One of these patients expressed the following words:

> *"I think we can drag it out a bit more. The way it feels now, it is a lot of repetitions when you arrive there since it has not gone a very long time. Other than that, it is good."*

Often the patients meet the nurses during these visits as well. Otherwise, most of the contact occurs through phone and the frequency varies among the patients and their state of health. One nurse said:

> *"Often they call us. But it happens that we call them if we think it has gone a long time since we last heard from them".*

The patients are also offered support from a dietitian and a counselor if needed. If relatives are provided support remains unclear. The healthcare providers did not give homogenous answers.

All twelve patients claimed that they, in general, get the support they need from the healthcare regarding their dialysis. Though, two of the patients had an objection. One of them said:

> *"I did not get the support from the hospital, or the healthcare when I wanted. But after, as said before, 7 weeks of fighting they gave in".*

This person referred to how difficult it had been to get a NxStage machine instead of the standard HD machine the hospitals usually recommended at that time. The second patient has aAPD and said that the healthcare workers often are very good but that sometimes they have been careless. The result was that the patient had to take antibiotics to prevent infection.

The data indicated that the healthcare providers (nurses and doctors) and the patients have a good relationship. One nurse said:

> *"If I talk about home dialysis, I would say that we have a very good relationship with our patients. They feel that they are so safe. And the reason I say this is because many patients say: "I feel so safe" when they are here. They call us regarding everything that has to do with their body. There we need to explain to them that we need to limit it, otherwise we become a health central".*

Four patients talked about the limited opening hours at the hospital. Three of the patients do their treatments in the evening or at night. It means that they cannot get any technical support for their machine. One of the patients said:

> *"No, we have the option to call department nine but they are worthless because they do not know what we talk about. No, they do not know anything about the machine."*

During the weekends or other holidays, when the dialysis department is open at limited hours, similar problems arise. Some patients contact the technicians directly and some patients go through the nurses to get in contact with them. However, both services – provided by the technicians and the nurses - have limited opening hours. As of today, patients say they would have to stop their treatments if technical problems arise which they could not solve by themselves.

Another limitation found in the data is the lack of space at the hospital. It is another reason why patients choose home treatments instead. One nurse said:

> *"...to be as good as possible, to survive for as long as possible, to be in as good condition as possible for transplantation they need to do a lot of dialysis. And that is not something we can offer at the hospital. There you come maybe three times a week for four and a half hour maybe."*

Four nurses mentioned that they believe that more patients will have home dialysis in the future due to socio-economic responsibility. Space is limited at the hospital and it costs more to have patients there than at home.

3.2.12.1 Comments

A major trend identified in this theme was the need for more support for home dialysis patients. This could be for example an on-call service. Due to limited opening hours at the hospital, some patients may choose to run their dialysis daytime since they know that they cannot receive any help at nighttime.

3.2.13 **Noise from the machine**

For patients performing APD or HHD, a dialysis machine is needed. This theme includes the noise coming from the machine, such as the noise the machine makes when running and alarms. One patient said that there can be alarms if the power stops working, another mentioned that there can be alarms if the outflow is bad, and one said that sometimes it is not clear why there is an alarm. Ten patients use a dialysis machine either APD or HD. Six of these patients use it at night, and five of them sleep during their treatment.

Three patients said that the noise was not bothering them. One of them, who ran the machine nighttime, was using earplugs. Four patients answered that noise is a little bit bothering. One CAPD patient had tried an APD machine at the hospital but did not like it because of the noise. Questions were asked to find out if the sound from the machine affected the patients' sleep in a negative way. Five patients said that they are sleeping well unless alarms wake them up. One patient said:

> *"I do not know if it is the machine that is the problem or it is me that is the problem. When I get a fold on the catheter or it suspects it, then it is like a fire alarm, so that is not that fun! It has not happened that often. But during the night until yesterday I*

> *had 13, or 10 out of 13 alarms were this kind of alarm. And there is nothing wrong, you just sign them off. This night I had like four."*

One patient run the APD machine during the day, since the machine is too loud to use at night. For two patients, the sleep of their partners was also affected by the sound of the machine.

When practicing at the hospital before they became home dialysis patients, they were taught how to handle different alarms that may occur. But as two patients said, it is easy to forget this information if the alarm does not occur frequently. One patient mentioned that there is no on-call service available if something happens outside of the opening hours. As one patient expressed:

> *"Then, of course, you have a manual you can use, but you rarely have time to look in that manual when you are in a pressured situation. Then you do as all other idiots, you press every button to see if something happens."*

3.2.13.1 Comments

The need for an on-call service was found in this theme as well. More support is needed to help the home dialysis patients when something happens outside of the opening hours. This could be for example help with handling alarms, considering the patients cannot remember how to handle all alarms. The noise from the machine was an issue for many patients as well as their relatives. A need could be to find other ways than sounds to alert patients about alarms, such as vibrations.

3.2.14 **Treatment decision**

This theme describes important factors that can affect the patients' decision of treatments. The healthcare workers' opinions seem to affect the patient's treatment decision a lot, the decision of whether to choose HD, APD or CAPD. Eight patients said that they either did not make the decision themselves. Four of them had just followed their doctors' or nurses' recommendations. Four of them did not have any choice due to other physical implications. A senior physician in nephrology estimated how important a doctor's decision is and said:

> *"I think it is very important in the decision making. Of course, you can control the patients very much as a doctor."*

The data also indicate that healthcare providers are not only important in the decision of what form of treatment the patients should practice but also if they should do it in the hospital or at home. One nurse said:

> *"Our goal is to catch the patients that come here as soon as possible and make them interested in self-care and maybe even make them take it home. When we have made them that interested up here - that they can consider taking a machine home - then they are slot down to the home dialysis department."*

The same nurse also said how important it is that nurses focus on the patient's abilities and not disabilities, to know how to work with them so that they do not lose their confidence. All hospital providers that was interviewed mentioned how crucial it is for them to involve the patients in their treatments early on at the hospitals. Otherwise, the patients might get too hospitalized and comfortable that they do not wish to take it home anymore.

Another interesting data collected, was the answer the senior physician in nephrology gave regarding whether to convince a patient to choose PD over HD. The answer was:

> *"Yes, indeed! Because that is also a treatment that you have in the home. And if you have had PD it is often much easier to consider having hemodialysis at home."*

In that hospital, they have a goal that 65% of all new patients should end up with PD. There are different principles applied at different hospitals to how they work with self-care and such. Therefore, some hospitals have more home dialysis patients than others.

Data implies that the patient's knowledge in the area affects what decisions they make. One patient said:

> *"My best tip is not to a new dialysis patient but rather to the hospital. And that is, to be honest and explain to the patient from day one - or maybe even before the kidneys are completely dysfunctional - what will happen, what a responsibility that person has to take back their life, and not to pamper the patients."*

The same patient also said:

> *"It is not just about reducing the number of nurses or something like that, it is only about giving the patient power over their own situation."*

It is not only of importance that the information comes early on, but also that it is enough. To the question of what might be the reason why a patient might not want dialysis at home, a nurse answered:

> *"Fear and bad information. When they have been poorly informed about the fact that patients that have it at home, in general, feel better and live longer."*

The same nurse also said:

> *"… A well-informed patient is a safe patient."*

Another nurse said that one reason could be that the patients do not want to be responsible for the treatment.

Two nurses talked about home dialysis patients being more free and flexible compared to patients at the hospital. Nine patients said that the best thing about having home dialysis is the freedom to decide when to do dialysis, that they are in charge of the treatment, and that they do not have to adapt their schedule according to the hospital. One CAPD patient said:

> *"Yes, it is the freedom. One morning I can do it at 7 am, and during the weekend maybe I do it the first time at 9.30 am."*

Another patient said:

> *"I have received directions about how… Because I need to take my 16 hours per week. But I can decide how I want to split it up. I could take 2.5 hours per day if I want. So, I have a schedule I can follow. But I think that four times per week suits me, so I do my hours."*

All twelve patients said that they felt safe and confident when performing dialysis at home.

The patients were asked to identify the hardest part about having dialysis. Two patients could not find an answer, they acknowledge the need for treatment. Six patients said that the hardest part about the treatment is that it is very time-consuming and that they feel tied up in their everyday life. Two of them said that the dialysis is like a full-time job.

3.2.14.1 Comments

As described in Section 2.3, in the ideal case, the patient consults nephrology healthcare professionals about what dialysis treatment that will suit the best. This may not always be the case, some might just follow the doctor's recommendation. Eight of the patients interviewed said that they did not choose dialysis modality themselves. This was due to medical reasons or they followed the doctor's recommendation. Patient attitude and lifestyle could be important to consider to find the optimal treatment option. The doctor needs to consider this, the question is: do they? The patients need to receive information at an early stage. This was stated by both patients and healthcare professionals during the interviews. A well-informed patient has more to say about treatment options. By pointing out the advantages of self-care and home treatment early, hospitalization of patients can be prevented and self-care can increase.

3.2.15 **Training**

Before doing dialysis at home, the patients must practice at the hospital. They need to learn how to perform their treatment, what to do with different kinds of alarms, how important hygiene is, and so on. The time of practicing dialysis varied among patients. The average practice time for HD patients was three months. It was noticed that the two patients using the machine NxStage had a shorter training period compared to the other three patients. For three patients, the training time was extended due to different reasons. For one of them, the machine was not available, one had to wait for the completion of home adaptions, and another stayed longer at the hospital since the staff did not want the patient to go home during summer holidays. For PD patients, the practice time varied from one day to three months. One aAPD patient did not practice at all since the patient was not going to perform the treatment.

One nurse said that if it appears that the patient is not handling the treatment well, they must redo some of the practice. This could be due to the patient not following the guidelines given, such as hygiene instructions, or that the patient is no longer capable of performing the dialysis at home. Patients can also be reminded in other ways, one patient said:

> *"What is valuable is that sometimes when something has gone wrong and you have gone to the hospital to get dialysis, then you get to learn some new things. That has been the positive side of it."*

Ten patients felt satisfied with the training at the hospital. The following question was asked: What was good and what was not as good with the training? One patient answered:

> *"There is nothing I found to be less good. You prepared the machine and you did it step by step. The nurse saw what I understood, and what I did not understand. Everything was really good in my opinion."*

One patient said that the practice increased the feeling of security when performing dialysis. Though, the same patient also said:

> *"Like with all kinds of education, there will be some cramming."*

When it was time for the patients to start doing dialysis at home, the feelings were mixed. Four patients mentioned that they felt a bit nervous, but two of them had their nurse with them and the other two knew they could call the nurse if they had any questions. One said:

> *"You even get their private number so you can call them if something happens."*

Three patients said that they felt good the first time doing dialysis at home. Two of them had their nurse with them as support. The third one said that it took a bit longer the first couple of times, but then it went more smoothly. The first time for one HD patient was described as following:

> *"It was terrible. To put in the needles in the arm without having a nurse by my side. I think I sat there just looking at the needle for about 20 minutes before I dared to move it closer to the skin. And then when I finally put it in, I realized it felt just the same as when a nurse is observing me. And from that day there were never any concerns."*

Two nurses said that to put in the needles is one of the hardest things for the HD patients to do, since the mental threshold is high.

Two nurses mentioned that the training can look very different for different patients and that they plan for it together with the patient. One of them pointed out that:

> *"It is not the training period itself that takes the longest time, but rather the time for the patient to become comfortable."*

The patients were asked what advice they could give to new dialysis patients. Seven patients agreed that the best thing to do is to practice a lot, ask many questions, and follow the advice from the nurses.

3.2.15.1 Comments

During the training period at the hospital, there is a lot of information for the patients to absorb and remember. A need identified was a way of reminding them of routines and information, which they may forget after a while. Reviews are necessary. A nurse pointed out that there are not enough resources to perform the optimal work considering promoting self-care. More resources are needed, and perhaps a product could be a cost-effective option.

3.2.16 **Quality of life**

The dialysis treatment has a great impact on the patients' life. This theme describes the quality of life for home dialysis patients, and how it has changed since they started their treatment. Seven patients stated that their quality of life was good. Though one of them answered:

> *"Today is a good day. Tomorrow could be worse, so the answer might be different then. But right now, it has been pretty good."*

Three patients said that they had accepted the situation, and as one expressed it as:

> *"I have reconciled with my situation. The alternative would have been four meters below the ground and that is not a good option."*

Four patients said that their quality of life is bad, or at least not as good as it used to be. This was due to different reasons, one said it was because of the incapability of working, and two said it was due to several things such as other illnesses and not only the dialysis. All ten patients stated that they felt like they were in control of their lives, although they are somewhat limited.

Seven patients said that the aim of their treatment was to stay alive and to feel as good as possible. One patient saw the treatment as temporary, something that has to be done to be able to live until transplantation. The senior physician and the nurses were asked questions about if they could identify certain characteristics among the home dialysis patients. Four nurses and the senior physician mentioned that, when comparing to patients performing dialysis at the hospital, home dialysis patients are feeling better, they are happier, live longer, have more energy, and are more in control of their lives. They possess a lot of knowledge and insight concerning their condition. As the senior physician expressed:

> *"Patients performing their treatment at home are sitting behind the wheel of their life's cars, or what to say. Those performing it at the hospital are sitting in the backseat, are being driven."*

3.2.16.1 Comments

Seven patients said that the aim of their treatment was to stay alive and to feel as good as possible. To help them achieve this, they would need help to quantify this goal into smaller partial goals. To feel good could be diffuse, while optimizing blood values could be a more concrete goal. This could increase their feeling of being in control and in charge of their well-being, which could improve their quality of life.

3.2.17 **Technology**

Questions regarding technology were asked to better understand what technologies the patients are familiar with and currently using. Ten patients are regularly using a computer, iPad or mobile phone for different reasons: to order equipment for dialysis, to communicate with others, to keep track of their health, or to use it as a calendar. One patient strictly stated an unwillingness of using a computer as part of the dialysis treatment. This patient, along with four other patients, said that they used a paper calendar to keep track of things they had to do regarding their treatment. Two patients said that they keep track of their doctor appointments by looking at the pile of letters received from the hospital which state time and date.

Two patients mentioned that they would prefer to send emails to the nurses rather than to call them, but this is not possible anymore due to GDPR. In their experience, this has complicated the communication with the nurses at the hospital.

3.2.17.1 Comments

Some experience with technology was visible among the patients, even though it varied quite a lot. When generating the concepts, it is important to keep in mind that the product needs to be easy to use.

3.3 Method discussion

3.3.1 **Trustworthiness of data**

To achieve trustworthiness in a study several aspects need to be taken into consideration. Traditionally three areas are taken into consideration when analyzing qualitative data to achieve trustworthiness, and these are: credibility, dependability, and transferability [42].

3.3.1.1 Credibility

Data selection is an important step to gather proper data needed to study the focus of the project. One data collection barrier related to the field of medicine is the privacy of the patients. Healthcare workers are very restricted in what information they can share. Due to legislations, such as patientdatalagen [15], patients' contact information is not readily accessible to the public. To schedule the interviews for this project, healthcare workers had to ask their patients if they wanted to participate. Only if the patients wanted to participate, interviews could be conducted. Furthermore, the healthcare workers did not have the time to ask all their patients and only some of the healthcare workers managed to convince their patients to participate. In summary, it was impossible to achieve a random sampling.

Instead, a purposeful sampling strategy was applied to still assure a participant selection that would provide rich data [43]. Certain sampling goals had been established. The goals were to interview the same number of PD and HD patients and to find participants of various age from home dialysis. Initially, it was not obvious if PD and HHD shared the same needs and if people of different ages had experienced similar problems. It was thought that this variety of patients would generate wider aspects of needs and experiences. A relatively good distribution of HHD and PD patient was reached, five HHD patients and seven PD patients were interviewed. As mentioned in Section 1, more dialysis patients have PD compared to HHD in Sweden [8]. Therefore, the achieved distribution became more representative of the reality. The patients were in the 41-85 age range, showing a quite good age distribution for the home dialysis patients. Worth to mention again, is the fact that older people are more likely to suffer from CKD [4]. Another factor affecting the robustness of a data gathering method is the number of participants. [14, pp. 227-228] In this project, twelve patients were interviewed. With more time and resources, a random sampling with more patient interviews could have been conducted. It would have made the approach more robust.

All the interviews were made in the user context, the patients' homes, to remind them of the real issues they have regarding their treatments. It was thought that by sitting in the environment in which they usually perform their dialysis, they would have the right mindset to answer the interview questions. Most interviews were made in person, but two patients were interviewed on the phone. The latter option was due to, for instance, the patient living far away.

Healthcare providers were also interviewed. They were interviewed partly since they could be potential secondary users of the final project concepts. Another reason to why they were interviewed is their great knowledge about dialysis patients. The healthcare workers have worked with dialysis patients for many years. Therefore, they also have experiences from other patients than the ones interviewed for this project. Their answers were valuable since they could provide information that applies to a larger group of patients which further supported the purposeful sampling strategy, mentioned before, for this project.

Not all healthcare workers had time for interviews and the ones who had time were interviewed. Furthermore, the healthcare providers were all females. If male nurses or doctors were interviewed, maybe other experiences would have been discussed [42]. A similar argument goes for the patients since most of the patients were males, important data perspectives might not have been collected.

The different themes and the data in the themes have been reviewed and discussed between both writers of this report. It has decreased the risk of incorrect subjective interpretations. The discussions were also helpful in the decision of what data that is of importance and not when the interviews were coded. Statistics have been used to emphasize the dimension of the different areas of need. It helps the reader to verify the quantity of the needs related to the patients' opinions and experiences. Furthermore, relevant citations from the interviews have been provided to give the reader a chance for subjective interpretation. The citations and the statistics make it possible for other people, who have not participated in this research, to interpret and compare data within and between different themes.

3.3.1.2 Dependability

To avoid data to change over time, all interviews were conducted before the data analysis step. Thus, the time dependability on this aspect was eliminated. Main questions were established and tested before the interviews. These main questions were then used in all interviews to make sure that the focus of the study would not change. The more interviews that had been conducted the more the knowledge about patients' typical opinions and experiences were gained. Since semi-structured interviews were conducted the follow-up questions might have changed over time consequently due to newly gained insights.

Since the character of the project is more exploratory, semi-structured interviews were used to gather data. Semi-structured interviews give flexibility so that more detailed questions can be asked following an interesting answer. The method can help the researchers to gain a better understanding of the subject. The ability to slightly reshape the interview based on the patient's answers also made the interview more personal and relaxed [44].

One problem with the semi-structured approach is that not all participants get the same set of questions [44]. Some patients did therefore not get the same opportunity to elucidate some of the aspects mentioned in the report. Result says: “X number of patients think that…”, it does not in imply: “out of the 12 patients X think that…”. Some patients might never have been asked that question. However, this project was more of an explorative study, as mentioned in Section 3.1, meaning that it was more important to explore and find the width of the problem space rather than the frequency of experienced needs and problems. In the future, a more descriptive study could better define the problem frequencies. Nevertheless, the overall structure, topics, and main questions did not change between the interviews. It means that most of the questions in Appendix A.1 have been asked to all patients.

3.3.1.3 Transferability

All patients interviewed, lived in the southern part of Sweden. Many of the needs found in this research can probably also be seen among dialysis patients from other parts of Sweden. It is likely that they share the same needs due to, for instance, cultural similarities. However, several findings can probably not be generalized to patients from other countries. More distinct cultural, social, technological, and economic differences can be seen between countries. Baxter has more of a global presence [16] making it interesting to know how needs and UXs from different countries diverge. Future studies could maybe verify which needs that can be generalized for other countries.

4 Conceptual design

A robust conceptual model can give users the knowledge of what tasks they can perform with a product and how to use the product to achieve these goals. It is a powerful tool that, if used well, make it possible for designers to communicate with their users through the design. The aim was to create a conceptual model that is comparable to a user's mental model of how a product works. The conceptual design section is divided into two iterations, iteration 1 and iteration 2. Iteration 2 is a refined version of the concept constructed in the first one and will, therefore, be presented after iteration 1. Both iterations are divided into the following subsections: method, result, and discussion.

4.1 Iteration 1

4.1.1 **Method**

During the data analysis process, reflections were written as comments next to the codes. These comments contained initial ideas of concepts and functionalities that could cover the need a patient experienced in a specific situation or context that was described during the interview. Not all the patients shared the same needs and some needs laid outside the scope of the project. For example, needs that could not be solved with an interactive service and needs that were difficult to interpret were excluded. Therefore, some of these initial ideas were removed after the data analysis.

After the data analysis, more concepts and functionality ideas were generated through brainstorming [14, p. 323]. It stimulates idea generation and with many ideas, it is more likely that novel ideas will appear. Each theme was studied again to generate new ideas. Three personas [14, p. 357] were created to help the researchers acquaint themselves with the primary users' needs and establish common characteristics and requirements for a typical user. It also provides an objective way of studying needs without focusing on specific stories provided by the interviewees. The method prevents the evaluation from becoming biased due to personal connections with certain patients. The personas were created based on the data collected in the user study and they represent typical home dialysis patients. Irrelevant ideas, that were not associated with the project aim were excluded. For each persona, a customer journey map [34] describing an event in their everyday life was created. These customer journey maps contain several touchpoints between the customer (the persona) and a service, such as other people or computer systems [34]. The maps were created based on data from the user study and were used to better understand interactions occurring in a dialysis patient's life.

Groups of user needs and requirements that were considered to belong together were grouped together. The functionalities related to these needs and requirements were, thereafter, compared and some of them were selected. By discussing how the different functionalities relate to each other and what functionalities that naturally could be used in the same concept, four final concepts were generated. Relevant metaphors were created to make it easier for potential users to understand the concepts. The concepts were presented to the human factors team at Baxter.

4.1.2 **Results**

In this section, three personas are presented, see Figure 4-6. A customer journey map was created for each persona, see Figure 7-9. Finally, a description of four concepts generated based on user needs are shown.

4.1.2.1 Personas

Lisa

Lisa has just started her dialysis treatment, and has had her APD machine at home for about three weeks. She chose home dialysis since it was recommended by the doctor, and she wanted the APD machine to be free from dialysis during the day. Ever since she got the machine, Lisa has had trouble sleeping. The alarms are waking her up, and it is stressful when coming across new types of alarms which she does not know how to handle. Even though the alarms are bothering her, she finds it comfortable not having to travel to the hospital for dialysis.

Lisa loves traveling and each summer, she and her husband go on vacation abroad. This year, she is planning a trip to Greece. Since she has never needed dialysis when traveling before, Lisa is a bit overwhelmed with the planning needed. She worries that her dialysis equipment will not get to the destination in Greece on time. She also has concerns regarding how her blood test results will be affected by having CAPD during the vacation, instead of her usual APD.

Lisa's husband loves cooking, so he is in charge of that. Both Lisa and her husband do not really know what Lisa should and should not eat. During the training at the hospital, Lisa got overwhelmed with all information provided, and could not absorb everything. Lisa does not want to call the hospital to ask about something she learned three weeks ago, so instead she tries to google the information but cannot find what she is looking for. She is thinking about asking at her next doctor's appointment, if she remembers.

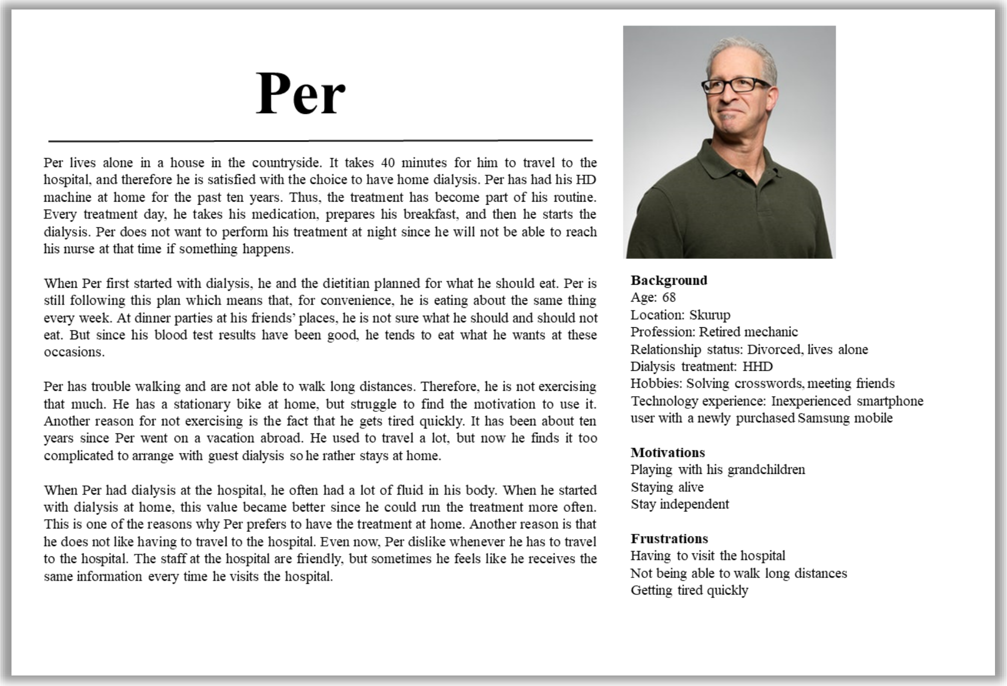
Lisa regularly practices yoga, even though she feels less energetic compared to before starting with dialysis. She loves drinking water, especially after a yoga class. Therefore, Lisa struggles to adapt to the fluid intake restrictions, even though she cannot really feel any difference in her well-being. She wonders if it could have some effect on her test results. She would love to discuss things like this with other dialysis patients, to exchange experiences and help others. The goal with her treatment is to manage her treatment carefully and to have good blood test results to be able to receive a kidney transplant.

Background
Age: 45
Location: Helsingborg
Profession: Yoga-instructor, part-time
Relationship status: Partner
Dialysis treatment: APD
Hobbies: Traveling, practice yoga
Technology experience: Experienced iPhone and Ipad user

Motivations
Staying healthy and active
Getting a kidney transplant
Helping others

Frustrations
Noise from the APD machine
Limited energy
Having to plan her life around the dialysis

Figure 4. Description of the persona Lisa.



Per

Per lives alone in a house in the countryside. It takes 40 minutes for him to travel to the hospital, and therefore he is satisfied with the choice to have home dialysis. Per has had his HD machine at home for the past ten years. Thus, the treatment has become part of his routine. Every treatment day, he takes his medication, prepares his breakfast, and then he starts the dialysis. Per does not want to perform his treatment at night since he will not be able to reach his nurse at that time if something happens.

When Per first started with dialysis, he and the dietitian planned for what he should eat. Per is still following this plan which means that, for convenience, he is eating about the same thing every week. At dinner parties at his friends' places, he is not sure what he should and should not eat. But since his blood test results have been good, he tends to eat what he wants at these occasions.

Per has trouble walking and are not able to walk long distances. Therefore, he is not exercising that much. He has a stationary bike at home, but struggle to find the motivation to use it. Another reason for not exercising is the fact that he gets tired quickly. It has been about ten years since Per went on a vacation abroad. He used to travel a lot, but now he finds it too complicated to arrange with guest dialysis so he rather stays at home.

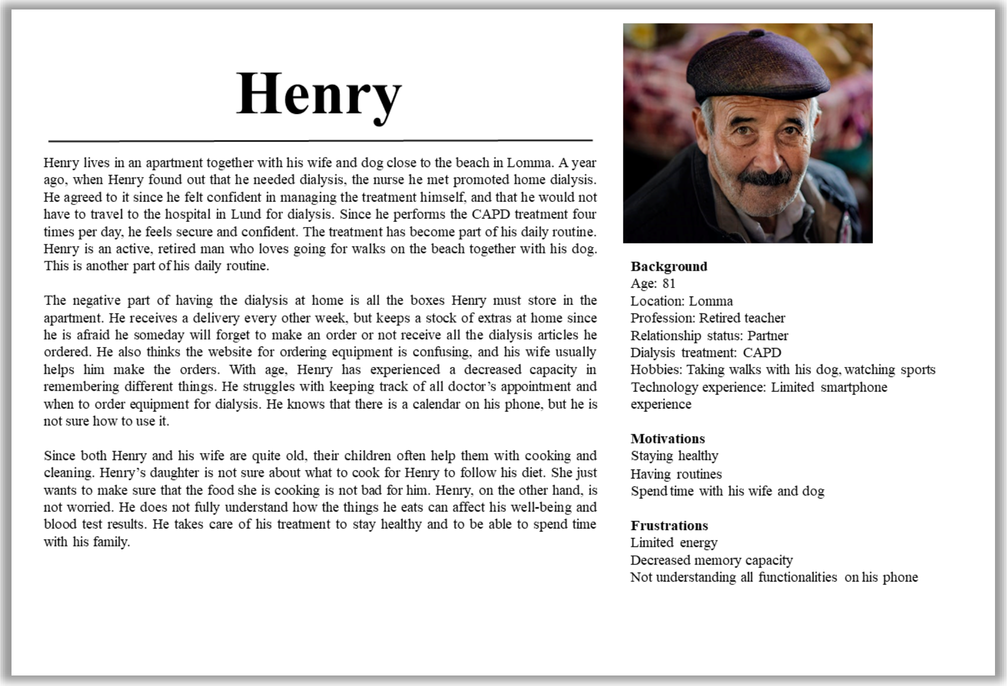
When Per had dialysis at the hospital, he often had a lot of fluid in his body. When he started with dialysis at home, this value became better since he could run the treatment more often. This is one of the reasons why Per prefers to have the treatment at home. Another reason is that he does not like having to travel to the hospital. Even now, Per dislike whenever he has to travel to the hospital. The staff at the hospital are friendly, but sometimes he feels like he receives the same information every time he visits the hospital.

Background
Age: 68
Location: Skurup
Profession: Retired mechanic
Relationship status: Divorced, lives alone
Dialysis treatment: HHD
Hobbies: Solving crosswords, meeting friends
Technology experience: Inexperienced smartphone user with a newly purchased Samsung mobile

Motivations
Playing with his grandchildren
Staying alive
Stay independent

Frustrations
Having to visit the hospital
Not being able to walk long distances
Getting tired quickly

Figure 5. Description of the persona Per.



Henry

Henry lives in an apartment together with his wife and dog close to the beach in Lomma. A year ago, when Henry found out that he needed dialysis, the nurse he met promoted home dialysis. He agreed to it since he felt confident in managing the treatment himself, and that he would not have to travel to the hospital in Lund for dialysis. Since he performs the CAPD treatment four times per day, he feels secure and confident. The treatment has become part of his daily routine. Henry is an active, retired man who loves going for walks on the beach together with his dog. This is another part of his daily routine.

The negative part of having the dialysis at home is all the boxes Henry must store in the apartment. He receives a delivery every other week, but keeps a stock of extras at home since he is afraid he someday will forget to make an order or not receive all the dialysis articles he ordered. He also thinks the website for ordering equipment is confusing, and his wife usually helps him make the orders. With age, Henry has experienced a decreased capacity in remembering different things. He struggles with keeping track of all doctor's appointment and when to order equipment for dialysis. He knows that there is a calendar on his phone, but he is not sure how to use it.

Since both Henry and his wife are quite old, their children often help them with cooking and cleaning. Henry's daughter is not sure about what to cook for Henry to follow his diet. She just wants to make sure that the food she is cooking is not bad for him. Henry, on the other hand, is not worried. He does not fully understand how the things he eats can affect his well-being and blood test results. He takes care of his treatment to stay healthy and to be able to spend time with his family.

Background
Age: 81
Location: Lomma
Profession: Retired teacher
Relationship status: Partner
Dialysis treatment: CAPD
Hobbies: Taking walks with his dog, watching sports
Technology experience: Limited smartphone experience

Motivations
Staying healthy
Having routines
Spend time with his wife and dog

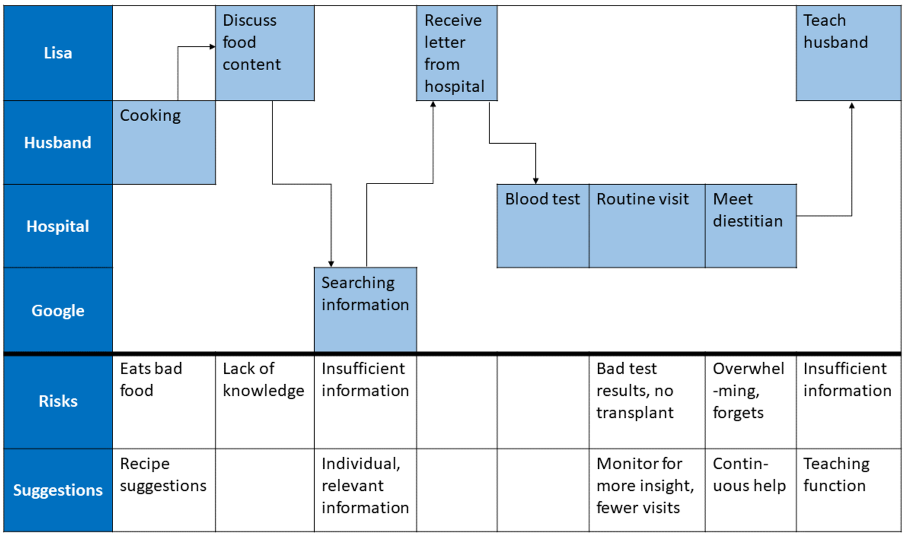
Frustrations
Limited energy
Decreased memory capacity
Not understanding all functionalities on his phone

Figure 6. Description of the persona Henry.

4.1.2.2 Customer journey map

Lisa's customer journey map

Lisa and her husband think it is hard to remember what Lisa should and should not eat. This problem arises almost every day, and the customer journey map describes how Lisa is currently trying to solve the problem, see Figure 7. Lisa's husband is in charge of cooking, but he and Lisa usually discuss the ingredients and try together to figure out if it is a proper meal for Lisa. Commonly, Lisa consults Google and tries to find information about diets for dialysis patients. Every month, Lisa receives a letter containing information about when to do her blood tests and when to visit the doctor. Lisa takes her blood tests at the hospital and, when the test results have arrived, she meets her doctor. During these visits, she also gets the chance to meet a dietitian to discuss her diet. Lisa then returns home and tries to explain to her husband what she has learnt from the dietitian.

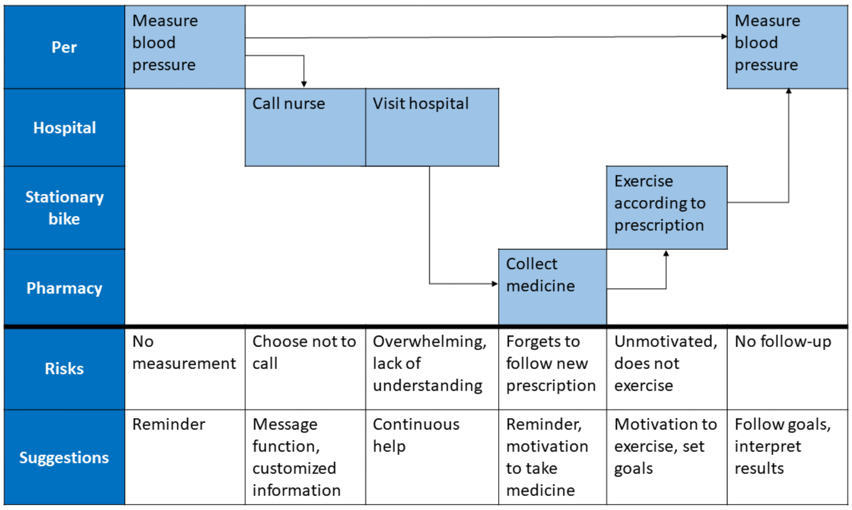


Risks	Eats bad food	Lack of knowledge	Insufficient information			Bad test results, no transplant	Overwhel-ming, forgets	Insufficient information
Suggestions	Recipe suggestions		Individual, relevant information			Monitor for more insight, fewer visits	Contin-uous help	Teaching function

Figure 7. Customer journey map describing how Lisa tries to find information about her diet. The last two rows present possible risks concerning the touchpoints and suggestions of how functionalities in a service can prevent these risks.

Per's customer journey map

Per has had home dialysis for a long time. Every day, he monitors, for example, his weight and blood pressure. The measuring of blood pressure is represented as a touchpoint in the customer journey map, see Figure 8. After this point, the map can continue in two different paths. If the blood pressure is normal, no action has to be made, and Per does not have to think about it until the next time to measure. If the blood pressure is unnormal, Per has to contact his nurse. This interaction could result in Per having to visit the hospital to be examined. The health professionals may change Per's medical prescription and prescribe more physical activity. Per picks up the new medicine at the pharmacy. He exercises according to the prescription using his stationary bike. When Per measures his blood pressure the next time, he assesses whether or not his blood pressure has gone back to normal.

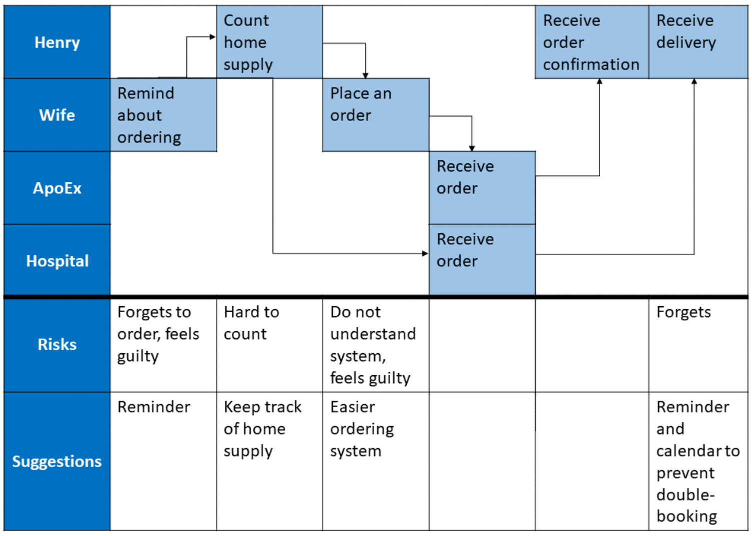


Per	Measure blood pressure					Measure blood pressure
Hospital		Call nurse	Visit hospital			
Stationary bike					Exercise according to prescription	
Pharmacy				Collect medicine		
Risks	No measurement	Choose not to call	Overwhelming, lack of understanding	Forgets to follow new prescription	Unmotivated, does not exercise	No follow-up
Suggestions	Reminder	Message function, customized information	Continuous help	Reminder, motivation to take medicine	Motivation to exercise, set goals	Follow goals, interpret results

Figure 8. Per's customer journey map when measuring blood pressure. The last two rows present possible risks concerning the touchpoints and suggestions of how functionalities in a service can prevent these risks.

Henry's customer journey map

Henry struggles with a decreased capacity in remembering different things and he also thinks that ordering dialysis equipment is hard. The following customer journey map describes a typical day in Henry's life when he must make a new order, see Figure 9. For start, Henry's wife must remind him that it is time to place an order since he has forgotten. After being reminded, Henry counts the equipment he has at home to estimate how much to order this time. After this point, the customer journey can continue in two different paths. If the order was placed on time, ApoEx send a confirmation message to Henry. About a week after placing the order, the equipment is delivered to Henry's home. If the order was not placed on time, Henry has to call his nurse to receive equipment from the hospital instead. Either Henry has to pick up the equipment at the hospital, or they could deliver it to his home.



Henry		Count home supply			Receive order confirmation	Receive delivery
Wife	Remind about ordering		Place an order			
ApoEx				Receive order		
Hospital				Receive order		
Risks	Forgets to order, feels guilty	Hard to count	Do not understand system, feels guilty			Forgets
Suggestions	Reminder	Keep track of home supply	Easier ordering system			Reminder and calendar to prevent double-booking

Figure 9. Customer journey map describing the scenario when Henry is about to order dialysis equipment. The last two rows present possible risks concerning the touchpoints and suggestions of how functionalities in a service can prevent these risks.

4.1.2.3 Concepts

BaxterHome

BaxterHome is an unmanned dialysis center which will be available on various sites in Sweden and in other countries. This will be a place for dialysis patient to go when they cannot perform their treatment at home, for example, when traveling. They are open every day around the clock for dialysis patients to visit. Dialysis machines and equipment will be available for the patients to use. *BaxterHome* will be connected to a service that will allow patients to make reservations for when they want to use it. It will also be possible to take blood tests here. Some extra equipment will be stored at *BaxterHome* for patients to be able to pick up equipment if something goes wrong with their delivery. *BaxterHome* could replace the existing guest dialysis concept. It could also be an alternative for patients who do not want to have dialysis at home due to storage issues. They can visit *BaxterHome* instead of going to the hospital for dialysis. In this way, they can be responsible for their treatment without involving healthcare providers and without having the equipment at home.

Last-Minute Guest Dialysis

The *Last-Minute Guest Dialysis* service is a booking system for guest dialysis. This service will make it possible for dialysis patients to travel more spontaneously. It will be possible for patients to view available dialysis machines all around the globe. Last-minute available seats at guest dialysis centers will be announced, and the patients will receive instant feedback about completed reservations. It will be possible for users to rate and comment on the different guest dialysis sites, to help other patients. There will also be a forum where the users can discuss, for example, traveling experiences. Information and checklists of what patients need to think about and do before, during, and after the trip will be available. It will be possible to, in an easy way, obtain and access certification papers needed for traveling.

Dialysis School

The *Dialysis School* is a service which provides information about dialysis treatments along with information about diet, medication, and exercise. The service will be a platform to learn new things and become more independent. The intended users are patients who are about to start with dialysis treatment, but also relatives, friends, bosses, and colleagues who want to know more about dialysis. The service will provide customized recommendations to the user such as custom-made exercise programs and food suggestions. Individualized challenges based on the user's goal will be another feature to promote self-care. Patients who are about to start with dialysis might find it hard to decide what type of dialysis treatment would suit the best. The *Dialysis School* service will, therefore, provide a modelling tool, where patients can simulate the treatment results depending on different parameters such as time of dialysis, test results, and well-being. Using the modelling tool, patients could, for instance, find out how to attain good test results with as few hours of dialysis as possible. Another feature is personal checklists with reminders about things that need to be done concerning the treatment. This could be, for example, doctor's appointments, medication, and when to order equipment. A forum will be available for the users to get in contact with other users to exchange experiences and find new friends.

The Dialysis Bag

The Dialysis Bag is a service which contains the items dialysis patients keep with them and use in their everyday life. Each feature of the service represents different items one keeps in a backpack during a regular day. The bag's seven main functions are described below. *The Dialysis Bag* is visualized in Figure 10.

The first function found in the bag is food and drinks, which aim to help dialysis patients to keep track of their diet. They can log food ingested to ensure a good diet. General information about diets for dialysis patients will be available. Since dialysis patients have restrictions regarding, for example, potassium intake, recipe suggestions and recommendations are available. It is also possible to create new recipes based on chosen food items. To make it easier for the patients to remember what food they have eaten, a photo should be taken of each meal. Then, the patient can review the food intake and trace a bad test results back to a certain meal. In that way, the patient will learn what not to eat.

The second function is a machine manual, which will help the patients to handle the dialysis machine. For example, this function will help the user with alarms. Information about the alarms will be provided, as well as step-by-step actions to solve them. It will be possible to adjust the settings of the machine using this function. A possible add-on product could be a vibrating bracelet which could replace the alarm signal from the machine. The manual will provide support for the user and for relatives who can be connected to the service. Some functions could be remote-controlled.

A third function is a calendar which reminds the patient about things concerning their treatment, for example, doctor's appointments or when to take medication. Letters from the hospital could be viewed here as well.

Function number four is a training log which helps motivating physical activity. The function provides workout programs to perform both at home and at the gym, during or after dialysis treatment.

The fifth function is dialysis equipment. This function helps the patients to remember when to order new equipment, what to order, and provides support if they encounter any difficulties. Personal ordering suggestions will be available and the possibility to track orders.

A sixth function is a journal where the patients can log parameters regarding their treatment. In the journal, they can see blood test results visualized in graphs and tables to help them interpret the results and connect them to the treatment. They can model their treatment, the same way as described in the *Dialysis School* concept. They can also receive feedback from the doctor.

The last function is a gamification to keep the patients up to date concerning knowledge about dialysis. New quizzes will be available each day, and it will be possible to compete against other users.

Figure 10. The dialysis bag represents a backpack a dialysis patient carries every day.

4.1.3 **Discussion**

The four different concepts were presented to the human factors team at Baxter where the team then had an opportunity to comment on the different concepts, generate more ideas, and ask clarifying questions. The team was positive to all concepts and saw advantages with each of them. They did not want to influence the project too much by giving advice on what concept to continue working with. Since the concepts differ a lot from each other, it is difficult to compare them straight away. The concepts solve different kinds of problems and different number of problems. At this stage, evaluation methods, such as Pugh's Matrix, were not suitable to use. Therefore, the concepts were analyzed once more after the presentation, this time from a patient's perspective. The following questions were asked: Which concept will the patient benefit from? Which one will empower them and make their lives easier? Which one will increase their quality of life?

4.1.3.1 Concept evaluation using personas

As mentioned in the method, three personas were created to represent typical dialysis patients. The personas' needs represent the needs identified among the patients interviewed. Lisa loves traveling but struggles with the planning needed, and would, therefore, make use of the *Last-Minute Guest Dialysis* service, see Figure 4. She would benefit from being able to monitor her blood test results and to model her treatment to gain a deeper understanding for the factors affecting her test results. She could, for example, compare the dialysis effectivity for APD compared to CAPD using the modeling tool. Lisa and her husband could also use some help when planning what to eat, for Lisa to follow her restrictions. These are things *The Dialysis Bag* could help with. In the *Dialysis School* service, relevant information about dialysis will be available which will enable her to learn new things. Then, the service might provide answers to some questions and she would not have to contact her doctor or nurse. Lisa wants to get in contact with other dialysis patients, another service which the *Dialysis School* provides.

Per could need some motivation to exercise more to become healthier, see Figure 5. He could also use some help in eating more varied food. *The Dialysis Bag* could help him with these things. Both *BaxterHome* and *Last-Minute Guest Dialysis* could make it easier for Per to travel. *Last-Minute Guest Dialysis* could help him to plan the trip and inform him of what to think about concerning travel with dialysis. He could perform his guest dialysis at *BaxterHome* instead of at the hospital, since all he needs is to access a dialysis machine.

Henry struggles with ordering dialysis equipment and would need a simpler way of doing it, see Figure 6. Since he is not that familiar with new technologies, *The Dialysis Bag* service may still be too difficult for him to use. This is something which needs to be considered when designing the service. The design needs to be simple enough to make it possible for people with different levels of technology experience to use it. If he were to use to the service, he could also make use of the calendar to remember things concerning his treatment. With access to his test results and the modelling tool, he could obtain a better understanding of his condition and the effect of his treatment. Henry wants to survive for as long as possible. Therefore, he could make use of a service where he could divide this goal into smaller partial goals for how to stay healthy. His children could also benefit from the service when they want to cook good food for him.

BaxterHome and *Last-Minute Guest Dialysis* both solve the problem of making it easier for patients to travel more spontaneously. This was a need identified among several of the users, and can be found in the personas as well. Though, the patients who found it hard to travel may not change their mind even if these concepts were implemented. Even if they did, the regular patients may only use *BaxterHome* and *Last-Minute Guest Dialysis* a few times a year, not daily. Since these two concepts would only be utilized by a small amount of all dialysis patients, for a limited number of occasions per year, they will not be explored further. Furthermore, there are already guest dialysis and traveling apps available for patients today. This means that maybe the *Last-Minute Guest Dialysis* would not make it easier to travel, compared to the help that is already available. With a limited number of functionalities, the service would probably not differ that much from the services available.

The *Dialysis School* is a concept which is profitable for multiple stakeholders, not only dialysis patients. By educating the patients and promoting home care, a cost reduction could be made since it is less expensive to treat dialysis patients in their homes compared to at the hospital. This information was obtained from nurses during the interviews. The concept is also beneficial for relatives, friends, colleagues, and bosses since they would get the opportunity to learn more about dialysis in an easy way. These secondary users have not been interviewed in this study and it is, therefore, unclear if an interest for this service exists. Since there is no time in this project to investigate if there is an interest, this concept will not be further evaluated. The goal is to empower the patients, and this concept is not specifically focusing on the patients.

The final concept, *The Dialysis Bag*, is the most useful concept for the patients in their everyday life. All three personas could make use of this service in different ways. Furthermore, both Lisa’s, Per’s, and Henry’s motivations were to stay healthy and to stay alive. This is a focus in *The Dialysis Bag*, to help motivate the users to reach their goals. For a regular dialysis patient, this concept will matter the most as it solves more needs compared to the other concepts. Therefore, this concept will be the most beneficial, empower the patients, make their lives easier, and hopefully increase their quality of life. There are similar applications available today where dialysis patients can monitor, for example, their treatment and fluid intake. However, it is believed that *The Dialysis Bag* contains a unique combination of functionalities which have been combined after identifying needs among the users. Since the functionalities are based on the needs identified through a thorough user study, it is believed that the service would be more helpful to dialysis patients, compared to the services available today.

4.1.3.2 Concept evaluation using customer journey maps

The customer journey maps were created to better understand interactions occurring in a dialysis patient's life. For each touchpoint, there are possible risks of things that could occur. To further motivate why the concept *The Dialysis Bag* could be useful to home dialysis patients, the concept was evaluated together with the customer journey maps to examine which risks and touchpoints that could be eliminated or improved using the concept. All risks mentioned below may not all appear at once. The goal is to highlight the possible risks, and present how the concept *The Dialysis Bag* could eliminate the risks.

For Lisa, there is a risk that she is eating things that she should not since she lacks knowledge, see Figure 7. *The Dialysis Bag* could eliminate the risk through the function where the service provides suitable recipes for her diet. By monitoring her food, she can learn more about nutrition and therefore gain a deeper understanding of what to eat. When searching about her diet on Google, she may not find adequate information. *The Dialysis Bag* provides relevant, individualized information in one place. In this case, the touchpoint will change from being an interaction between Lisa and Google, to be between Lisa and *The Dialysis Bag*. Not following diet restrictions could influence Lisa's blood values. Worst case, it could result in poor values and prevent transplantation, see Figure 7. By monitoring her values in *The Dialysis Bag*, she will gain more knowledge about how to obtain good test results. This could, in the long run, make her suitable for transplantation, but also that she may not have to visit the doctor as often. Patients who have stable blood values tend to meet their doctor less often compared to patients with non-stable values. Therefore, this could result in fewer touchpoints. When meeting with a dietitian, the information could be somewhat overwhelming and there is a risk that Lisa will forget part of the information after returning home. In the service, Lisa can continuously access help about her diet. By using *The Dialysis Bag,* the touchpoint where Lisa interact with a dietitian could possibly be eliminated since the service provides all information she needs. Another advantage of *The Dialysis Bag* is that Lisa's husband can use it as well and learn what to cook for Lisa. If Lisa was to teach him, the information provided by the dietitian might get lost on the way.

There is a risk that Per, for some reason, will not measure his blood pressure, see Figure 8. Since *The Dialysis Bag* will send motivating notifications about measuring, he would be more likely to do it. If he notices that his blood pressure is too high, there is a risk that he does nothing about it and choose not to contact his nurse. The service can improve this touchpoint by making it easier to contact the nurse through a message function. *The Dialysis Bag* can also provide individualized information and continuous help, to make Per to understand why his blood pressure is high and what he could do about it. When meeting his doctor, the information can be overwhelming and he might not fully understand what the doctor means, see

Figure 8. As mentioned before, the service will be available to help at any time which will improve this touchpoint. After receiving new medication and exercise prescriptions, there is a risk that Per will forget to follow them. *The Dialysis Bag* service will remind and motivate him to take the medication and to exercise. It will help him to set goals for physical activity, and to keep track of them. When measuring his blood test again, there is a risk that Per does not follow up and analyze whether his blood pressure is better than before. This touchpoint can be improved by using the service since it will keep track of his results and interpret them for him.

In Henry's case, there is a risk that he forgets to order dialysis equipment, see Figure 9. If he forgets and his wife has to remind him, he might feel guilty that she has to look after him. By using *The Dialysis Bag*, the service will remind him instead, which will make him less dependent on his wife. The service will keep track of the amount of equipment Henry has at home, and he would not have to count his storage. This touchpoint could, therefore, be eliminated, using *The Dialysis Bag*. Another touchpoint which can cause trouble for Henry is when he is about to place the order. Since he struggles to use the ordering system, his wife must help him, see Figure 9. With a simpler ordering system, Henry would be able to place orders independently. There is a risk that Henry will forget when he will receive the delivery, he might not be at home or maybe he has to reschedule other things last minute. With *The Dialysis Bag*, he will be reminded about deliveries which will reduce the risk with this touchpoint.

4.2 Iteration 2

4.2.1 **Method**

When establishing the concept *The Dialysis Bag*, many different functionalities were considered. A general description of the concept was established. However, the design concept was still not clear. To explore different options of initial design ideas, the two authors drew two very simple sketches [14, p. 389], one each. Concept drawing was used to get a better grip of the relationships between the different functionalities and to design it in a way that helps the user understand the structure. The sketches were drawn separately to generate different ideas on how to solve different problems and cover the user's needs.

The sketches were thereafter compared and evaluated using Pugh's Matrix [45], usability goals [14], and Nielsen's heuristics [37]. Pugh's Matrix is a method that compares different alternatives based on certain criteria to find the best option. The criteria for the matrix were established based on many of the needs identified from the user study that the concept *The Dialysis Bag* was thought to be able to cover. Some needs were more related to the three other concepts, found in Section 4.1.2.3**,** and were excluded from the matrix. A scoring system from minus one to two was used, where the concept that better met the criteria got a higher point. If a concept for a criterion scored negative the concept did not meet the requirement and rather worsened it. Concept one was used as a baseline for the evaluation.

Based on the individual sketches, the ideas that best solved the needs were selected. These ideas were then used to generate a joint concept before designing a low-fidelity (lo-fi) prototype [14, pp. 389-390].

4.2.2 **Results**

In this section, images of the initial sketches can be seen in Figure 11 and 12. Table 2 presents the results from Pugh's Matrix when comparing the two concepts.

Figure 11. Two of the sketches from concept one. The left-hand sketch shows functionalities related to ordering. The functionalities are divided into four different buttons, four different paths. The patient can either make a new order (Ny beställning), track an order (Tracka beställning), check the home stock (Ditt lagersaldo), or get support (Support). The right-hand sketch presents the patient's last blood test results and related information.

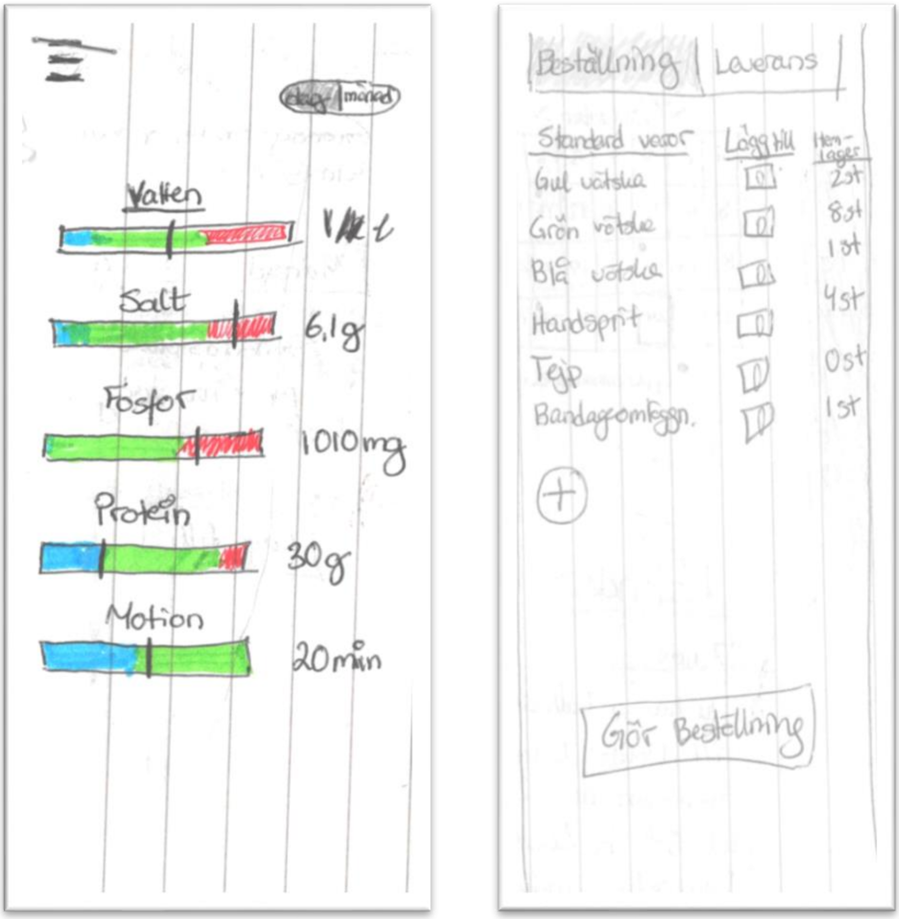


Figure 12. Two of the sketches from concept two. The left-hand sketch represents an overview of important parameters for dialysis patients to keep track off. The right-hand sketch shows an ordering function. In the same sketch, the patient can both make an order (Beställning) by adding dialysis articles as well as to check the delivery (Leverans) status of the previous order. On the ordering page, the user can see the home stock as a support for ordering new articles.

Table 2. The result from the Pugh's Matrix evaluation of the two different concepts for the given criteria.

Criteria	*Concept one*	*Concept two*
Facilitate planning and time management	1	1
Simplify ordering	1	2
Increase order reassurance	1	2
Cognitive support	1	1
Individual physical adaptation	1	1
Exercise motivation	2	1
Diet motivation	1	1
Works on multiple devices	2	2
Raise awareness	1	2
Get and interpret feedback	1	1
Increased understanding of medication	1	1
Re-training	2	0
Set, quantify, and follow goals	1	1
Choice of getting in contact with other patients	1	0
Self-care	2	2
Total score	19	18

4.2.3 **Discussion**

4.2.3.1 Pugh's Matrix evaluation

Criterion 1. Facilitate planning and time management

Both sketches had some weaknesses and some strengths. One thing that was noticed during the evaluation is that in both concepts, users must spend some extra time in the beginning to perform certain tasks. However, in the long run, the patients will be able to use the functions more smoothly. For instance, a patient must add all the dialysis articles that he or she usually orders in the beginning. The same goes for recipes. Then, articles and recipes will be stored for later usage and thereby make it easier for the patients to make orders or log food later. Alternatively, common dialysis articles for the specific treatment type could be suggested in a list at the beginning. Hence, both concepts aim to speed up the time needed to perform user tasks and fulfill the usability principle *flexibility and efficiency of use* [37].

One way to facilitate time management is by making it easier for the patient to adapt their treatment to their lifestyle. There are several parameters in a treatment that can affect the adequacy such as the time duration. To encourage and support the patient in the development of a new treatment with the same adequacy as the one used before, a modeling function was included in both sketches. By setting values to the given parameters, the application could model the adequacy of different treatments. In concept one, it was easier to compare the current treatment to another one. They were presented on the same page which made it easier for the user to evaluate the different treatment alternatives. Consequently, that design was more *efficient to use* [14], in accordance with the usability goal.

Both the sketches had included a calendar to make it easier for the users to remember and plan different activities related to the treatment. Concept one had more in detail thought about color coding for different events to help the patient when planning. The ideas from concept one will be used since it is thought to provide a better *utility* [14] for the user improve the overall usability.

Criterion 2. Simplify ordering

Both concepts had thought of the problem that patients need to go through the dialysis stock at home before they can make an order of new dialysis articles. However, in concept two the patient could both see the storage of different articles and make new orders of new articles on the same page, see Figure 12. It made it easier to compare them and make an order. In concept one, the information was presented as two separate functionalities. Concept two provided a higher *efficiency* [14] of the task, since the user could compare the articles on the same page. Presenting them on the same page probably also made it *easier to remember how to use* [14] the system since a fewer number of step was needed to carry out the task. Thus, these two usability goals were covered.

Criterion 3. Increase order reassurance

The delivery system today has proven to make some patients worried. Some patients have had bad experiences not receiving all the dialysis articles that they ordered. Concept one provided information about the status of the delivery by a circle that gradually was filled in depending on how far in the delivery process the order had come, see Figure 11. Concept two scored a higher grade since it presented the delivery process in more detail regarding when the delivery will arrive, and wherein the delivery process the patient’s order is. Concept two supports the user more in the task to see how far in the delivery process an order has come and is hence better at achieving the design principle of *effectiveness* [14].

Criterion 4. Cognitive support

In general, concept one divided the information into steps, see Figure 11. With this design, the user does not get overwhelmed by too much information. It reduces the risk of *inattentional blindness* [46]. However, to reach the different functionalities the user must go through several pages which sometimes could be inefficient. Hence, there needs to be a balance between the perceptual load and the load on the user’s memory [14]. In concept two, more information was presented on each page which in some cases were beneficial. The patient was, for instance, able to more quickly get an overview of the current health state using concept two, see Figure 12, since the information was presented on the same page. In concept one, the patient had to go into different functions to see many of the different health-related parameters. A combination of the two concepts would probably create a more efficient design with a good level of detail to decrease the perceptual load and working memory needed. Both the usability principle *Aesthetic and minimalist design* [37] and the usability goal *Efficiency* [14] should be taken into consideration in the lo-fi prototype. More tabs, such as “Beställning” (“Ordering”) and “Leverans” (“Delivery”) seen in Figure 12, will be used for the lo-fi prototype since it can speed up the interaction but at the same time divide the information into different pages. By using the tabs, the design is also thought to increase the *User control and freedom* [37] one of the usability heuristics.

Criterion 5. Individual physical adaptation

In both concepts, individualized workouts will be provided depending on how active the user is. In both concepts, there was also an idea of having a read-aloud function. Even though it is not shown in Figure 11 or 12, the sketches had the idea that the patients maybe should be able to communicate orally with the app. It is a function that will not be tested in this project, but it could possibly be tested and implemented in a future application.

Criterion 6. Exercise motivation

Concept one provides the patient with both information about how close the patient is to achieve the daily goal and comments to encourage more exercising and to set new goals. In concept two, personalized goals could be set. However, the concept did not provide encouraging notifications or comments for the user. The goals for both concepts were not entirely clear and could be further developed to improve the motivation for application usage.

Criterion 7. Diet motivation

The two concepts got the same score but for two different reasons. Concept one wanted to motivate the patient to continue to log food. Concept two wanted to motivate the patient to log and monitor the diet by showing the patient the daily nutrient consumption based on the food the patient log. A combination of them both might generate the best diet motivation for the user.

Criterion 8. Works on multiple devices

Both concepts are thought to work on multiple devices such as on the computer, iPad, and smartphone even though only a prototype with the shape of a mobile phone will be developed in this project.

Criterion 9. Raise awareness

People around patients might sometimes have a hard time understanding how it is to be a dialysis patient. Through concept one's quiz function, other people than the dialysis patients can also get to learn about the treatments. The quiz provides questions that can help friends and relatives become more aware. In concept two, relatives can be invited by the patient to review specific health parameters and use certain functions selected by the patient. The relatives can also use the application to create and view recipes. Since the recipes show how much of the different nutrients a standard portion provides, the relatives become more aware of what they can cook considering the general recommendation for dialysis patients. A combination of the two concepts would probably raise more awareness among other people.

Criterion 10. Get feedback and help to interpret it

The first concept helps the user interpret the results from the blood tests and give a recommendation on how to improve them by for instance taking medication. The second concept links symptoms to ingestion and medicine, and gives recommendations based on the symptoms a patient might experience. Both concepts are important and a combination of the design would create something better and more accurate since all those parameters are linked to each other. Hence, the combination will probably make the interpretations more correct and the functionality *safer to use* [14], in accordance with the design principle.

Criterion 11. Increased understanding of medication

The scores were set with the same motivation as for criterion 10.

Criterion 12. Re-training

In concept one, patients can get retraining from the quiz. The sketch also provided general information regarding for instance food recommendation from which the patient can update and review knowledge that has been forgotten. Concept two did not focus on re-training at all. In the new concept, ideas from concept one will be included.

Criterion 13. Set, quantify, and follow goals

Concept one helps the user to quantify goals mainly from the patients' blood test results and treatments. The patient can also set exercise goals and follow them. Concept two monitor the daily intake of nutrients and let the patient follow it. Daily, patients need to think about all these aspects and by combining all these functionalities there will be a better match between the system and the real world. In accordance with the heuristic goal *match between system and the real world* [37], a combination of the two concepts will provide a concept more familiar to the user.

Criterion 14. Choice of getting in contact with other patients

Through the quiz in concept one, the patients can choose to play and to chat with family, friends, and other dialysis patients. The chat room is private and voluntary. Concept two has no similar functions.

Criterion 15. Self-care

The whole idea of both concepts is to help the patient monitor and improve their health. Both concepts are therefore highly focused on facilitating self-care, though in slightly different ways. Again, a combination of the two of them is thought to provide an even better concept.

4.2.3.2 Pugh's Matrix discussion

The total scores from the two concepts are very similar. A reason for this is that the concepts had many similar ideas. It was unavoidable since different functions had been discussed before the sketches were drawn. It was also very difficult to compare the two concepts with each other due to the many features and functionalities evaluated. If the concepts had been downscaled to only a few functions a more fair and correct grading could have been made. If both concepts got the score one for a criterion, it does not consequently mean that the concepts were equally good. It could also mean that the different concepts achieved two very different aspects of the criterion. Fewer and more specific criteria would have made it easier to grade the concepts.

Pugh's Matrix was used on sketches and not complete prototypes. The aim was to get a better grip on the relationships between the different functionalities and generate initial design ideas. Since the sketches were not fully developed in all aspects, the evaluation was in some cases hampered. The scores in the matrix are very subjective and should not be analyzed too carefully. Instead, the discussion around the scores is something that should be considered much more important. By using Pugh's Matrix, new ideas were generated. For most of the criteria, a combination of the ideas from the two concepts was thought to be able to generate something even better. In conclusion, Pugh's Matrix was a good method to use to rethink the design of the overall concept as well as specific features and functionalities. However, the scores cannot be viewed alone since it does not give the reader a clear picture of what has been evaluated. Instead, the discussion around the grading should be viewed simultaneously.

4.2.4 **Final concept**

The final concept contains the best features of the two sketches made from *The Dialysis Bag* concept. The idea about *The Dialysis Bag* origins from the metaphor of a backpack one carries every day. Each day, a dialysis patient needs different things to keep with them. As mentioned when describing the concept, each feature of the service represents different items one keeps in a backpack during a regular day. This could be, for example, food and drinks, a calendar, dialysis equipment, treatment journal, and dialysis quiz.

The final concept will contain seven functions, like *The Dialysis Bag* did, though somewhat refined. The machine manual function was removed in the final concept. This is a big and important function, but since the concept already contains many functions, it had to be removed. The other functions are more linked to each other, while the machine manual function could be a service of its own. This function did not fit into the metaphor, since a machine manual is not something one regularly keep in their backpack. The idea of the concept is still to be useful for patients in their everyday life.

The first function: “Food & Drinks” should contain the following functionalities: food and fluid intake monitor, recipe builder, recipe bank, and general information about diets for dialysis patients. When manually monitoring food, a list of things the user usually eats should come up, and it should also be possible to log the created recipes.

A second function is a calendar, which was described in *The Dialysis Bag* concept. It was decided that the different events in the calendar should be color-coded to make it easier for the patients to keep track of the different things they have to do. For example, the events could be doctor’s appointments, blood tests, deliveries, and ordering dates.

The third function is a training log. This function should motivate users to exercise by letting them set up a goal for daily physical activity. Feedback will be received when reaching the goal, and remind the user to raise their goals. Workout sessions adapted to the physical ability of the user will be available and it will also be possible for the users to create their own workout programs.

As described in *The Dialysis Bag* concept, an ordering function will make it easier for the patients to order dialysis equipment. It will be possible for the users to see how much equipment they have at home when they are ordering, and suggestions of what they are usually ordering will be presented. After making an order, they will be able to track and see the status of it.

The fifth function was described as the journal in *The Dialysis Bag* concept. This function will make it possible for the patients to keep track of and log parameters regarding their treatment. By monitor the equipment used for each treatment, the service will keep track of the amount of equipment the patient has at home. By using this function, they should also be able to compare their dialysis treatment to another using the modeling tool.

In a sixth function, it will be possible for the patients to keep track of their health status. Results from previous blood tests will be visible along with information about which values are good and which ones that need to be improved. Advice, about how to prevent a value from being too high, will be provided. In this function, the users will have the opportunity to describe symptoms they may experience, and will be given recommendations about what to do to feel better.

The last function is the dialysis quiz as described before. The user will be able to choose whether to play against added friends or random users. There should also be an optional chat room available, to make it possible to communicate with the people the user is playing against. The purpose of the quiz is for the user to learn new things and to stay updated.

All functionalities will be linked to each other. When the patients log their treatments, the used dialysis articles will be registered and hence, the application will be able to keep track of the patient’s home stock. Similarly, if the user suddenly experience a symptom, the application will help the patients understand why the symptom might have occurred based on important health parameters such as treatments, medicine, diet, and exercise.

5 Prototyping

To test whether the general concepts hold, prototyping is a great design instrument to use. Through a prototype, the designer can evaluate concrete design ideas and see if the tester understands and interacts with the prototype as expected. Often lo-fi prototypes are generated at first since it takes less time and sometimes even less money to create them. When the designer is more confident with the concept and design, high-fidelity (hi-fi) prototypes are generated. They have more similar characteristics to the end product. In this project, no exceptions to this commonly used strategy were made. Therefore, the report will, present the method, result, and discussion of a lo-fi prototype. A section about the method, result, and discussion of a hi-fi prototype will be covered afterward.

5.1 Iteration 1

5.1.1 **Method**

Many of the functionalities described in the concept in Section 4.2.4 are linked to one and another. In this project, only a few of these functionalities were designed in more detail. Three functionalities were in focus when generating the lo-fi prototype [14 p. 389]. These were: “Food & Drinks”, “Health State” and “Order”. Based on the discussion from Pugh’s Matrix of the two concepts found in Section 4.2.3, the best design ideas and features were used to generate the lo-fi prototype. The lo-fi prototype was built of a pile paper with the size of a mobile phone. Design principles and laws such as Norman’s design principles [36] and the Gestalt Laws [47] were used during the work.

To test the lo-fi prototype, the method Wizard of Oz [14, p. 391] was used together with three created scenarios [14, p. 371] named: *Investigate symptoms*, *Order dialysis equipment*, and *Log a meal*, see Appendix C. The method Wizard of Oz provides a way to simulate responses when the user interacts with the lo-fi prototype. Scenarios were used since they put the users in the right mindset and describe the tasks to perform. By using these methods, different aspects of the product were tested. Before proceeding with the tests, the testers were asked to put themselves in the mindset of a PD patient. Altogether, five workers from Baxter tested the prototype given the provided scenarios. All testers had been in contact with dialysis patients before and were familiar with their treatments and life situation. The testers were asked to comment on the structure and the design of the lo-fi prototype. They were asked to express what they see and what they think about when they interacted with the prototype. In this way, feedback was provided regarding the general design and more detailed design ideas. Observations on how the prototype was used were also made. Notes containing feedback and observations were taken during the tests.

5.1.2 **Results**

5.1.2.1 Lo-fi prototype

The three scenarios used in the tests can be found in Appendix C together with the lo-fi prototype. The images of the prototype are organized in accordance with the three different scenarios. Three examples from the lo-fi prototype are shown in Figure 13.

Figure 13. The left-hand page shows the main menu of the lo-fi prototype. In the middle, a page with a list of symptoms is shown (even though it is not clearly marked, the user is here viewing the information under the tab "Symptom"). The right-hand page shows how a patient is logging the weight of a portion of Beef Stroganoff.

5.1.2.2 Test feedback

In general, the testers were very satisfied with the prototype and thought it was easy to understand. Even though many comments are presented below for the different scenarios, the users managed to go through almost all scenarios without external help. Many of the comments concern design details which could help the user understand the prototype slightly better the first time they use it. The feedback from the different scenarios is summarized as follows.

Scenario 1. Investigate symptoms

Some of the menu options, see Figure 13, confused three of the testers. The names “Behandling” (“Treatment”) and “Hälsostatus” (“Health Status”) were the ones the users specifically commented on. The names of the options did not fully explain the underlying functionalities. Eventually, all users chose the correct option, “Hälsostatus”. Nevertheless, two of them selected “Behandling” before they realized that they had to pick “Hälsostatus”. Based on the testers’ comments, the name “Hälsostatus” was vague. One tester suggested renaming the option to “Hälsostatus & Råd” (“Health Status & Advice”). In that way, the underlying functionality of advice for symptoms would be easier to find. One tester was more confused with the main menu than the others. At first, the tester was clicking on the menu tab to go to the main menu. However, the user was already viewing the menu without realizing it. The confusion arose due to the name of the application. In Swedish, the name of the concept was *Dialysväskan (The Dialysis Bag)*, which confused a tester who read it as “Dialysvätskan” (“Dialysate”). During the test, an explanation of the name had to be made for the tester to proceed with the scenario.

After marking a couple of symptoms, see Figure 13, a recommendation page was presented to the users. Two of the testers thought the information was difficult to remember after closing the page, see Figure 19 in Appendix C.1. One of the testers suggested to have clickable keywords that are linked to other pages of the prototype that describes the words more thoroughly. Another tester also wanted to have an optional function to send the recommendation and get in contact with a nurse or a doctor after filling in the experienced symptoms.

Two of the testers wanted to find possible symptoms on the page over the previous blood test results, see Figure 17 in Appendix C.1. They expected some risks and symptoms to be found under the nutrient tabs that had a warning sign. The information under the tab was not available in this prototype. One of the testers liked the tab “Symptom”, see Figure 13, that showed a list of markable symptoms but also wanted to have the option to press the nutrient tabs mentioned before. In one of the tests, the user requested to see graphs of blood result values over time. It could be found under “Historik” (“History”), see Figure 17 in Appendix C.1, but the tester did not see it.

Scenario 2. Order dialysis equipment

The dialysis article “Avflödespåse” (“Drainage Bag”) was not defined in the default list, see Figure 21 in Appendix C.2. Instead, the user had to press the plus sign button to add a new item. Three testers were not sure how to add the new article. Two of them wanted to press the button “Nästa” (“Next”) before they found the plus sign button. One tester also demonstrated a deficiency in the prototype, when the design did not help the tester remember to specify how many “Avflödespåsar” that were to be ordered after adding it to the ordering list, see Figure 23 in Appendix C.2 Worst case, the article would not have been ordered.

All testers noticed and appreciated the column that showed the patients home stock, see Figure 21 in Appendix C.2. Two testers wanted to have a third column that showed the sum of the home stock and the added dialysis articles in the new order. One of the testers also wanted this summation column on the confirmation page of the new order, see Figure 24 in Appendix C.2. Another patient asked what would happen if one of the articles from the home stock were to be spoiled before usage. How would the user then register the new number of articles kept at home? It was a scenario that had not been taken into consideration. Under the tab “Leverans” (“Delivery”) one tester thought the prototype lacked the function to check previous orders.

One tester suggested that the menu option “Beställning” (“Ordering”) should not exist in the prototype. The tester thought it did not fully belong with the other health-related options. Instead, the functionality could be provided in a separate app that is synchronized with *The Dialysis Bag*.

Scenario 3. Log a meal

Many of the testers liked the bars showing the nutrients consumed during the day, see Figure 27 in Appendix C.3. However, the users had different ideas of what the values meant. Some testers thought the values were what was recommended for them to eat and some thought it was a max value. One tester asked for a weekly representation over the nutrients consumed.

Two testers wanted to press the button “Dagens Måltider” (“Meals of Today”), see Figure 27 in Appendix C.3, to log the meal. The name confused the users. Instead of interpret it as the food logged today, one of the testers thought it would contain the user’s favorite foods. The rating of the dish “Biff stroganoff” (“Beef Stroganoff”), see Figure 30 in Appendix C.3, was also misinterpreted as how suitable the dish is for dialysis patients rather than how tasty it is.

No tester immediately understood how to fill in the weight of the food, see Figure 31 in Appendix C.3. They were confused with the box “Lägg till vikt” (“Add Weight”). Three testers interpreted the information text “1 portion = 290g, 490cal” as a preset weight and only if they had eaten a larger or a smaller portion, they would need to fill in a new number. The text was supposed to be used as a reference to know what to fill in rather than an already completed alternative. One tester also wanted to press the title of the dish to fill in the weight of the eaten meal, which did not work. Another tester did not associate food with weight and thought this part of the prototype was difficult to interact with.

Two testers commented on the list of nutrients that came up after filling in the weight of the meal, see Figure 32 in Appendix C.3. One tester did not see the point of it since the meal was probably already eaten. Instead, the user would have wanted to see some warning sign or exclamation mark already in the menu before logging the food to prevent exceeded consumption of nutrients. When another tester saw the exclamation mark in the nutrient box, the tester said:

> *"Now I should take a Resonium pill for my high calcium value".*

A suggestion was made in one of the tests, to connect a dietarian to the application. Patients would then have the option to share logged data and ask questions regarding their diets.

5.1.3 **Discussion**

5.1.3.1 Design aspects

The sketches made during the conceptual design did not only refine the overall concept, it also gave inspiration to the design of the lo-fi prototype as described in Section 4.2.3. Hence, when comparing the figures of the lo-fi prototype seen in Appendix C with Figure 11 and Figure 12 many similarities can be seen.

When designing the lo-fi prototype, acknowledged design principles and laws were also utilized. The Gestalt laws were used when designing the different buttons and tabs. Buttons of the same characters were given the same shape and placed close together. It can, for example, be seen in Figure 13, on the page "Hälsostatus" ("Health Status"). The tabs are of the same shape and placed close together and the same goes for the list of the symptoms. According to *the law of closure* and *the law of similarity* [47], these tabs and buttons will more likely be grouped together and interpreted to be of the same type. On the same page, the placement of the button "Nästa" ("Next") was made with *the law of proximity* [47] in mind. The button is placed further away from all the other buttons since it has a function that is different from the rest. Buttons placed close to each other tend to be grouped together, according to the law. Hence, by placing the "Nästa" button further away, the user will be less likely to group it together with the other buttons. *The law of continuity* [47] can be seen on the page "Hälsostatus. The horizontal lines for the tabs "Provtagningsresultat" ("Blood Test Results") and "Symptom" ("Symptoms") are connected and according to the law, they will be perceived to belong to each other.

The six fundamental design principles were also used. Norman's design principle *affordance* [36] can typically be seen for most of the buttons in the prototype, see Appendix C. In general, the design of the different buttons and tabs are similar. The button area is marked with a rectangle that invites the user to press it. When a button is pressed, the prototype gives relevant feedback. Norman's principle *feedback* [36] was applied to help the user understand the result of an action. On the page "Loggning" ("Log"), see Figure 13, the empty checkboxes are checked when pressed upon. Similarly, when the "back" arrow is pressed, the previous page is presented. On the same page, one can also see how Norman's principle of *constraints* [36] has been applied. To prevent mistakes, only numbers can be used when the users wanted to fill in the weight of the portion.

The usage of Norman's design principle *visibility* [36] can also be seen on several pages in the prototype. For instance, the main functionalities ("Behandling", "Mat & Dryck", "Motion", "Hälsostatus", "Kalender", "Beställning", and "Dialysquiz.") in the main menu represent a larger part of the page than the submenu ("Meny", "Mål", and "Profil"). The main menu is considered more important to the user at this step. Therefore, it is given a larger space for more visibility. Norman's principle about *consistency* [36] has also been applied when designing the application to make it learnable and usable. Consistency can be seen in, for instance, the submenu since it is placed and look the same on all pages. The submenu can be seen on all pages of the prototype. The law has also been utilized for the "back" button and many other buttons. Furthermore, the upper tabs are used on many pages and they are placed and designed in the same way.

On the page "Favoriter" ("Favorites") see Figure 29. in Appendix C.3, a list of recipes is shown. These are arranged in alphabetical order. It matches, for instance, how a register in a physical address book is designed. Furthermore, all pages present their information and options in a logical order where the user performs the different steps in a top-to-bottom fashion. Icons and labels have also been used for many of the buttons and tabs in the prototype. All these examples show how Norman's design principle *mapping* [36] has been applied to make the design explicit and user-friendly.

5.1.3.2 Test feedback

There was not enough time to implement all functions in the lo-fi prototype. Instead, the focus was to implement and evaluate a few of them. Many of the testers were impressed by the prototype and liked interacting with it. Based on the feedback in the result, Section 5.1.2, some parts of the design could be refined for the hi-fi prototype.

After the suggestion of removing the main menu option "Beställning" ("Ordering"), see Figure 13, from the prototype, the general concept was reviewed. The concept seemed to be a bit too extensive which makes the metaphor vague to the users. Furthermore, the name The *Dialysis Bag* was not successful since it confused one of the users to such an extent that the first scenario could not be solved independently. To better achieve the usability principle *Match between system and real world* [37], only concepts and words familiar to a dialysis patient should be used. A patient should not be required to read the application name carefully to understand the general concept. Hence, the concept and the name The *Dialysis Bag* did not prove to work ideally. By excluding the ordering function from the prototype, the application is more focused on parameters that affect health, see Section 4.2.4. It suggests a new concept that is more focused and easy to understand. The new name *DialysMästaren* (*The Dialysis Master*) would be more suitable. The new concept is based on the metaphor of a dialysis master. To become a master, you need to learn from a master. Therefore, *The Dialysis Master* will help the patient become, and motivate the patient to remain, a master of their own health.

The hi-fi prototype should be used as a tool for the patients to become masters of their own health in relation to their dialysis treatment. In the new concept, the patients will not only be able to log quantitative health parameters as seen in the lo-fi prototype, but also monitor their moods. The aim is to help the patient to connect and see the relation between symptoms, medicine, treatment, food and water consumption, exercise, and mood. If a patient feels low one day, the application could, based on parameters that have shown poor values lately, give helpful recommendations to achieve better health and increased well-being.

To clarify the alternatives in the main menu, see Figure 13, the option “Hälsostatus” (“Health Status”) will be renamed to “Hälsostatus & Råd” (“Health Status & Advice”). The problem seemed to arise more due to the name “Hälsostatus” rather than the name of the menu option “Behandling”. Other buttons that were hidden or unclear to the testers will be modified. Modifications such as the name, position, symbol, color, or shape of the buttons will be done with design principles such as Norman’s design principles [36] and the Gestalt Laws [47] in mind.

Under the tab “Symptom”, see Figure 13, the patients should be able to find more individualized risks and recommendations based on the experienced symptoms. However, under the tab “Provtagningsresultat” (“Blood Test Results”), see Figure 17 in Appendix C.1, information about the general risks of having too high or too low values of certain blood nutrients such as phosphate will be presented in the hi-fi, just as the testers wished for. Similarly, in the hi-fi prototype, the user will be able to press keywords such as names of nutrients to read more about the nutrient and the patient’s current value as requested during the lo-fi tests. The aim of this functionality was to help patients see the relation between test results and symptoms, therefore, the feedback given during the test was important for improvement. Some recommendations might have to be examined by a nurse or a doctor, for instance, when new medicines need to be prescribed. The new prototype will, therefore, include a function to get in contact with a healthcare provider. With these changes, the new prototype is expected to increase the usability goal of *having a good utility* [14].

The split interpretation of the rating of the recipe, see Figure 30 in Appendix C.3, should not be a major problem. It is the users who will rate the different recipes. Since both taste and nutrient balance is something of importance for the patient, both these will probably be taken into consideration in the ratings. Norman's law of *visibility* [36] motivates some sort of a clarification of the stars. Therefore, a rubric “Smakbetyg” ("Taste Score") will be included in the hi-fi. It will also be possible for the users to read and write comments about the dish. Furthermore, on the same page, the button “Detaljer” (“Details”) will be replaced with a recipe button for the user to read more about the recipe and nutrient content.

In the weight box, see Figure 13, the value of a standard portion will be filled in as a default value to ensure that weight is registered. The informing text of the weight of a standard portion will be put in parenthesis. These changes are thought to better inform the patient about what is going on and increase the usability principle *visibility of system status* [37]. The default value will probably also make it *easy to learn* the system [14] as well as to *remember how to use* [14] it, and thereby improve two usability goals. The user will also have an option to add or decrease the value by pressing on buttons with a plus or a minus sign. Hopefully, it will be enough to help the user understand how to specify the eaten weight and to easier associate food to weight.

Different testers interpreted the bars over the nutrients consumed during the day, see Figure 27 in Appendix C.3, in different ways. The design made some of the testers believe that when they have filled in the bar they have consumed the recommended daily intake. The recommendations for a patient can, however, not be symbolized by one value. The patient can, for example, drink both too much and too little water. Instead, the recommendation should rather be viewed as an interval of acceptable values. To symbolize this, the bars will be color-coded. When the patient has eaten too little of a nutrient the bar will be blue. If the recommended intake is achieved, it will be green. Finally, if the recommended intake is exceeded, the bar will go from orange to red. By having four colors instead of two the user will hopefully better understand that the green area symbolizes the range for recommended intake, while the blue and the red/orange color are of a more warning character if the intake is/is getting too low or too high. The new color-code is hoped to improve the *visibility of the system status* [37]. Furthermore, these colors will also be used for other functions in the prototype to symbolize recommendations and warnings. It follows Donald Norman’s design principle *consistency* [37], to help users recognize the prototype’s way of presenting information.

The list of nutrients showing up on the page “Loggning” (“Log”), see Figure 13, will remain there for the hi-fi. The clickable exclamation mark will make the patients reflect on their intake and give them recommendations (such as to take an extra Resonium pill if a lot of potassium has been consumed) based on the current situation. The hope is that the new prototype will help the users better see the relationship between food consumption, medicine, and blood test results. Patients will also receive notifications if they are about to or already have exceeded the recommended intake of some nutrients. It will pop-up before the users’ next meal. In case the patient is not able to maintain good nutrient levels for several days, the new prototype will enable the patient to get in contact with a dietarian to improve the utility of the food logging function. However, it should be optional. Otherwise, the patients might feel supervised rather than empowered.

5.2 Iteration 2

5.2.1 **Method**

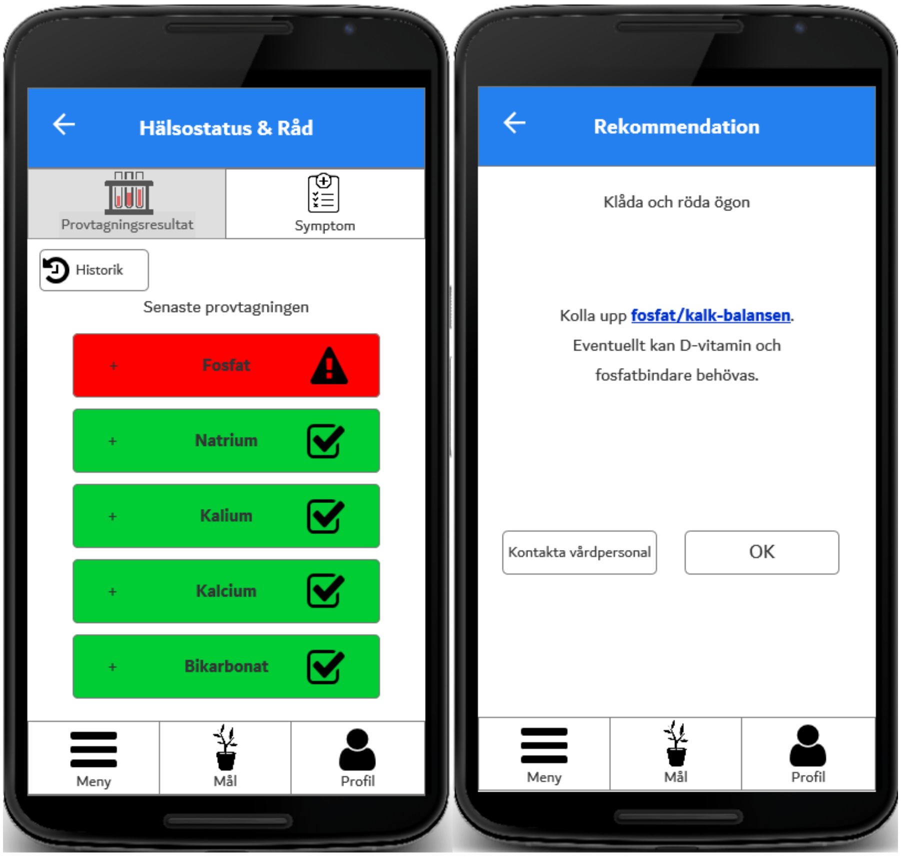
Based on the comments received during the lo-fi tests, the prototype was refined. The general concept needed to be improved. A new concept called *DialysMästaren* (*The Dialysis Master*) was established. Overall, only a few changes had to be made in terms of the design of the prototype to fulfil the new concept. In addition, some design details were modified to increase the UX. The changes that had to be made can be found in Section 5.1.3.

The hi-fi prototype [14, pp. 391-92] was created using the prototyping tool Axure RP. The prototype was designed to fit a smartphone. To test the hi-fi prototype, the scenarios, *Investigate symptoms* and *Log a meal* in Appendix C.1 and C.3, were reused. Altogether, six workers from Baxter tested the prototype given the provided scenarios. Two of them had tested the lo-fi prototype. Four testers were new to the prototype and the concept. The testers were asked to put themselves in the mindset of a PD patient. The testers were asked to comment on the structure and the design of the hi-fi prototype. They were asked to express what they see and what they think about when they interacted with the prototype. Observations regarding how the prototype was used were also made.

5.2.2 **Results**

5.2.2.1 Hi-fi prototype

The hi-fi prototype can be seen in Appendix D. Four examples of the hi-fi prototype can be seen in Figure 14 and 15.



Kolla upp fosfat/kalk-balansen. Eventuellt kan D-vitamin och fosfatbindare behövas.

Figure 14. The left-hand page shows blood test results. It is a page the user encounters when pressing the main menu option "Hälsostatus & Råd" ("Health Status & Advice"). The right-hand image shows a recommendation of how to cure the symptoms red eyes and itching.

Fosfat 0,7 av 1g
Kalium 4,4 av 4,7g
Kalcium 1 av 1,25g
Natrium 0.8 av 1.5g
Protein 30 av 70g
Vatten 1 av 1,5l

Välj Måltid:
☐ Frukost ☐ Lunch ☐ Mellanmål ☑ Kvällsmat

Biff stroganoff
(1 standardportion = 290g, 490cal)
Ange vikt: - 290 + g

Näringsinnehåll:

Fosfat:	0,23 g
Natrium:	0.59 g
Protein:	20g
Fiber:	1.8g
Kalcium:	0,056g
Kalium:	0,42g

Figure 15. In the left-hand image, the first page of the “Mat & Dryck” (“Food & Drinks”) function is visible. It shows the amounts of nutrients the user has eaten over the day. The right-hand image shows a step where the user logs food. The user can select the type of meal (breakfast, lunch, snack, or dinner) eaten and how big the portion was.

5.2.2.2 Test feedback

In general, the testers liked the prototype. The overall comments about the hi-fi prototype were that the application was easy to use, the design was appealing, good icon size, the wording was good, and that it contained a good amount of information. One tester said that the design looked good and that it should not be too simple or else people might not want to use the application. The two testers, who also tested the lo-fi prototype, noticed the new name *DialysMästaren* (*The Dialysis Master*), see Figure 33 in Appendix D.1. One of them thought the name was neat.

Scenario 1. Investigate symptoms

All testers chose the right menu option, “Hälsostatus & Råd” (“Health Status & Advice”) when they were to investigate their symptoms, see Figure 33 in Appendix D.1. Two specifically said that it was because of the word “Råd” that they chose this option. Four of the testers immediately found the tab “Symptom”

(“Symptoms”), see Figure 14, and started to fill in their symptoms. Two testers did not see it instantly. One said that since the different blood test results, which appears first when clicking on “Hälsostatus & Råd”, are colorful the focus is drawn to them, see Figure 14. Consequently, the tester did not see the tab “Symptom”. It was suggested that a thicker frame around the tabs and less intense color on the blood test results would make it easier to distinguish the tabs. The same tester realized that it would be too extensive to search under each blood test result in the list to find the symptoms and, therefore, eventually found the tab “Symptom”. The other tester, who did not chose the symptom tab, was not sure if it was possible to click on it. Instead, the tester found the information by clicking on the “Fosfat” (“Phosphate”) in the test result list under the tab “Provtagningsresltat” (“Blood Test Results”), see Figure 14. The same tester also wanted to be able to get an overview in the calendar, see Figure 33 in Appendix D.1, to see if the person had followed the treatment, eaten well, and so on. In that way, the user could see which events could have possibly caused the symptoms. Another tester was not sure if it was the tab “Symptom” or the tab “Provtagningsresultat” that was open in the page “Hälsostatus & Råd”, see Figure 14. The tester would have preferred the open tab to have same color as the background, and not grayed.

When reading the recommendation for the given symptoms, two of the testers clicked on the link (highlighted words) in the recommendation to receive more information, see Figure 14 and Figure 37 in Appendix D.1. One of them associated this advice to the test results, and said that after following the advice, the phosphate tab should turn green at the next test. Three testers did not click on the link, they clicked on “OK” and searched for more information in the test result list. Since the phosphate tab was red, they clicked on this tab. One of the testers, who did not click on the link, suggested that the link could be replaced with another button to increase visability. Then, this button could be used instead of viewing the test results. The same tester wanted to come back to the main menu after pressing “OK”. It was also suggested that next to the heading “Senaste Provtagningen” (“Latest blood test results”), see Figure 14, the date should be included. Another suggestion was to add a tick in box, named “Other”, see Figure 35 in Appendix D.1. If the patient then tick in that box, they should be recommended to contact healthcare professionals for further assistance. The tester proposed that the recommendation given could be divided under different headings, to make it easier to understand.

Scenario 3. Log a meal

The main menu option “Mat & Dryck” (“Food & Drinks”) were the obvious choice for all testers when wanting to log their food, see Figure 38 in Appendix D.2. Three testers accessed the logging function by clicking on the button “Logga Mat” (“Log Food”), see Figure 15. The same person thought that “Favoriter” (“Favorites”), see Figure 40 in Appendix D.2, contained default recipes and not your own recipes. One tester wanted to choose the button “Vanligaste” (“Most Common”), but then chose “Favoriter” on the same page. One of them looked at the recipe before logging the food. The same person thought that the favorite recipe list, see Figure 41 in

Appendix D.2, could be represented in some other way. If, for example, you only have five recipes saved as favorites, the tester found it unnecessary to have them in alphabetical order. Three other testers accessed the logging function by going to the tab “Recept” (“Recipe”), see Figure 15.

When the testers were about to fill in the weight for the food they had eaten, they all noticed that the standard portion was already filled out, see Figure 15. One of them wondered if the portion size was individual. Two testers forgot to tick in the box to choose which meal they have eaten, see Figure 15. It was noticed, in two other cases, that the testers initially forgot to select which meal they have eaten, but did it before continuing to the next page. Four of the testers clicked on the information symbol next to potassium, but all six testers thought that this symbol meant that there was additional information available. One who did not click on the symbol were already aware of the fact that the potassium value was high. This was noticed when the tester entered the menu option “Mat & Dryck”.

One tester expressed that it was not clear that it was possible to add your own recipes under the tab “Recept”. Another tester, who looked at the recipe, thought it was good that information about nutrients was available. It was suggested to give some additional indication to the user to warn them if a recipe contains a lot of, for example, potassium.

After logging the food, a green notification “Maten är loggad” (“The food is logged”) was showed to confirm the log, see Figure 45 in Appendix D.2. One user wanted the notification to contain information about what food has been logged. The same user liked the bars for the different nutrients, see Figure 15, and thought they were easy to understand. Though, it was not obvious to the user what all the colors meant. The tester thought that green is good, orange means there is something to pay attention to, and the blue color was a bit confusing. It was suggested that some sort of description of what the colors represent could be added. The tester thought that this information could be useful the first couple of times when using the application. One last comment about the overall design of the prototype concerned the menu icon placed at the bottom-left corner in all pages. One tester thought that this icon meant that there were additional functions available if clicking this button. To be a menu button, the user would have liked to place the icon in the upper right corner. Moreover, it should not be visible on the menu page.

5.2.3 **Discussion**

5.2.3.1 Design aspects

The result from the lo-fi prototype worked as a ground for the design of the hi-fi. That is why many similarities can be seen when comparing the lo-fi prototype, see Appendix C, with the hi-fi prototype, see Appendix D. However, some changes had to be made. The feedback from the lo-fi tests was used to improve the overall design and interaction. Some of these changes are described in Section 5.1.3.2.

As described by Norman [36], even though usability is an important factor for UX, users often prioritize aesthetic more than usability. Since the prototyping tool, Axure RP, provided more efficient prototype tools than the ones used for the lo-fi, typography and other more specific and concrete design choices were brought into focus for the hi-fi.

Depending on what designers want users to think of when they see a product, different color options should be considered. Different colors give rise to different emotions and impressions. Users associate several colors, such as blue and purple, with high-quality, stability, and reliability [48]. The meaning of color blue has shown to be independent of the user context and can, therefore, be used for many different types of products and brands without the change of meaning [48]. As can be seen in Figure 14 and 15, one of the main color used in the hi-fi is blue. The color was chosen due to the motivation described above. Blue was used in the heading for the different main functionalities in the prototype. The white color was used for the background. A brighter color was chosen for the background to achieve a more bright and desired appearance. White is associated with purity [49], and since this application is related to health service and healthcare, purity seemed like an appropriate impression to bring out.

In the hi-fi prototype, the same typography was used for all texts. The one chosen for this prototype was Dubai, which is a Sans Serif font. On applications with screens, Sans Serif is better suited. Those fonts have a lower level of detail than Serif and look, therefore, better at low resolutions [50]. Headings and names of the same type were given the same text size. Only a few different sizes were used to illustrate different groupings, such as headings and subheadings. It was thought to improve the overall *visibility* [14], in accordance with Norman's design principle.

In both the lo- and hi-fi prototype, icons were used to improve Norman's design principle *mapping* [36], between the functionalities and different tabs and buttons. When icons were used, names were also used to describe the option. The users did not show any confusion or dislike with the icons for the lo-fi prototype. Hence, as many of the icons as possible were re-used in the hi-fi. Some of the icons were, however, not assessable when using the Axure RP tool. Therefore, some differences can be seen between the lo- and the hi-fi prototype. Again, the design principle *consistency* [14] was applied and all the chosen icons were uniform, with the same sizes and colors. In the hi-fi prototype, the layout was more consistent than for the lo-fi prototype since it was easier to use grids and more precisely, using a y- and x-coordinates, place the different groups of information.

5.2.3.2 Test feedback

The testers were impressed by the application and liked interacting with it. The concept *The Dialysis Master* was found to be a stronger concept compared to *The Dialysis Bag* since it did not cause the same confusion. The testers seemed to accept the concept, and it did not prevent them from performing their intended tasks. With more functions implemented in the application, further analysis about whether the concept was successful could be performed.

In response to the feedback received from the tests of the lo-fi prototype, the menu option "Hälsostatus" ("Health Status") the name was changed to "Hälsostatus & Råd" ("Health Status & Advice"). The change was made to help the user better understand which functionalities could be found in this menu option. When testing the hi-fi prototype, all testers immediately knew which menu option to choose to seek for information about their symptoms. This confirmed that by changing the name, the *mapping* [36] between the name of the menu option and the underlying functionalities was improved.

From the tests, it was realized that there were some potential improvements to the design of the application. For example, the user was not sure what tab that was open due to poor *visibility* [36]. In Figure 14, the tab "Provtagningsresultat" ("Test Results") is grey, which indicates that the user is currently located in that tab. Poor *affordance* [36] made some users question whether it was possible to push the button "Symptom" ("Symptoms"). To increase the *affordance* [36] and *visibility* [36] the tabs need to look more clickable and it should also be more evident which tab the user is currently located in. This could be done by, for example, adding a frame around the tabs, and change the color of the tab so the open tab has the same color as the background. By improving these aspects, the usability and thereby the UX will become better. The benefits with the tabs, is that they allow the user to quickly access different functionalities in the application, and therefore, provide *flexibility and efficiency of use* [37].

One tester suggested that beside the header "Senaste Provtagningen" ("Latest Test Results") the date the test was taken could also be included, see Figure 14. This would help to reassure the user that it is the latest test results which are presented. Another suggestion was to add the option "Other" in the symptom list, see Figure 35 in Appendix D.1. The idea of the symptom list is that the options of symptoms available are based on the user's test results and food consumption. If, for example, the calcium value is high, then suggestions of symptoms related to high calcium values will be presented. To add the option "Other" could still be relevant though, since the user could be recommended to contact healthcare providers for more help. It would improve the *utility* [14] of the application. After choosing symptoms, the user will get a recommendation about what to do to cure the symptoms. Further information could be accessed by clicking on the highlighted words in the recommendation, see Figure 36 in Appendix D.1, or by looking in each test result tab: phosphate, calcium and so on. One tester proposed that the information could be accessed by a third button on the page. Adding another button could increase the *visibility* [36] since it will be more apparent to the user which options are available.

After reviewing the recommendation and pressing "OK" in Figure 36 in Appendix D.1, the user returns to "Hälsostatus & Råd", see Figure 15. One tester would prefer to return to the main menu after pressing "OK". Though, there are reasons why the interactions look like this. The idea about the *The Dialysis Master* is to make the dialysis patient more aware of their health condition and to help them feel better by providing support. By letting the user return to the test results after seeing the recommendation about how to cure their symptoms, then it will be easier for them to understand the connection between symptoms, test results, and treatment. For example, if the recommendation to cure the symptoms says that the patient has high phosphate and should take more pills, then, when pressing "OK" the patient will view the test results and see that the phosphate tab is red. After taking more pills, the patient will feel better and cure the symptoms, and the test results will improve, the phosphate tab will turn green. The same idea is applied in the food logging function. After the users have logged their food, they will return to the page where they have an overview of nutrients ingested during the day, see Figure 15. They will receive *feedback* [36] both that the logging was successful, but they will also see that the values of the nutrients bars have increased. This will make the users more aware of what food is good for them by keeping track of nutrients ingested. The color coding of the nutrient bars created some confusion during the tests, the meanings of some colors were more obvious than others. To reduce this confusion, and make the app *easy to learn* [14], some information about the meaning of the different colors should be available. This could be done in different ways, the information could be provided the first time using the application, or an information button could be added below the bars.

When the testers were asked to log their food in the application, the testers accessed this functionality either through "Logga Mat" ("Log Food") or by pressing the tab "Recept" ("Recipe"), see Figure 15. By providing two options of how to access a function, the application is *flexible and efficient to use* [37]. One tester did not think it was clear that it was possible to add your own recipes under the tab "Recept". This is something which should be made more clear in a future version of the application.

When logging food in the lo-fi prototype, having to add the weight of the food created some confusion for the testers. This was improved in the hi-fi prototype by having the standard portion filled in per default and that the information about how big a standard portion is inside brackets, see Figure 15. From tests of the hi-fi prototype, it was evident that the improvements have made it easier for the user to fill in the weight of the food. Though, in many cases, the user's attention was drawn to the weight page and the nutrients list and some of them did not see that they should fill out the type of meal at the top of the page. Some changes need to made to improve the *visibility* [36] of this. By increasing the visibility, the user will access the different parts of the page in a top-to-bottom order, which will prevent them from missing filling out important parts. Some *constraints* [14] could be added to the design, for example, that the user should not be able to log food without choosing what type of meal it is. Another option could be to divide the content into two pages to reduce the amount of information on each page. This would reduce the risk of the user missing information due to *inattentional blindness* [46].

One tester questioned why the list of favorite recipes had to be in alphabetical order. This format was chosen to ensure a good *mapping* [36] to make it easy for the user to find what they are looking for. Therefore, no change should be done. Another user found the menu symbol, visible in the bottom-left corner on all pages, somewhat confusing. This user was referring to how this symbol is usually used on computers. It was suggested that it should be moved to the upper-right corner to better match other systems. One risk about doing it would be a decreased *consistency* [36] in the design of the application. If moving the menu icon, more user tests must be performed to evaluate the outcome.

5.2.3.3 Final prototype

In conclusion, based on the feedback given during the tests, the hi-fi prototype was much easier to understand compared to the lo-fi prototype. The testers liked both the general concept as well as the design. The tests indicated that the prototype has a good potential to deliver a good user experience and be easy to use. However, this project only addresses the first step of a much bigger product development process. Therefore, there are still many improvements that could be made, some are mentioned in Section 5.2.3. *The Dialysis Master* is just one of many interactive products that could solve the problem. Based on the user needs it is believed that *The Dialysis Master* can empower the patients in their everyday life. The results from this report should, however, be confirmed by testing the prototype on the primary users i.e. home dialysis patients.

6 General discussion

6.1 Results

The main part of this project was to identify home dialysis patient’s needs. By interviewing home dialysis patients and healthcare professionals, it became clear that dialysis treatment requires a lot of time, planning, and changes of lifestyle. Dialysis patients constantly need to keep track of their health, for example, what they eat and how they manage their treatment to feel well. The prototype of the application *The Dialysis Master* created in this project, was designed with the user needs in mind. This application will help dialysis patients in their everyday life, empower them, and make them feel like they are in control of their lives. The intended users are home dialysis patients, but perhaps the application could also encourage patients performing dialysis in-center to be more involved in their treatment and promote self-care.

Even though this project resulted in a health application, there were many needs identified during the user study which could be further investigated. Baxter and other dialysis companies could use these results to further develop and improve their products. The results could also be used to develop completely different products to improve the life of a dialysis patient. For instance, if restaurants provided special menus adapted to the food restrictions a dialysis patient could more easily eat out with their friends. The results from this report could also be used in other contexts. It could be used for educational purposes to educate nurses, doctors, and common people about how it can be to have dialysis at home. The knowledge about dialysis patients and their needs could also be used when discussing the political aspect of chronic kidney disease. It could enlighten and encourage municipalities to allow and help dialysis patients install the equipment needed for the home treatment. As appeared during the interviews with the nurses and patients, home dialysis is significantly less expensive than in-center dialysis in Sweden. Other sources, such as the report [51] posted by Stockholm County Council, also stresses this. Still, some municipalities prevent dialysis patients from taking home their treatments. It does not only affect the life of the patients negatively, but also taxpayers.

6.2 Design Process and methods

The interviews and observations performed during the user study generated a lot of data. Throughout the project, better knowledge about handling a large amount of qualitative data has been obtained. New skills were acquired when prototyping, where both authors learned how to use the prototyping tool Axure RP. Another lesson learnt was how to develop concepts. The design process has been a true iterative process where the concepts continuously were evaluated and refined in accordance with the user needs. This project has shown why an iterative process is favorable to use for design. The iterative process has not only proved to be a way to move on with a project, it also highlighted more concrete improvement areas in every step of the process. Hence, an iterative design process is useful since it ensures improvements of both the concept and the general product design. Each concept can progress to a better concept and every prototype can be used to create a better and new prototype. It became clear when the name of the concept was changed towards the end of this project.

When reviewing the design process, there are some things which could have been done differently. The biggest challenge encountered was to get in contact with the primary users. To save valuable time, the planning of the user study could have been initiated at an earlier stage of the process. With earlier planning, perhaps more interviews could have been conducted or more time could have been spent working on the concepts and prototypes. The data collected were already extensive and with more data, the analysis would have taken longer time. Another thing which could have been done differently, was to generate a larger number of more refined concepts. It was realized at an early stage, for example, that the concept The Dialysis Bag contained many ideas. Conceptual design is an important step of the design process. More focused concepts tend to be easier for the user to understand, something that has been learned during this project. Hence, this concept should have been divided into smaller pieces earlier. Finally, before testing the lo- and hi-fi prototypes, pilot tests should have been performed. By doing it, obvious errors in the prototypes could have been eliminated before the actual tests. Then, the tests would focus more on the design and interactions, without the testers having to comment on unnecessary errors.

During the conceptual design the different concepts needed to be evaluated. There was not time to continue working on all of the generated concept. A method to evaluate the different concepts against each other, despite their different abilities to solve different kinds of problems and different number of problems, had to be found. Initially, personas was not intended to be used. Since the concepts differed a lot from each other, it was difficult to compare them straight away. Many evaluation methods, such as Pugh’s Matrix, were not suitable to use. By evaluating the concepts based on a method that visualize a patient’s perspective, i.e. personas, the problem was avoided. The method also provided an objective way of studying needs without focusing on specific stories or needs provided by the interviewees. It prevented the evaluation from becoming biased due to personal connections with certain patients.

As mentioned in the beginning of this report, customer journey map was a method considered to be useful for the project. It was thought that by compiling a typical dialysis patient's treatment journey over a week or a month, ideas of how certain touchpoints could be improved would be provided. After the interviews were conducted and data was analyzed, it was realized that a patient encounter a lot of touchpoints over a week and incredibly many over a month. Therefore, it became clear that the map would be too undetailed if a patient's journey over a week or month would have been created. The method could, therefore, not be used to identify improvement areas for touchpoints. Hence, it was not useful when generating ideas for new concepts and functionalities. However, it became a suitable method to use when evaluating the chosen concept. By designing smaller and more detailed customer journey maps based on the personas, the method suggested how the different personas would use for the concept in different ways and how they concept would benefit from the concept more in detail. The method, therefore, helped the authors in an objective way to better envision and ensure the usefulness of the concept. It guaranteed a user centered approach.

The user study performed in this project resulted in many needs identified among home dialysis patients. These needs were kept in mind during both the conceptual design and the prototyping phase. Due to the limited time, neither the lo- or the hi-fi prototype was tested on the primary users. It would have taken too much time to schedule meetings and travel to their homes again. Instead, heuristic evaluations and prototype tests performed by people familiar with dialysis patients and their living conditions were conducted. The tests performed gave information about the overall design and how the interactions between the user and the application worked. Primary users would be able to give feedback about the content of the application and how useful they find it. To obtain more reliable feedback, more tests should be conducted and they should also be performed by the primary users. It is an improvement that should be taken into consideration for future work. Another target group which could be interviewed in the future, are people performing in-center dialysis. With an interactive product helping them, they might consider home dialysis as an option.

The user study was extensive. It can be questioned whether all data was needed. However, if all the data had not been collected important aspects would have been excluded. Since an explorative user study was conducted, the aim was to find the problem scope. If not all the questions had been asked, the same deep understanding about the patients and their needs would not have evolved. It could have resulted in a prototype with a lack of important functionalities for the patients. However, for future work it would be recommended to do a more focused user study, where a specific set of patients are interviewed. As mentioned before, patients have different treatments, machines etc. Furthermore, there are also age, gender, social, cultural, and geographical differences among the patients. These factors could be correlated with the needs. A more focused study could probably better identify these correlations. That insight could then be used to better cover more specific needs and provide an even more individualized product for the patients.

6.3 Future work

The next steps to take for *The Dialysis Master*, apart from the parts mentioned above, includes implementing and testing the other functionalities, such as “Behandling” (“Treatment”), “Motion” (“Motion”), “Kalender” (“Calendar”), and link them to each other. The tab “Profil” (“Profile”), see Figure 14, also needs to be implemented to adjust the functionalities to provide support that is specific and individualized. Another important design aspect to consider is how to motivate users to continue to log their food and beverage intake, treatments, etc. In the long run, patients might think it is too bothersome to fill in all their treatments and food consumption. Therefore, it is important to make the tasks as easy as possible, to keep them motivated. Maybe gamification could be utilized to achieve this. Gamification can be used in products to increase the users’ engagement and motivation [52]. The tab “Mål” (“Goals”), see Figure 14, was thought to contain motivating features. Furthermore, to make patients stay loyal to *The Dialysis Master*, it should also include some sort of lock-in functions. Collecting and storing the patient’s old data could be one way to make them stay and prevent them from switching to other apps. Finally, the last step would be to develop and implement a real application that works on multiple devices.

7 Conclusion

The purpose of this project was to investigate how to further involve home dialysis patients in their treatment, from an interaction design perspective. More specifically, the question was whether an interactive product could empower dialysis patients, both regarding their treatment and their life in general. Based on the information gathered from the literature study and the user study, it can be concluded that there are many needs among home dialysis patients. Therefore, there are many ways to answer the research question. When interviewing home dialysis patients and healthcare professionals, some needs recurred and some were individual. The major needs were summarized into 17 themes such as travel, ordering dialysis equipment, exercise, diet, and medication. Based on these themes, different concepts were generated.

The concept *The Dialysis Bag* was found to matter the most for a regular dialysis patient since it solves more of the needs from the 17 themes than the other concepts. *The Dialysis Bag* is a service which provides functionalities the dialysis patients could use in their everyday life including help with keeping track of their diet, a machine manual, a calendar, a training log, an ordering function for dialysis equipment, a journal to log their treatment, and a quiz. When comparing the concepts to each other, *The Dialysis Bag* was found to be the most beneficial, to empower the patients, to make their life easier, and to improve their quality of life.

Through several iterations using methods such as Pugh's Matrix, Nielsen's heuristics and prototyping, the overall concept was refined and delimited. The final concept became a health application called *The Dialysis Master* which would help the user to keep track of their health daily.

The prototype tests showed promising results regarding the concept and the design of the prototype. In general, *The Dialysis Master* seemed to provide help and support for the users in an understandable and desirable way. However, not all functions were implemented in the prototypes. Therefore, the rest of the functions should be implemented and tested to further evaluate the concept and the design of the application. Tests should also be made by the primary users to assure its usability and the overall UX.

In conclusion, there are many needs among home dialysis patients and, therefore, there are many ways of empowering them. Though, to empower them in their everyday life, the major conclusion drawn from this project is that a health application which would be used daily, *The Dialysis Master*, would be most beneficial for the regular dialysis patient. With this application, the patients will be more involved in their treatment which will give them a sense of control and increase their quality of life.

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Appendix A Interview questions

A.1 Interview questions for patients

Bakgrund

Vi tänkte inleda med några korta frågor om vem du är och din medicinska bakgrund.

Demografisk information

- Kön
- Hur gammal är du?
- Bor du ensam eller tillsammans med någon?
- Vad för typ av bostad bor du i?
- Arbetar du?
- Hur lång tid tar det för dig att ta dig till sjukhuset?

Kortfattat, hur ser din medicinska bakgrund ut?

- Hur länge har du haft dialys?
- Har du testat olika typer av dialys?
- Hur länge har du haft dialys hemma?

Behandling

Nu tänkte vi ställa några mer specifika frågor som berör din behandling.

Hur ser din behandling ut?

- Vilken typ av behandling har du? (HD eller PD)
- Hur ofta genomför du den?
- Hur länge?
- Vad tycker du är det jobbigaste med din behandling? Något som är onödigt?
- Hur fördriver du tiden under behandling?

Hur var det för dig att välja dialysmetod?

- Hur fick du information om de olika alternativen? (från läkare, sjuksköterska, vänner, online..)
- Var informationen du fick tillräcklig?
- Kunde den varit formulerad på ett annat sätt?
- Vad bidrog till att du valde hemdialys?
- Involverades någon av dina anhöriga i valet av hemdialys? (Fick de ta del av information, mentalt stöd etc.)

Hur gick din träning till för att klara av att själv utföra dialys hemma?

- Vem var ansvarig för träningen?
- Vad var bra och vad var mindre bra med träningen?
- Hur länge tränade du?
- Hur kände du när det var dags att genomföra behandlingen själv hemma?
- Kunde något med träningen gjort annorlunda för att du skulle känna dig ännu säkrare?
- Vad är ditt bästa tips till en ny dialyspatient?

Relationer

Vi skulle nu gärna vilja veta mer om hur det är för dig att kommunicera med olika personer i omgivning.

Beskriv din relation med sjukvården

- Hur ofta behöver du vara i kontakt med sjukvårdspersonal?
- Hur sker dessa kontakter? (besök på sjukhus, hembesök, telefonsamtal, mejl osv.)
- Skulle du vilja att dessa möten sker på andra sätt? Hur?
- Upplever du att du fått det stöd från sjukvården som du behöver?
- Hur delaktig är du i din behandling och utformningen av den?

Beskriv din relation med din familj och dina vänner

- Hur viktiga är din familj och vänner för din dialysbehandling?
- Tycker du att de ger dig den stöd du behöver?
- Tycker du att de har en tillräcklig förståelse för din livssituation och behov?
- Vem tror du har bäst koll på dina behandlingsresultat - sjukvård eller nära och kära?

- Umgås du ofta med dina vänner?
- Skulle du vilja utveckla ditt kontaktnätverk?
- Hade du velat vara i kontakt med fler patienter som går på dialys?

Beskriv din relation med jobb

- Upplever du att din chef och arbetskamrater förstår din situation?

Beskriv vilka utmaningar du finner utanför ditt hem i dagens samhälle?

- Tycker du att du får tillräckligt stöd från samhället?

Upplevelser

Nu skulle vi vilja veta lite mer om hur det är att ha sin dialysbehandling hemma.

Vad är din upplevelse av att ha dialys hemma?

- Vad upplever du är det bästa med att utföra dialys i hemmet?
- På samma sätt vad upplever du som det sämsta med att utföra behandlingen hemma?
- Känner du dig säker när du genomför din dialys hemma?
- Vet du vem du ska vända dig till om tekniska problem uppstår?
- Har du någon gång fått medicinska komplikationer? Visste du vem du skulle vända dig till när/om det uppstod?

Vad behöver du tänka på, rent praktiskt, kring att ha dialysen hemma?

- Hur ofta behöver du vara i kontakt med tekniker?
- Gör du beställningar själv över engångsartiklar och receptbelagda produkter?
- Hur ofta levereras dessa varor hem till dig?
- Hur är ljudet på din dialysmaskinen?
- Påverkar maskinen din eller någon annans sömn negativt?
- Hur stor yta tar maskinen och varorna?
- Finns där något som du stör dig på gällande din behandling?

Livsstil

Vi inser att din behandling påverkat dig och ditt liv mycket.

Hur upplever du att din livsstil och attityd påverkas av din behandling?

- Har du ordinerade dieter (mat och dryck) du behöver hålla dig till?

- Upplever du att du kan anpassa dig till det?
- Motionerar du? Tror du att du rör dig tillräckligt mycket?
- Påverkar det ditt mående?
- Vad skulle kunna få dig att bli mer motiverad att läsa på och bli mer engagerad i din hälsa?
- Hur tycker du att din livskvalitet är idag?
- Känner du att du har kontroll över ditt liv?

Tilläggstekniker

Vi skulle vilja veta lite mer om din syn på och ditt användande av teknik idag.

- Hur håller du reda på allt du måste göra? (läkarbesök, beställningar, provtagning..)
- Vilka tilläggstekniker använder du för att underlätta din behandling?
- Kan du tänka ut någon teknik som skulle kunna underlätta din vardag?

Avslutande frågor

Vi har nu pratat om olika delområden såsom dina relationer, din behandling och din livsstil.

- Upplever du att det finns något annat område som begränsar dig?
- Vad saknar du mest från den tid du var frisk?
- Vad är din målsättning som du vill uppnå i din behandling?
- Utgående från det vi har pratat om, har du något mer att tillägga?

A.2 Interview questions for medical staff

Bakgrund

- Vad är din formella “titel”?
- Hur länge har du arbetat inom detta?
- Arbetar du med hemdialyspatienter just nu?
- Hur länge har du gjort det?

Upplevelser

Vad är din upplevelse av patienter som utför dialys i hemmet?

- Föredrar du att behandlingen utförs i hemmet eller på sjukhuset? Varför?
- Ser du något gemensamt hos de patienter som lyckas bra med sin behandling och följer den väl?
- Märker du någon skillnad på mående mellan dialyspatienter som genomför sin behandling på sjukhus relativt i hemmet?
- Märker du någon skillnad i attityd mellan dialyspatienter som genomför sin behandling på sjukhus relativt i hemmet?
- Vilka är vanliga problem som uppstår med hemdialys?
  - För patienter
  - För personalen
- Var brukar brister patienten i sitt ansvar? (äter fel, glömmer, missar behandling osv)

Initieringsfas

Hur ser övergången från dialys på sjukhuset till dialys hemma ut?

- Vilken information får patienterna om de olika behandlingsformerna?
- Vad är era rekommendationer till patienter gällande behandlingsform?
- Hur ser träningen ut för personer som ska gå över till att ha dialys hemma?
- Hur länge brukar patienterna i snitt behöva träna innan de klarar av att sköta dialysen själva hemma?
- Vilka är de vanligaste svårigheterna som patienterna stöter på?
- Vilka anledningar finns det till att patienter inte vill ha dialys hemma?
- Vad skulle man kunna göra annorlunda från sjukvårdens sida för att fler patienter skulle vilja ha sin dialysbehandling hemma?

Relationer

Hur ser kontakten ut mellan sjukvården och hemdialyspatienter?

- Hur tycker ni att kommunikationen är mellan sjukvård och hemdialyspatienter?
- Hur ofta brukar du vara i kontakt med hemdialyspatienter?
- Hur sker dessa kontakter? (Mejl, telefon, hembesök..)
- Görs hembesök? Hur ser ett typiskt hembesök ut?
- Hur ofta tittar du på monitoreringsdata från hemdialyspatienter?
- Försöker ni engagera patienter i sin behandling? Hur?
- Försöker ni få patienter mer motiverade? Hur?

Hur viktig är patientens relationer med vänner och familj?

- Hur tycker ni att kommunikationen är mellan sjukvård och anhöriga?
- Gör sjukvården något för att involvera anhöriga i behandling?
- Vilken information får anhöriga ta del av?
- Erbjuds anhöriga och vänner stöd?

Tror du att det är lätt för patienter att anpassa sig till dagens samhälle?

- Vilka problem ser du för dialyspatienter i samhället?
- Är det vanligt att patienter fortsätter att arbeta efter beslutet om dialysbehandling?

Framtid

- Tror du att det kommer att bli vanligare med dialys i hemmet i framtiden?
- Hur tror du att man skulle kunna göra patienten mer involverad i sin behandling?
- Har du någon idé på en tilläggsteknik som skulle kunna underlätta patientens liv, makt och attityd mot sin behandling?

Appendix B Informed consent form

B.1 Informed consent form for patients

Informerat samtycke för medverkan i intervju

Syfte

Studien ingår i ett examensarbete vid Lunds Tekniska Högskola som görs i samarbete med företaget Baxter. Syftet med intervjuerna är att ta reda på hur man kan förbättra dialyspatienters vardag och få dem mer involverade i sin behandling. Intervjuerna syftar också till att få en inblick i hur det är att vara dialyspatient och hur livet påverkas av behandlingen.

Genomförande

Intervjun beräknas ta cirka 60 min och kommer vara ett friare samtal kring dina upplevda problem och behov i vardagen. Om du vid intervjutillfället samtycker kommer intervjun att spelas in för att vi i efterhand ska kunna säkerställa att en korrekt tolkning av samtalet. Under intervjun kan du välja att avstå från att besvara vissa frågor. Deltagande i studien är frivilligt och som intervjuperson förbehåller du dig rätten att när som helst, utan särskild förklaring, avbryta intervjun och dra tillbaka ditt deltagande i studien. Om du ger oss ditt medgivande skulle vi eventuellt även vilja ta några bilder på din hemmiljö. Bilder och ljud kommer enbart användas som material för studien.

Sekretess

Allt material från intervjun kan komma att användas i studien (såvida du inte väljer att avsluta din medverkan). Dina svar kommer att hanteras konfidentiellt och endast de som är involverade i utförandet av studien kommer att få tillgång till intervjumaterialet. Du kommer att vara helt anonym och resultaten kommer inte att kunna kopplas till dig.

Kontaktuppgifter

Om du har frågor eller funderingar kring intervjun är du välkommen att kontakta oss via e-mejl:

Ebba Ahlberg: ebba.ahlberg.099@student.lu.se

Paula Carlsson: paula.carlsson.924@student.lu.se

Frivilligt deltagande

Jag intygar härmed att jag frivilligt ställer upp på en intervju enligt beskrivningen ovan.

Datum, ort: ____

Signatur: ____

Namnförtydligande: ____

B.2 Informed consent form for medical staff

Informerat samtycke för medverkan i intervju

Syfte
Studien ingår i ett examensarbete vid Lunds Tekniska Högskola som görs i samarbete med företaget Baxter. Syftet med intervjuerna är att ta reda på hur man kan förbättra dialyspatienters vardag och få dem mer involverade i sin behandling. Intervjuerna syftar också till att få en inblick i hur det är att vara dialyspatient och hur livet påverkas av behandlingen.

Genomförande

Intervjun beräknas ta cirka 60 min och kommer vara ett friare samtal kring din uppfattning av dialyspatienter och deras behov i vardagen. Om du vid intervjutillfället samtycker kommer intervjun att spelas in för att vi i efterhand ska kunna säkerställa att en korrekt tolkning av samtalet. Under intervjun kan du välja att avstå från att besvara vissa frågor. Deltagande i studien är frivilligt och som intervjuperson förbehåller du dig rätten att när som helst, utan särskild förklaring, avbryta intervjun och dra tillbaka ditt deltagande i studien.

Sekretess

Allt material från intervjun kan komma att användas i studien (såvida du inte väljer att avsluta din medverkan). Dina svar kommer att hanteras konfidentiellt och endast de som är involverade i utförandet av studien kommer att få tillgång till intervjumaterialet. Du kommer att vara helt anonym och resultaten kommer inte att kunna kopplas till dig.

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Frivilligt deltagande

Jag intygar härmed att jag frivilligt ställer upp på en intervju enligt beskrivningen ovan.

Datum, ort: ____

Signatur: ____

Namnförtydligande: ____

Appendix C Lo-fi prototype

C.1 Scenario 1. Investigate symptoms

Lately you have been having trouble with itchiness and red eyes. This is something that has bothered you for quite some time now, but you do not want to contact your nurse or doctor unnecessarily. Therefore, you want to investigate what the problem might be, using different functionalities in *The Dialysis Bag* application. Your task is to figure out why you have been experiencing itchiness and red eyes, and what you could do to cure your symptoms.

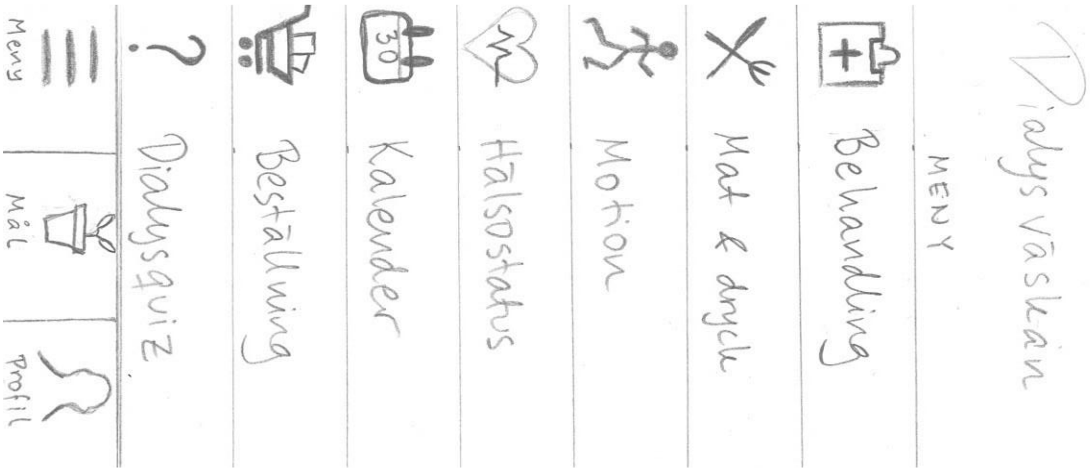


Figure 16. Main menu in *The Dialysis Bag*. The user presses "Hälsostatus" to continue to the next page.

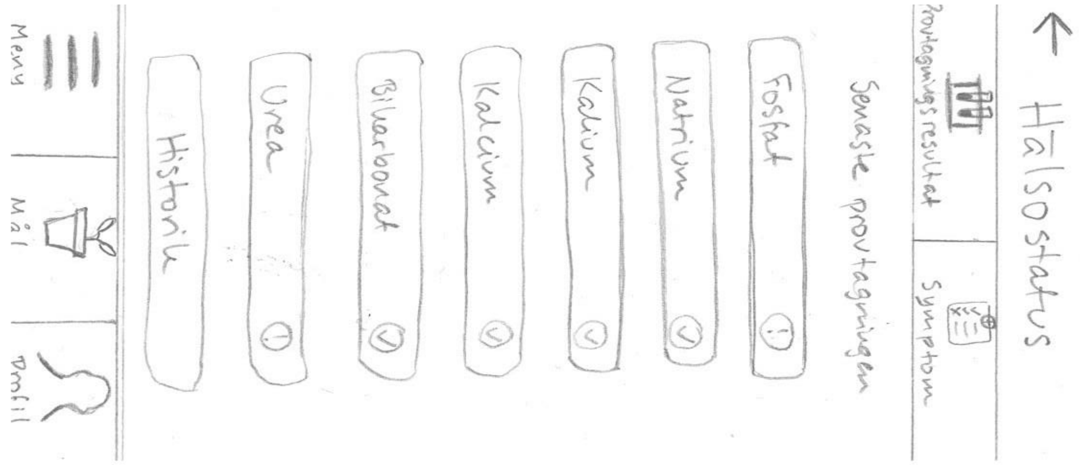


Figure 17. On this page, the user presses the tab "Symptom" to proceed.

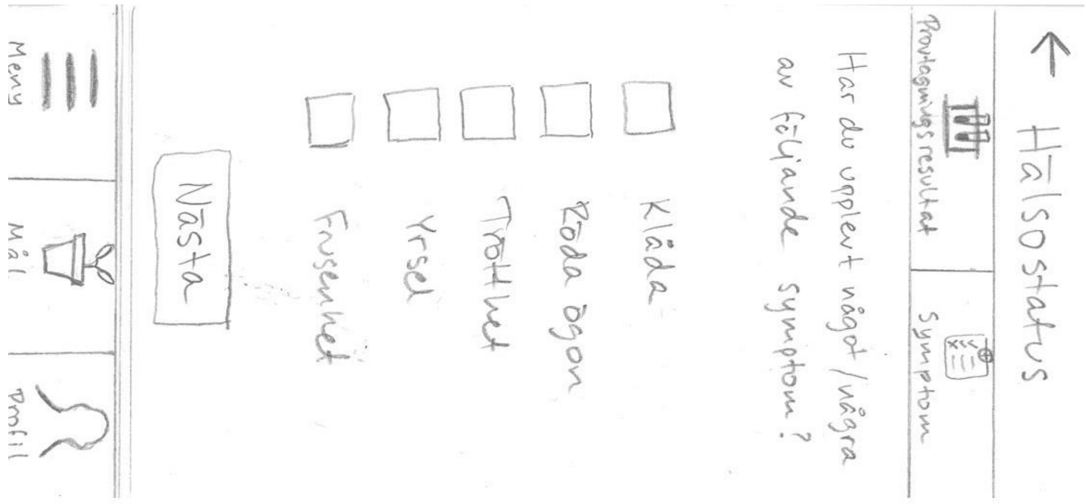


Figure 18. The user ticks the boxes indicating relevent symptoms then clicks "Nästa".

Figure 19. The recommendation of how to cure the symptoms appears. When pressing "OK", the user will come back to the page seen in Figure 17.

C.2 Scenario 2. Order dialysis equipment

You need to place an order of new dialysis equipment. You are not sure about how much equipment you still have at home, but after making the order, you want to have a total of:

- 10 extraneals bags
- 3 hand sanitizers
- 6 drainage bags

Since you are an anxious patient, after placing the order you want to make sure that it has been accepted.

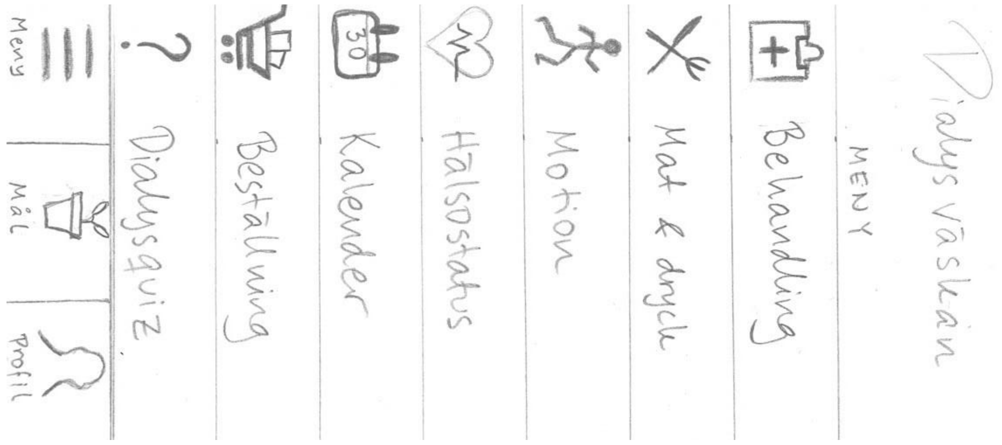


Figure 20. Main menu in *The Dialysis Bag*. The user presses "Beställning" to continue to the next page.

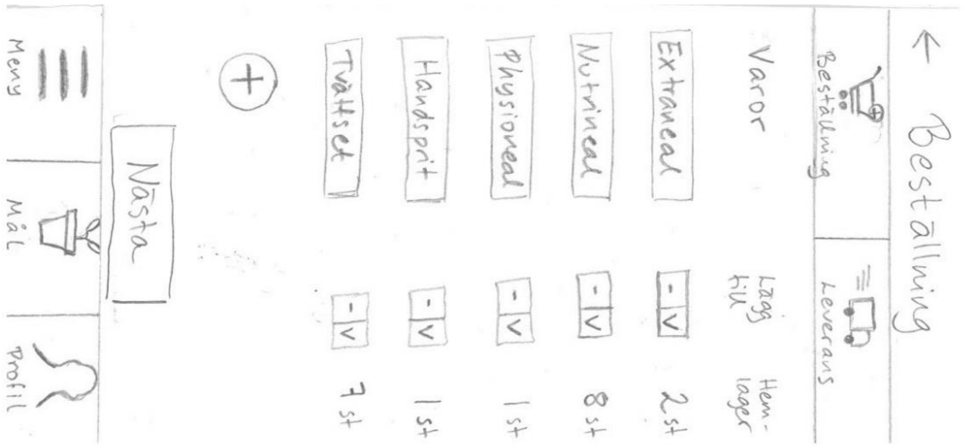


Figure 21. On this page, a list of commonly ordered equipment appears. Under "Hemlager" the users can see how much equipment they have at home, and to choose how much to order. When the user wants to add something new list, they press the plus sign button which directs them to the next page.

Figure 22. Here, the user can search for the item they are looking for. When pressing the item "Avflödespåsar", they will get to Figure 23.

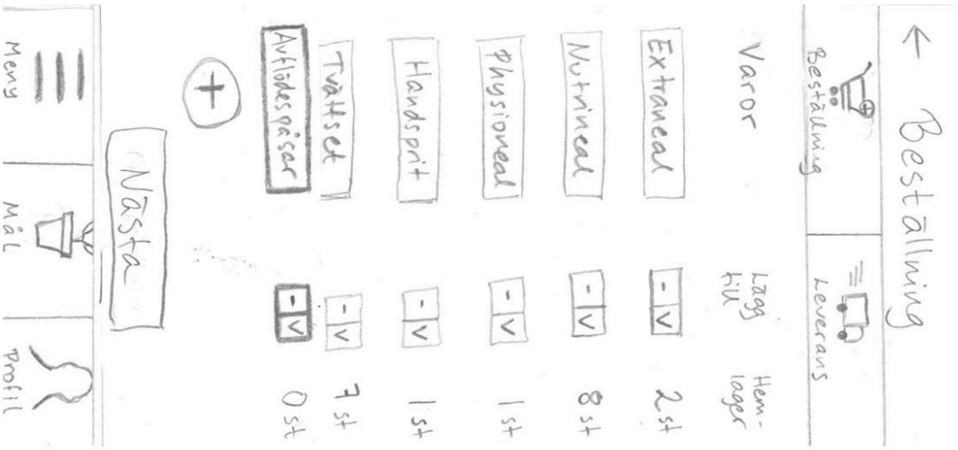


Figure 23. The item "Avflödespåsar" has been added to the list. To place the order, the user has to press "Nästa".

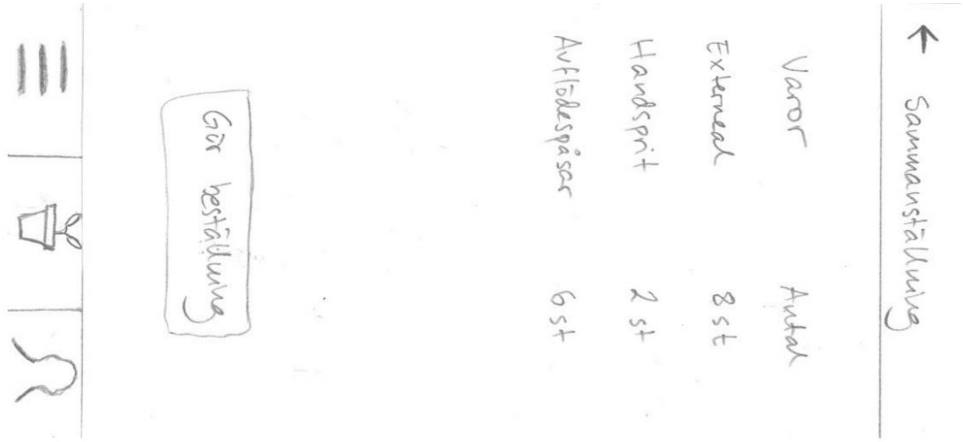


Figure 24. On this page, the user will get an overview of what they have ordered, before pressing the button "Gör Beställning" to actually order the equipment. The user then returns to an updated version of the page shown in Figure 21.

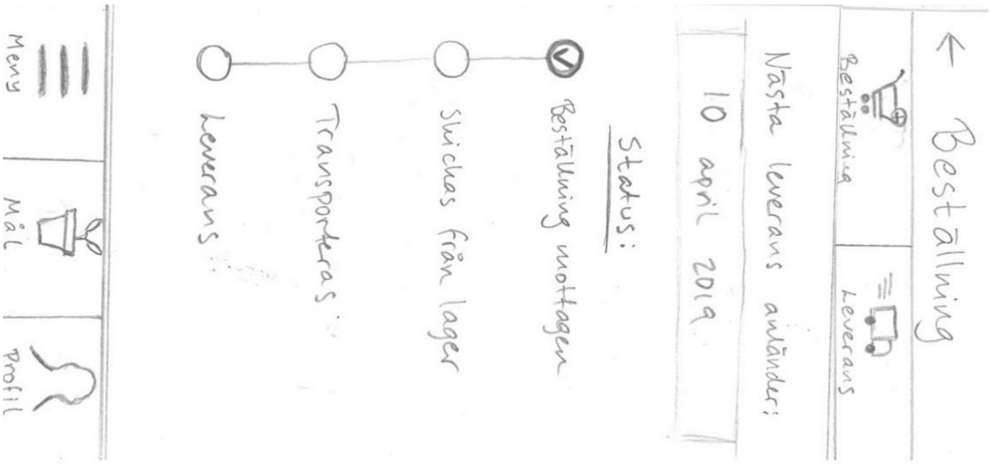


Figure 25. When the user presses the tab "Leverans" in Figure 21, the page above is presented. Here, the user can see the current status of their order.

C.3 Scenario 3. Log a meal

You have just made a nice meal you intend to eat for dinner. You made beef stroganoff and are going to eat a normal sized portion of this meal. To keep track of your nutritional values for the day, to make sure that you do not exceed the recommended intake, you want to log your food. This is a meal you usually make and therefore the recipe is saved in *The Dialysis Bag*. It is one of your favorite meals.

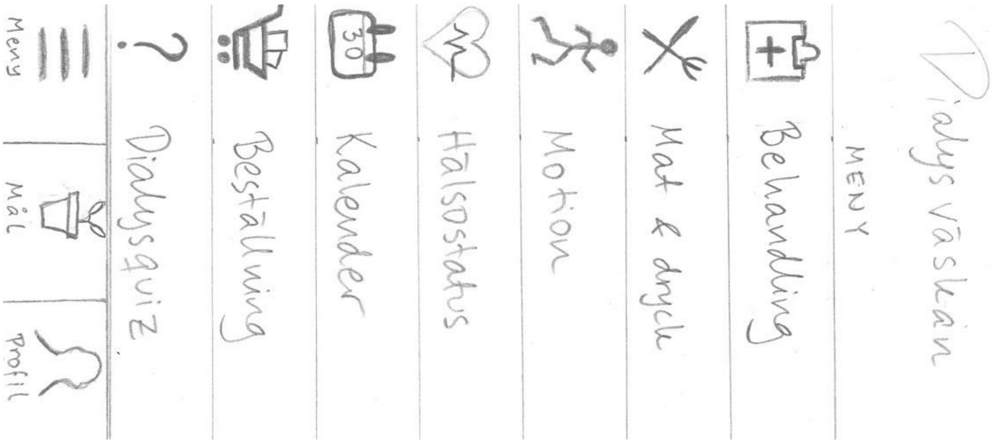


Figure 26. Main menu in *The Dialysis Bag*. The user presses "Mat & Dryck" to continue to the next page.

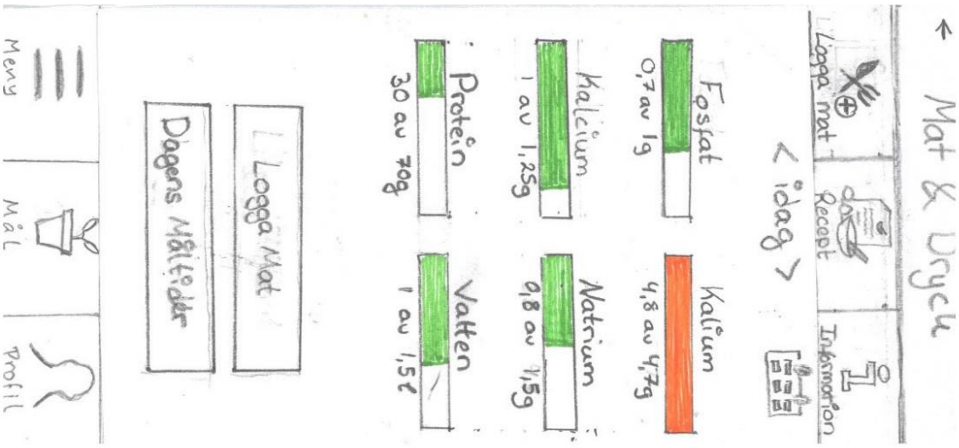


Figure 27. When clicking on the menu option "Mat & Dryck", this page is presented. To log food, the user presses the button "Logga Mat".

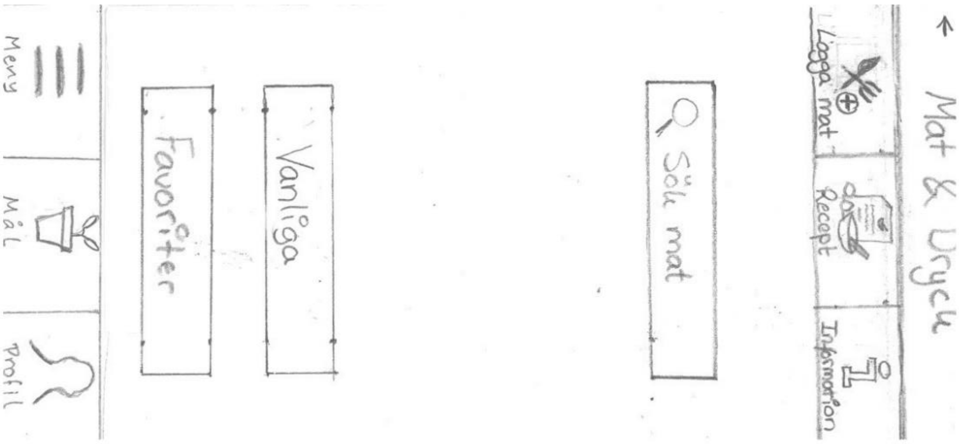


Figure 28. On this page, the user presses the button "Favoriter" to access their saved recipes.

Figure 29. A list of saved favorite recipes is presented on the "Favoriter"-page. To log the meal "Biff Stroganoff", the user presses that name in the list.

Figure 30. When pressing "Biff Stroganoff", a drop-down menu appears where the user presses "Logga" to log their food.

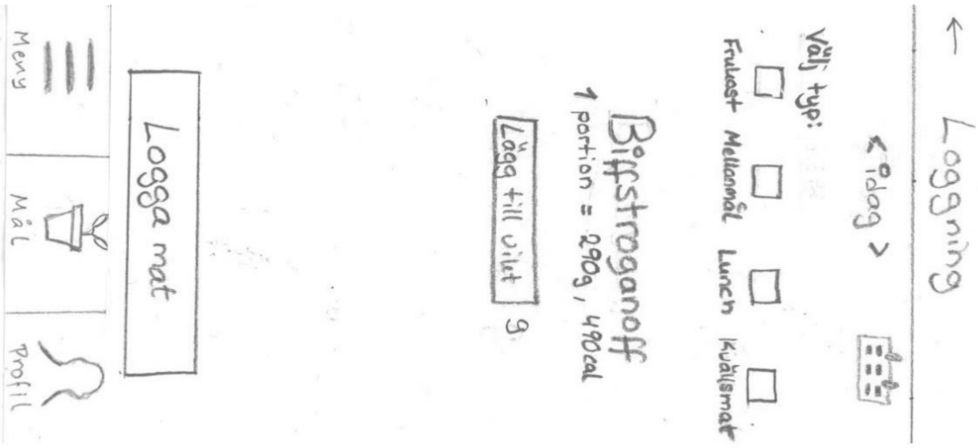


Figure 31. After the user pressed "Logga", the page above appears. Here, the type of meal and the weight of the meal should be filled in.

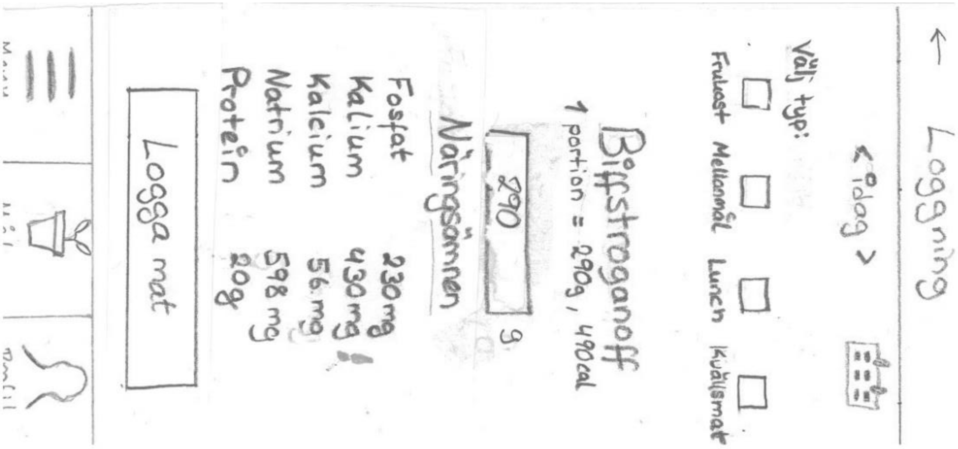


Figure 32. After filling out the weight, a list of nutrional content of the meal is presented. Lastly, the user must press the button "Logga Mat" to log their food.

Appendix D Hi-fi prototype

D.1 Scenario 1. Investigate symptoms

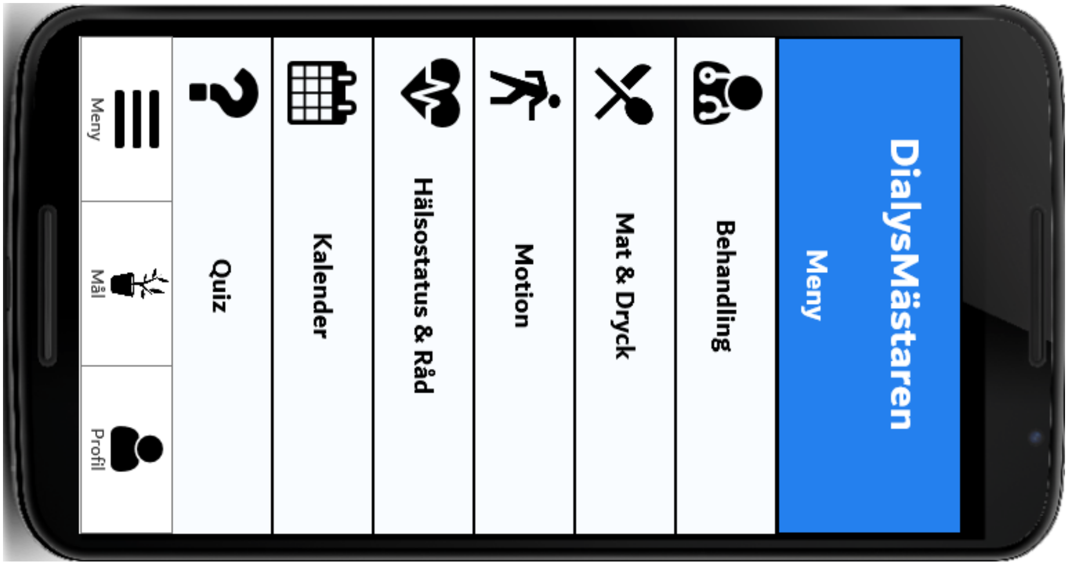
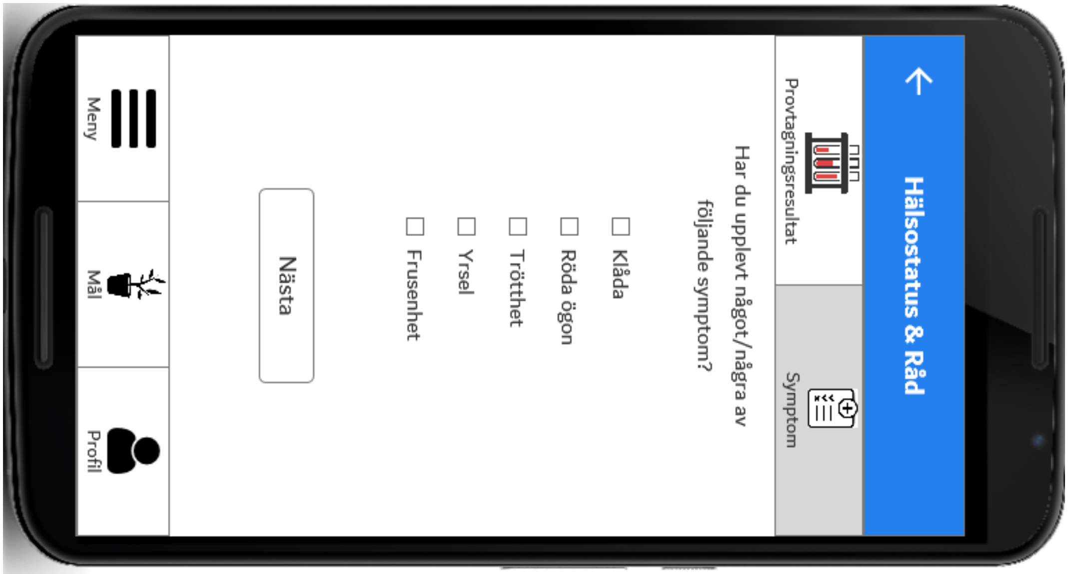


Figure 33. Main menu in *The Dialysis Bag*. The user presses “Hälsostatus & Råd” to continue to the next page.

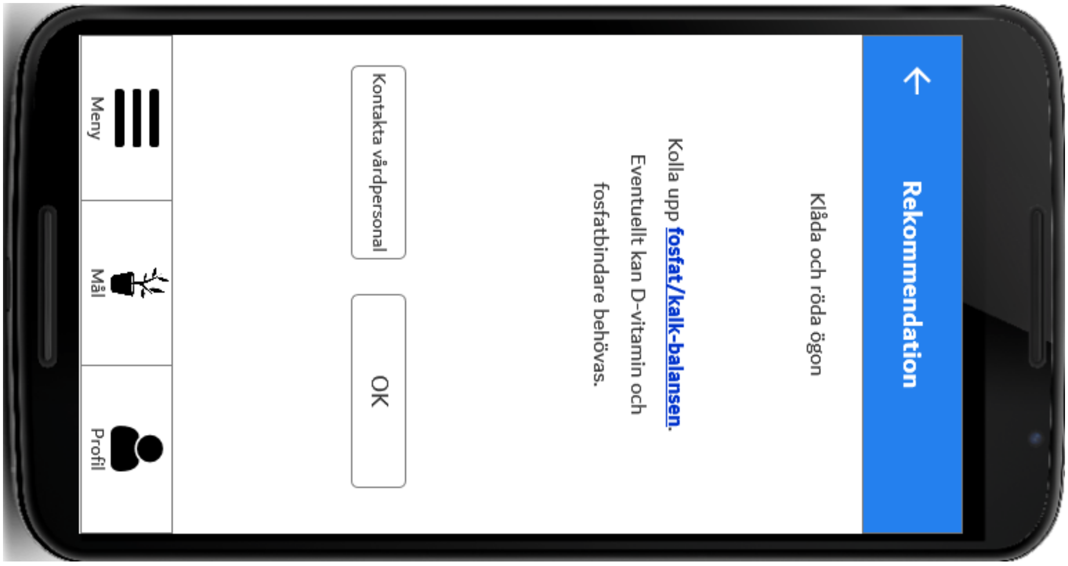
Figure 34. On this page, the user presses the tab “Symptom” to proceed.



Har du upplevt något/några av följande symptom?

☐ Klåda
☐ Röda ögon
☐ Trötthet
☐ Yrsel
☐ Frusenhet

Figure 35. The user ticks the boxes indicating relevent symptoms then clicks “Nästa”.



Kolla upp **fosfat/kalk-balansen**. Eventuellt kan D-vitamin och fosfatbindare behövas.

Figure 36. The recommendation of how to cure the symptoms appears. If clicking on the highlighted words, the pop-up window, seen in Figure 37, will show up. If the user wish to get in contact with healthcare providers, they can click on the button "Kontakta Vårdpersonal". When pressing "OK", the user will come back to the page seen in Figure 34.

Dina fosfatvärden ligger över det normala. Testa att ta 2 st extra fosfatbindare per dag. Vid frågor kontakta din läkare.

Figure 37. Pop-up window with more detailed information about how to cure given symptoms. When closing the pop-up window, the user will still be on the same page, see Figure 36.

D.2 Scenario 3. Log a meal

D.2.1 First option

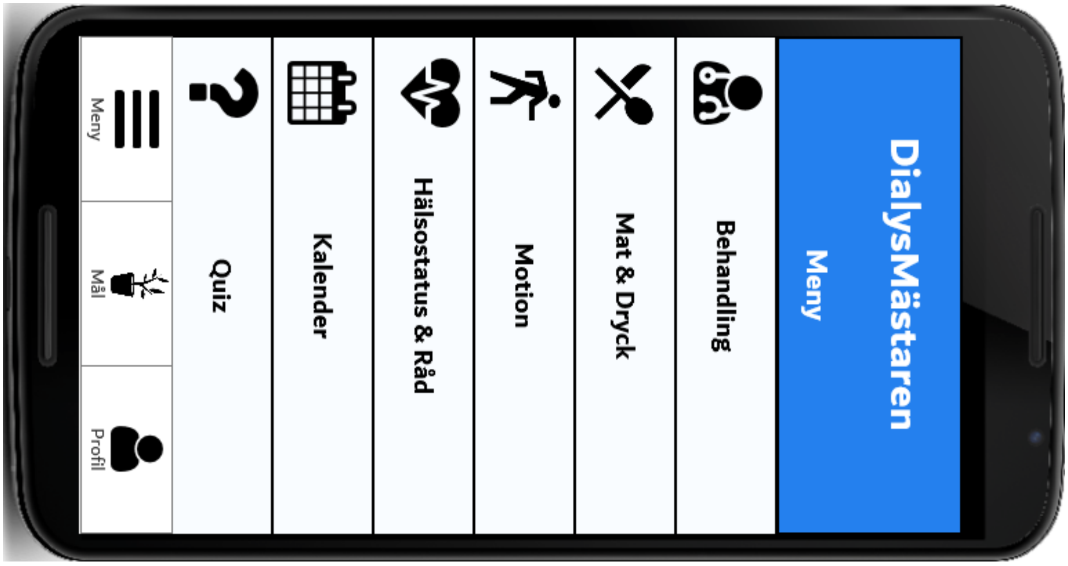


Figure 38. Main menu in *The Dialysis Bag*. The user presses “Mat & Dryck” to continue to the next page.

Figure 39. When clicking on the menu option “Mat & Dryck”, this page is presented. To log food, the user presses the button “Logga Mat”.

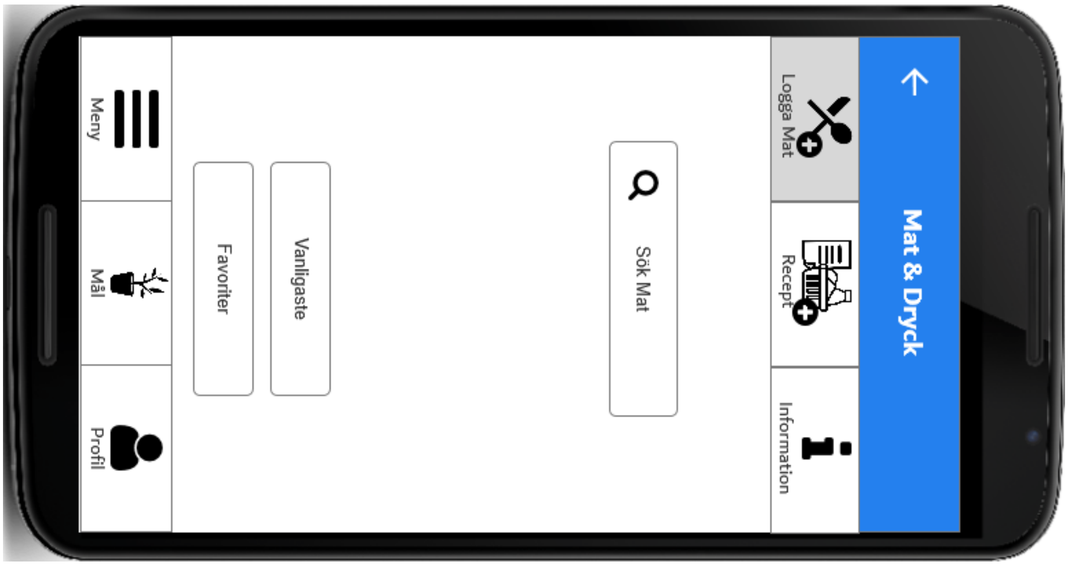


Figure 40. On this page, the user presses the button “Favoriter” to access their saved recipes.

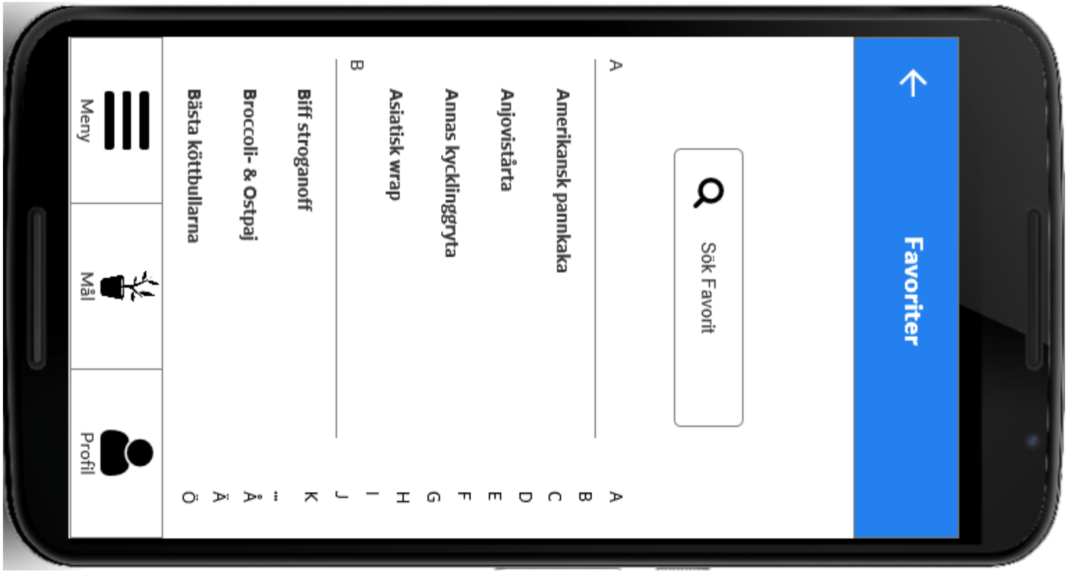


Figure 41. A list of saved favorite recipes is presented on the “Favoriter”-page. To log the meal “Biff Stroganoff”, the user presses that name in the list.

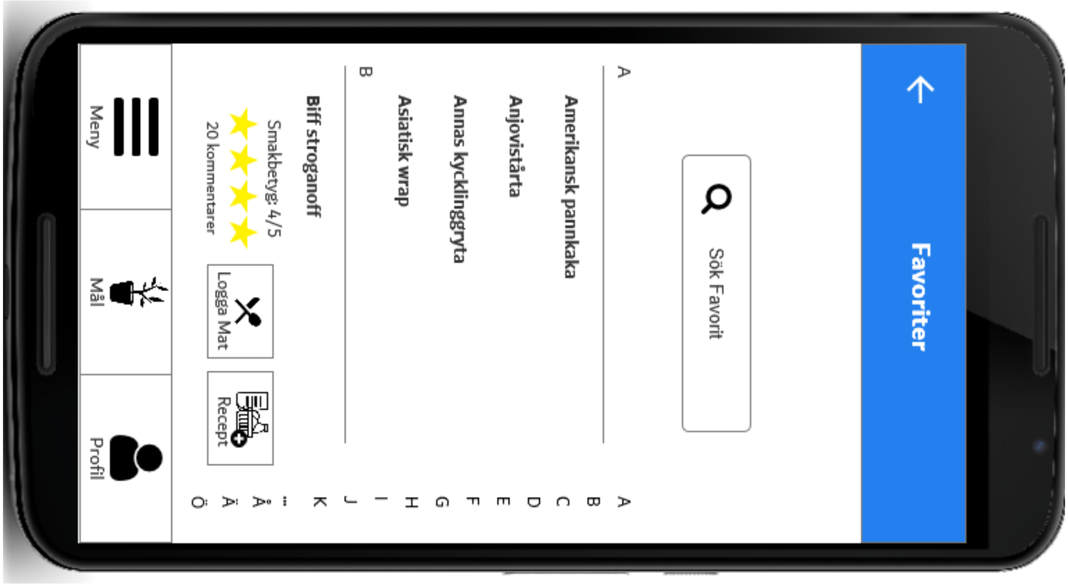
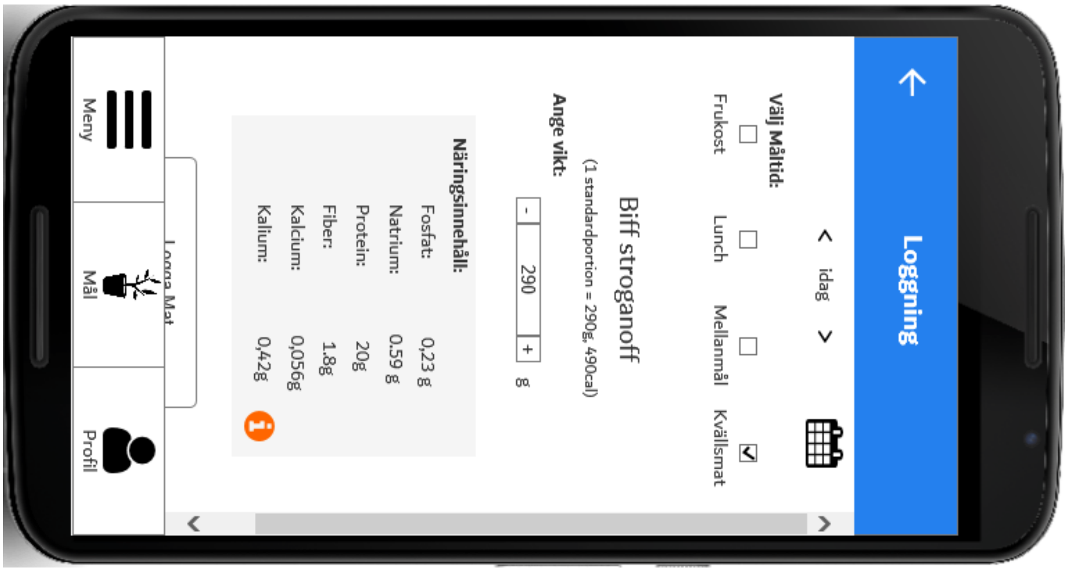


Figure 42. When pressing “Biff Stroganoff”, a drop-down menu appears where the user presses “Logga Mat” to log the food.



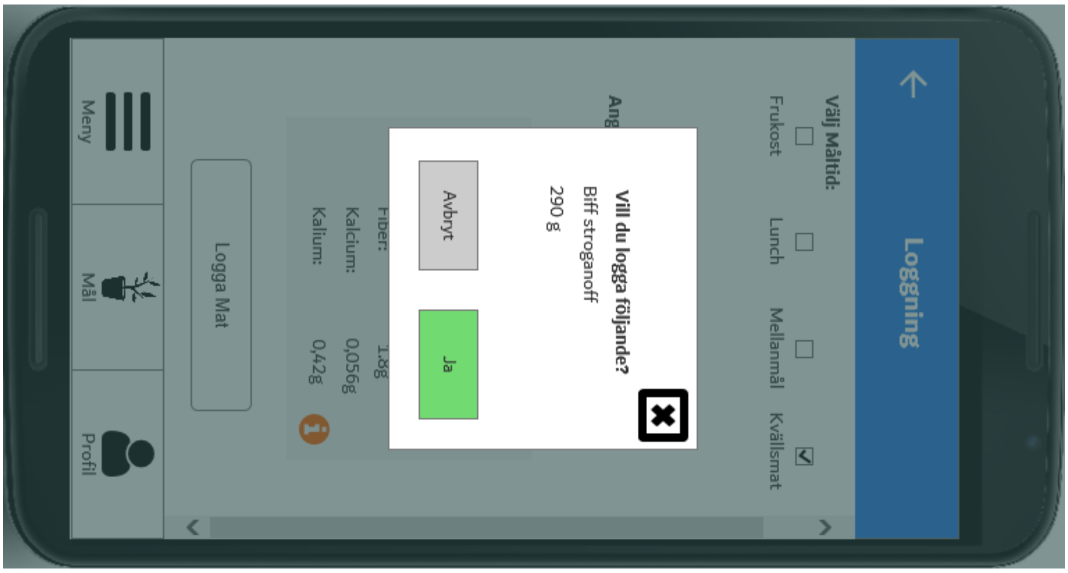
Välj Måltid:
☐ Frukost ☐ Lunch ☐ Mellanmål ☑ Kvällsmat

Biff stroganoff
(1 standardportion = 290g, 490cal)

Ange vikt: - 290 + g

Näringsinnehåll:
Fosfat: 0,23 g
Natrium: 0,59 g
Protein: 20g
Fiber: 1,8g
Kalcium: 0,056g
Kalium: 0,42g

Figure 43. After the user pressed “Logga”, the page above appears. Here, the type of meal should be selected. The weight of the meal is set to one standard portion per default. The user can change the weight of the meal by filling in another number, or by pressing the plus- or minus-buttons. The list of nutrional content changes as the weight changes. When pressing the button “Logga Mat” at the bottom of the page, the pop-up window seen in Figure 44 appears.



Vill du logga följande?
Biff stroganoff
290 g

Fiber: 1,8g
Kalcium: 0,056g
Kalium: 0,42g

Figure 44. Pop-up window to inform the users of what they are about to log. After pressing "Ja", the user will return to the first page of "Mat & Dryck". A green message will notify them that their logging was successful, see Figure 45.

D.2.2 Second option

Fosfat 0,7 av 1g
Kalium 4,4 av 4,7g
Kalcium 1 av 1,25g
Natrium 0.8 av 1,5g
Protein 30 av 70g
Vatten 1 av 1,5l

Maten är loggad!

Figure 45. The green notification visible indicate that a logging has been done. Another way to log the dish would be to press the tab "Recept". Then, the user would proceed to the page seen in Figure 46.

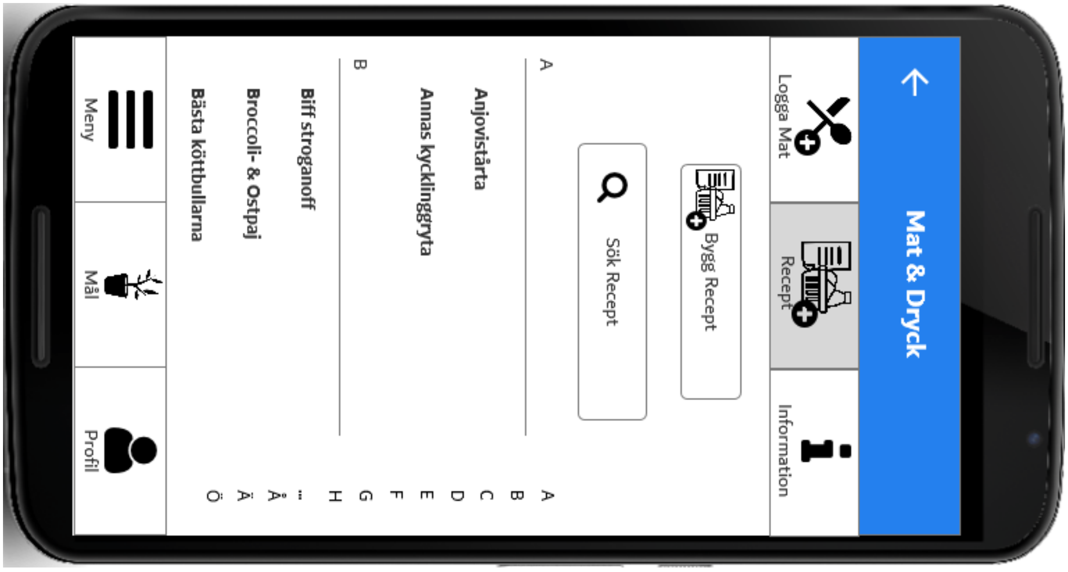


Figure 46. When pressing the tab "Recept", the page above is presented. A list of recipes is visible on the page. To log the meal "Biff Stroganoff", the user presses that name in the list.

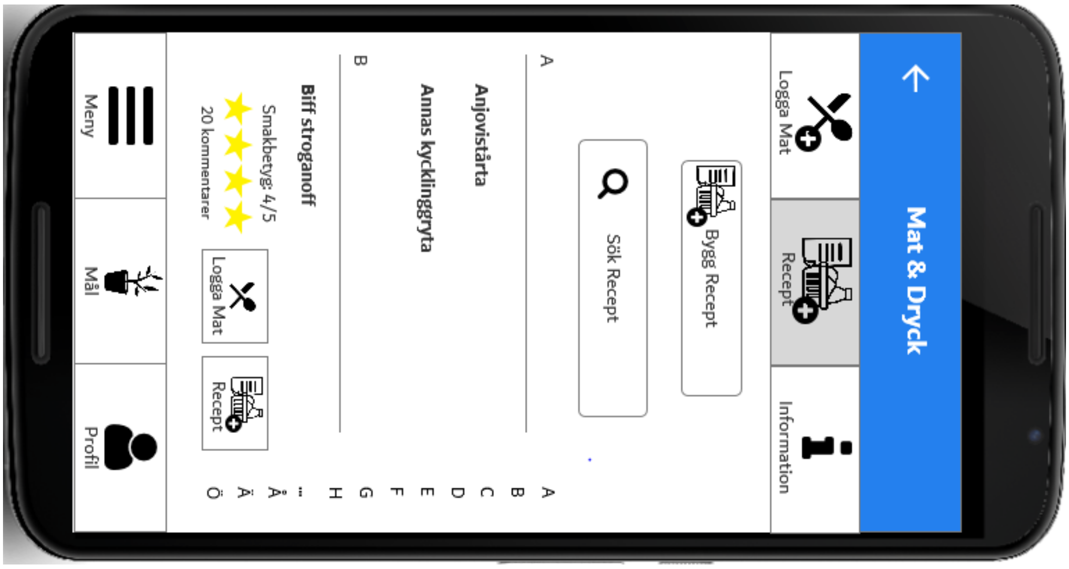
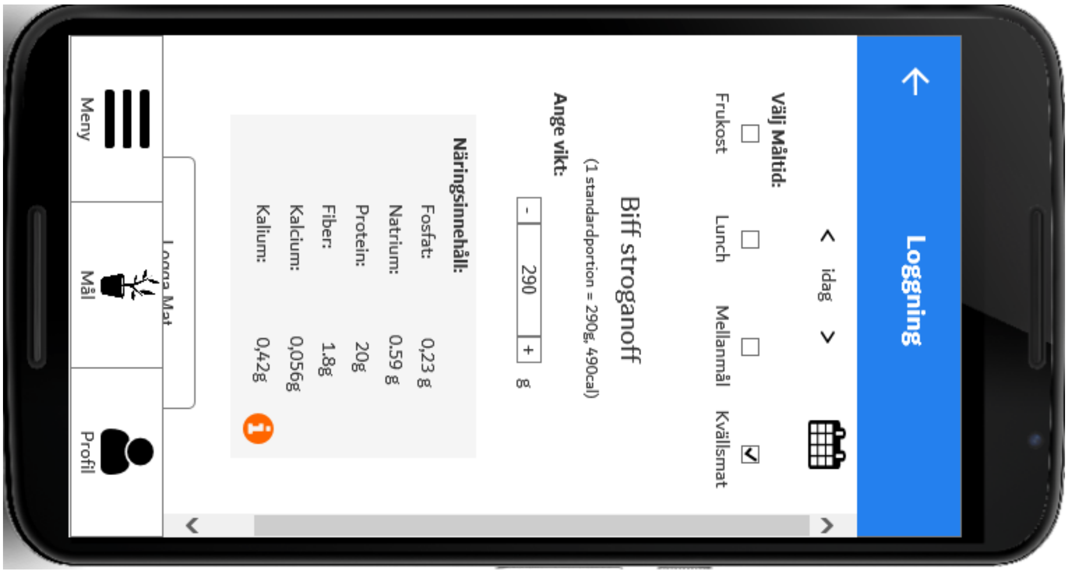


Figure 47. When pressing "Biff Stroganoff", a drop-down menu appears where the user presses "Logga Mat" to log the food.



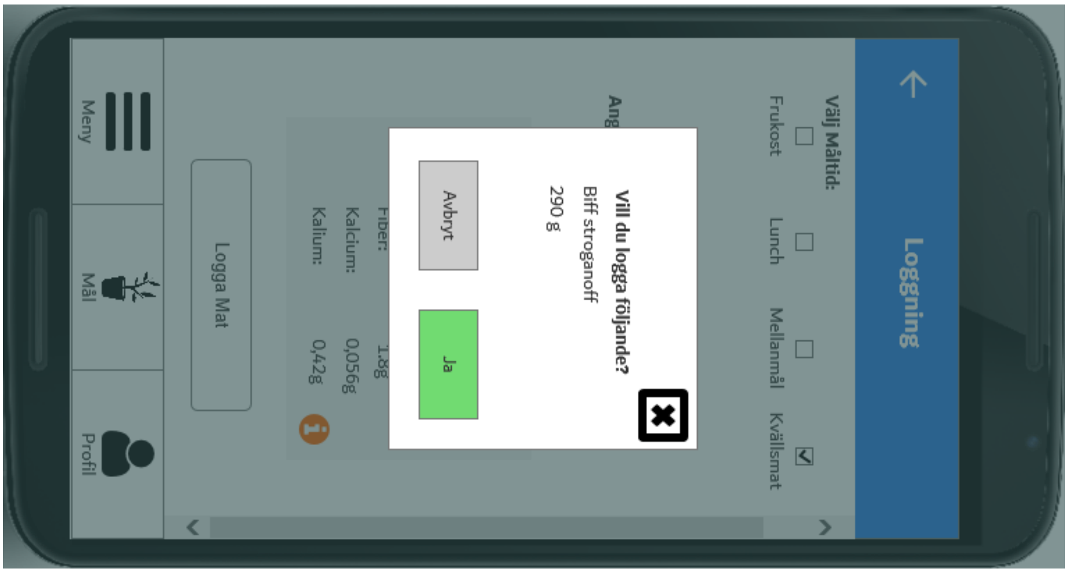
Biff stroganoff

(1 standardportion = 290g, 490cal)

Näringsinnehåll:

Fosfat:	0,23 g
Natrium:	0,59 g
Protein:	20g
Fiber:	1,8g
Kalcium:	0,056g
Kalium:	0,42g

Figure 48. After the user pressed "Logga", the page above appears. Here, the type of meal should be selected. The weight of the meal is set to one standard portion per default. The user can change the weight of the meal by filling in another number, or by pressing the plus- or minus-buttons. The list of nutrional content changes as the weight changes. When pressing the button "Logga Mat" at the bottom of the page, the pop-up window seen in Figure 49 appears.



Vill du logga följande?

Biff stroganoff

290 g

Figure 49. Pop-up window to inform the users of what they are about to log. After pressing "Ja", the user will return to Figure 45.