The Heart Companion:

DESIGNING AN EMPOWERING APPLICATION FOR HEART FAILURE PATIENTS

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ABSTRACT
Healthcare practices are changing as focus shifts from treating acute illnesses to chronic diseases. The responsibility of managing the treatment has shifted from healthcare providers to the individual in a higher degree. To achieve good treatment the patients need to be empowered so that they understand their condition and can make informed choices throughout their self-care. A research through design approach was used to investigate how to design a personalized empowering application for heart failure patients. Aside from information relating to the condition, the themes of physical activity, dieting and social connectedness were identified as central to the empowerment of this group. Patients, partners and healthcare providers contributed with different perspectives throughout the design process. As a result five personas, representing potential users, were developed. Based on the personas and knowledge of the domain, user scenarios in current- and preferred state were constructed in order to guide the design of the empowering application called ‘The Heart Companion’. It is a tablet application catering to the different needs of the personas that also addresses the three themes relevant for empowerment. The purpose of the application is to facilitate better understanding, a feeling of safety and a more active empowered life for the patient. The application enables personalization of the content by providing bookmarking and addresses empowerment of physical activity by enabling various guided exercise sessions, personalized feedback, the possibility of reflection and construction of personalized exercise sessions.

Author Keywords
Research through design; mHealth; Empowerment; Personalization; Physical activity; Social connectedness; Personal informatics

INTRODUCTION
There is currently occurring a major shift in healthcare practices. Chronic diseases are now the leading factor of morbidity and mortality in Europe. Caring for chronic diseases demands a coordinated effort from different health professionals as well as social care to accommodate for the different needs a patient may have [3]. The responsibility for management of the treatment is transferred from healthcare providers to the individuals. The European Network on Patient Empowerment (ENOPE) states that ‘health care is considered a process of co-production in which professionals and patients jointly work on solving health problems with the inclusion of the wider support networks such as his/her family and support group” [10]. This situation calls for increased efforts into the area of patient empowerment.

Interest in mobile health (mHealth) has increased rapidly in recent years. Tablet and smartphone applications targeting various health conditions are developed to support and complement healthcare staff in caring for patients. The various possibilities of interactive applications working as complements to existing healthcare provide an interesting opportunity for the empowerment of patients.

This paper focuses on the situation of heart failure (HF) patients and is conducted on behalf of the Centre of Innovation at the Karolinska University Hospital in Sweden. HF is a serious chronic disease and patients diagnosed with it are presented with a lot of new information that they need to understand and act on. To empower the patients they need to be provided with the tools necessary for improving the knowledge about their condition and increasing their ability for self-care. ENOPE [10] identify empowered users as those that better understand their condition as well as the effect it can have on them which leads to better self-care. They feel enabled to partake in decision-making concerning their health, can make informed decisions of their treatment and understand that they need to take responsibility for their lifestyle.

Today, patients at the Karolinska University Hospital are provided with spoken instructions and explanations as well as additional information in the form of printed medium. Something that is hard to achieve through a printed medium is regular dynamic support and personalized feedback, which can provide users with the opportunity of reflecting on personal information and increase their self-knowledge. This can be a valuable extension of the health care for the patients and increase the chance of them making more educated decisions regarding their health [15]. Through the study it was investigated how an interactive application, providing information about HF and self-care, could be designed for the empowerment of patients. To address this question a research through design approach was applied in order to investigate the design space and generate a design exemplar as a possible solution to the research question [25].

This study identified three main themes that needed to be addressed and incorporated for the empowerment of HF-
patients. Since HF in many cases leads to a fear of physical activity and decline of it in everyday life this is an important part to incorporate in the treatment for patients [23]. The same applies to dieting strategies as many patients have a hard time understanding how to change their food habits to achieve a healthier lifestyle [1]. A sense of isolation could arise from being afraid of physical activity or from following dieting strategies [9,12]. Therefore it may also be of importance to keep in mind how the aspect of social connectedness should be addressed. This paper focuses on how personas and the notion of personalization affected the design of the system.

RELATED WORK
Designing empowering technologies that can promote self-care for patients with chronic diseases is a challenging task. In this chapter two aspects, important to the design of an empowering health application, will be addressed. Firstly, as the aim is to achieve an empowering application, strategies for achieving this are listed. Secondly, an overview of applications related to the areas of mobile health and physical activity is presented to grant better understanding of the domain.

Strategies for empowerment and self-knowledge
When designing for empowerment concerning physical activity Kranz et al. [13] state that insufficient knowledge and low motivation are obstacles to self-directed and safe exercising. To reach a state of autonomous training a combination of skill assessment and personalized feedback can be an important step as it supports accurate exercising fitted for the individual. Intrinsic, i.e. internal, motivation is an important factor for achieving long-term motivation for regular usage and personalized feedback can help establish that as the exercising gets more tailored towards the patients needs and abilities. Concerning strategies for the empowerment of users, research on personal informatics is introduced. Personal informatics systems are, according to Li et al. [15], defined as ones that support users in collecting as well as exploring and reflecting on personal information. These systems have the goal of gaining and increasing self-knowledge through the means of self-reflection. Li et al. note that some of the main reasons for making use of personal informatics and collecting as well as reflecting on relevant personal information are curiosity, trigger events and interest in the data. The systems vary from user-driven to system-driven and are uni- or multi-faceted which means that they represent either one or many facets of a person’s life e.g. work life and physical activity. When collecting personal information for the sake of learning about oneself it is about manoeuvring to the future using the help of certain cues, bits of information and one’s intuition. This means that collection and reflection of personal information is, as Rooksby et al. mention, “for the purpose of a life being lived” [22]. To make sense of this personal information Ferreira et al. [11] state that users want contextual information in addition to the collected data. They deduce that by integrating short term history users could understand their own present state with less difficulty. By incorporating these perspectives users can hopefully navigate to a healthier future by reflecting on short-term history.

Fit4Life is a critical design concept created by Purpura et al. [20] intended to stir up discussion about the aspects of ethics and socioculture in persuasive design by drawing these persuasive strategies to their extreme. By using an entirely system driven approach Fit4Life calculates the users dieting and fitness-goals based on their BMI. Sensors collect data about the user and the system constantly assesses it to give feedback to the user on the way to their goals. The study addresses the limit between making an encouraging, persuasive and coercive design as well as who should be in control. A highlight in the discussion was that when taking the stance of focusing on primarily quantitative measurements the Fit4Life system rejected the importance of personal experiences. To make it easier reaching the goal the system also told users precisely how to act, excluding the possibility of personal reflection and discovery. Purpura et al. also mentioned that to achieve a sense of control over the condition reflection is among the top significant skills to develop. They conclude that the aim of exercise programs should probably not be “to make decisions for users but to eventually wean them by helping to establish self-reliance”.

Overview of related applications
To provide insight into the area of applications targeting healthcare and physical activity this paper introduces the work of Mosa et al. [19], Martínez-Pérez et al. [16], Chomutare et al. [6] and Kranz et al. [13]. Together, these reviews form a picture of what has been done in the field so far and what may be important to keep in mind when designing health applications. Healthcare applications target a variety of medical application areas; they have different goals and paths to reach these goals. In the review by Mosa et al. concerning applications for smartphones, it was found that applications targeted towards patients mostly were used for management of the disease and that a lesser portion was developed to help the patients learn about their condition. One of the primary findings in the review of academic articles and mobile applications related to the practice of cardiology, published by Martínez-Pérez et al., is that most mobile applications focus on mobile heart monitoring systems. When designing an application for HF-patients other areas of healthcare applications targeted towards chronically ill patients may also serve as inspiration. In the review published by Chomutare et al. academic articles and applications developed for diabetes management were explored. They found that educational modules were present in only 20% of the applications. Of these applications, only 26% made use of personalized education or feedback. The review emphasizes that personalized education and actionable feedback is highly recommended to include, by recent clinical guidelines, and that this shows potential to enhance the outcome of the self-care. By providing this, patients could be empowered to deal with
different scenarios related to their condition. In the comparative review by Kranz et al. the design space of physical activity applications was explored through Android Market where three main categories were identified. These were; GPS Trackers that record activities with location information, Exercise Books that focus on instruction and Workout Planners that are a combination of the two but often with lesser depth of information. Kranz et al. also concluded that mobile phone feedback could be used as an extension to physiological care since correct performance during exercises is important and that it is not possible to always have a physiotherapist present. None of the apps presented in the review provided personalized feedback for exercises just performed. Some allowed for uploading of the training information for later examination. The feedback provided by physical activity apps is more general than specific and according to Kranz et al. it calls for educated interpretation. In light of this information personalized education and feedback could be an area in need of more focus in the domain of mobile health and physical activity.

THE DESIGN CHALLENGE
When applying a research through design-approach on the design process designers strive to create artefacts that, as Zimmerman et al. puts it, ”transform the world from its current state to a preferred state” [25]. Hence, to guide the design choices in this study personas and user scenarios of the current- and preferred state were important to develop. Cooper [8] identify personas as goal-oriented and a representation of real people or “[…] hypothetical archetypes of actual users”. The persona-method has its share of advocates as well as critics. Chapman & Milham [5] highlight that personas are hard to validate and if they appear valid they risk only representing a small part of the span of potential users. But, despite of this, personas can still be of value in the design process since they can assist designers in engaging with users [4]. Bodker et al. emphasize that personas should be used as masks for the purpose of seeing the situation from different perspectives. They add that personas “activate, and reframe” prior knowledge which leads us closer to the use situation. They conclude with that personas can assist in tuning into the situation of preparing for real design participation as well as a means of processing and presenting data from this participation. The views of the current- and preferred state as well as personas are based on statistics from scientific articles and information collected during the study. The information is the result of observations and interviews with patients, specialist nurses and physiotherapists as well as other healthcare personnel that together could provide a better picture of the situation because of their prior knowledge of the domain.

The current state
When investigating the current material provided to HF-patients one thing in particular stood out. The material targets a fairly homogeneous group of people. Pictures and illustrations are most of the time of exclusively elderly, individuals or heterosexual couples with younger kids, supposedly grandchildren. In fact, many resources seem to target only this group. As an example, educational support groups meet during the day which risks excluding those who study or work during that time frame. This could be a problem as patients that either do not identify with this group or do not have the possibility to attend, can feel left out and e.g. perceive the information as less relevant. Also, they might not be able to take part of it in the same way or to the same extent.

Personas of potential users
Since patients are affected in different degrees of the disease, ranging from not affected at all when taking medicine to mostly bedridden, it is important to map out who they are, what their needs and abilities are, as well as what makes them feel more secure and empowered. In the annual report from The Swedish Heart Failure Registry (or RiksSvikt) [24] we find that the mean age for a heart failure patient is 75 years and that men make up 61% and women 39% of the patient group. The statistics tell us that when it comes to patients younger than 65 years 75% are men, but when it comes to patients older than 85 men only make up 45% of the group. 11% of HF-patients are unaffected by the symptoms of tiredness and shortness of breath, 44% experience them when engaging in more than moderate exertion, 38% when engaging in easier exertion and 6% also experience these symptoms when resting. Although most patients are older individuals younger ones can get affected as well. In a study, made in 2013, individuals younger than 45 years of age only stood for 1% of the patient group. But the number of patients aged between 18-34 years has increased with 50% between 1987-2006 and the number of patients aged 34-44 increased with 43% in the same time span [17].

In Figure 1 five different personas and potential users of the empowering application that guided the design choices in the study are presented. Users can either be patients themselves, partners to the patients or healthcare personnel such as specialist nurses. HF-patients are not a solely homogeneous group, most are elderly but if designing only for elderly many potential users risk being excluded. It is also important to remember that elderly patients are a diverse group as well, with different living situations and interests. Albin was included as a persona since he represents a group of patients that have the possibility to work on their physical activity to elevate their well-being since their HF-diagnosis is not too severe. Kim, on the other hand, is representative for patients that have a more severe type of HF and experience symptoms during low to moderate exertion. As younger adults can be diagnosed with HF as well Samir is included. He represents patients that have a hard time feeling included because he does not fit the patient norm. Partners and relatives to HF-patients are an important group to include and that is why the persona of Marie was created. Lastly, through the design
Figure 1. HF-patients Albin, Kim, and Samir along with the partner Marie and specialist nurse Eva.

process it was evident that incorporating specialist nurses as users was desired. By doing this it was believed that it would be easier to promote understanding during discussions in patient/nurse meetings. Two problem situations in the current state are presented together with how the personas, Albin and Kim, experienced them. Albin lives with his partner Clara in an apartment in Stockholm, they have two grown up children. He works as a project leader at the Social Insurance Bureau and uses computers and smartphones in his work to plan projects and keep in contact with colleagues and clients. He is interested in tech and also has a tablet that he uses to answer emails, read news and play games on. Prior to his diagnosis he tried to go to the gym once or twice a week to keep in shape. Since the diagnosis he feels too insecure to work out, he is afraid of exerting himself too much and in the process aggravate the condition. Since he does not know how to do it safely he stops working out and starts feeling frustrated and more isolated in the process. He does not feel that he has time going to the physiotherapist as it is often during working hours and he is busy during that time. Kim, on the other hand, lives by herself in an apartment in Solna, Stockholm. She is retired and sometimes visits her elderly neighbour to socialize. Kim often feels insecure about her own knowledge of the disease and wants to double-check if she has understood everything correctly whenever she can, e.g. while visiting the specialist nurses at the HF-clinic. As she has a more severe type of heart failure she does not want to challenge her situation by being too active. She often experience swelling of her ankles and shortness of breath, which are common symptoms of HF, and needs to be careful not to retain too much fluid. Because she doubts her self-knowledge a lot of her time is spent feeling isolated and insecure in her situation.

The preferred state
The preferred states, where patients become empowered and learn about themselves, were mapped out during the design process. In these preferred states the patients are provided with an empowering application. During a visit to the specialist nurse Albin was informed of the importance of physical activity. They discussed what he felt comfortable with and he was advised to try some exercises to start with. At home he takes out his tablet and starts the application, as he wants to try to exercise. He reads through some advises to know what to keep in mind during the exercises and feels better as he knows what to expect and how to handle it. He starts an exercise session and reads the instructions before easily mimicking the movements since each exercise is shown as an animation. Albin feels more secure that he is doing the exercises the right way now and gets more confident as the time goes. Before trying it out he felt a bit insecure if this would help but now he looks forward to the next session since he got some good feedback and knows what he can do next. At the same time Kim is in her apartment writing the shopping list to the grocery store and starts feeling really thirsty. At first she is insecure about what to do but then she remembers the application. She takes up the tablet and starts the application. As she starts to recognize her personal symptoms she has already saved this information and can quickly get access to it and read about possible actions to take for reducing thirst without retaining too much fluid. By using the application Kim is also able to make contact with other people in the same situation and nowadays she feels happier and less isolated.

THE DESIGN PROCESS
By applying a research through design approach focus was on; grounding of the design choices, ideation to generate solutions, iteration to constantly reframe the problem at hand and reflection to analyse and modify the sketches during the design process [25]. To design for easier understanding and learning, guidelines about multimedia principles [7,18] and visual design for elderly users were adhered to [14]. A brochure about HF created by RiksSvikt [21] was used as a starting point for the designs. Early on in the design process the themes of physical activity, dieting and social connectedness were identified as central to address for the empowerment of HF-patients as these can have a great impact on their lifestyle. The goal with this design process was to create a design exemplar addressing
the research question, in the form of a concept and prototype of a personalized and empowering application. This design exemplar should provide; general information about the disease, advices on how to act when experiencing a symptom and strategies for physical activity as well as dieting. In short, the application is supposed to provide personalized information and feedback along with strategies and tools to make the user feel empowered and accustomed to the new situation. With the help of personalized feedback and education the patients learn about their body, reflect on the situation and make better future choices. An overall goal is also to produce knowledge of applications and designs targeting HF-patients.

The process and methods
To make sure the concept and application adhered to the patient group and the user scenarios, feedback sessions were held with master students of interaction design. Iterations were continuously performed throughout the entire design process. Early on in the process five exploratory observations of patient/nurse meetings and two interviews with specialist nurses, conducted at Karolinska University Hospital in Huddinge and Solna, were held. Together with statistics they resulted in the creation of the personas (see Figure 1) and user scenarios. All interviews in this study were held in Swedish and any quotes presented have been translated into English.

With the use of parallel design and rapid prototyping multiple designs and concepts were initially produced in the form of paper mock up’s using the personas and user scenarios as reference points. Three different concept-designs were then selected, discussed and evaluated during a feedback session (see Figure 2). The ideas that best related to the personas and showed potential to relieve their problems were selected and reworked. The concepts were further iterated and evaluated with three specialist nurses and one physiotherapist before being shown to HF-patients. The specialist nurses and the physiotherapist contributed to the development of the application through their combined knowledge of the patients and their situation. Features were added, removed or further developed depending on how they would be able to support patients and function with the resources available in the healthcare domain. All three specialist nurses stressed the importance for patients to recognize their personal symptoms of HF and know what to do when experiencing them. Adding bookmarking as a function was considered useful as it could make the content more personalized in some ways and be helpful in pinpointing what is relevant for a specific user. They suggested that patients could use it as “a tool and a structure” together with specialist nurses by bookmarking content that is relevant to read until the next visit. When discussing where the responsibility should lie when selecting exercises they reasoned “everything that comes from the patients themselves carries more weight”. They added ”the patient can think it through and select [the exercises] and discuss it with us […] when they are here”. The physiotherapist emphasized that ”it is estimated exertion that we use as a starting point when we create an exercise program” and that this is what they always can refer to when adapting the program since ”that is what they [the patients] can refer to when they are at home”.

Additional iterations were made and discussed with the interaction design students to make sure the concept always adhered to the needs of the patients. Highlights in the discussion focused on how content was presented and how it could best be understood e.g. one student noted that using animations or videos could be beneficial as a way to instruct patients in correct exercising. History and logging was also considered a good way to design for more regular usage and better understanding. Additionally, they mentioned that the idea of personalizing the content (both general information and physical activity) based on what degree of HF a patient had would perhaps not be the best way to produce the result most suited to the patient and that other factors such as other conditions would affect the result to a higher degree.

Finally, one concept (see figure 3) was presented for three HF-patients and two of their partners. Two patients had been diagnosed a long time ago and could therefore provide insights into how they had used information provided by the healthcare and what they felt was lacking. It was evident that interest in information varied from patient to patient and in one case the partner was more interested in
the information and strategies than the patient himself. Many valuable insights in further development of the application came from the interviews and resulted in some final iterations of the concept and the prototype. For the application to fulfil its role one patient stressed the importance of incorporating exercise-suggestions and feedback. This is due to the fact that the patient often exerted himself too much and aggravated the condition in the process, even though he was used to exercising. He stated "the silly thing is that I never can restrain myself".

**CENTRAL FEATURES OF THE HEART COMPANION**

The resulting design exemplar is called 'The Heart Companion' or 'Hjärtkompanjonen' in Swedish. The concept addresses the three themes of physical activity, dieting and social connectedness. The features that made use of personalization to achieve empowerment of HF-patients are explained in this chapter.

**Start page, settings and general information**

At the start page (see Figure 4a) users can look up their personal bookmarked pages, search for and read up on content relevant to them, make use of the empowering tools or customize the settings. The general information is divided into the topics; 'About heart failure', ‘Good advices for symptoms’ and ‘Lifestyle tips’. The empowering tools focus on support for physical activity and dieting, they are referred to as ‘My exercises’ and ‘Advices & recipes for dieting’. One final page contains sources of information relating to support groups and the notion of social connectedness. Every part is colour coded to make it easier seeing which ones are connected. The users can personalize the form of the content in three ways (see Figure 4b). They can 1) choose the language of the content, 2) adapt the text to an appropriate size and 3) decide if they would like to make use of the text-to-speech-function to support their intake of information. When using ‘The Heart Companion’ to read about the condition, symptoms or lifestyle habits the user can bookmark the page they are on by using the star-button in the upper right corner (see Figure 5a) and in that way collect and personalize what information they quickly want to get access to. This function can also be used together with specialist nurses when on a visit to the HF-clinic to recommend relevant pages for the user to look into before the next visit.

**My exercises**

The first page of ‘My exercises’ (see Figure 5b) presents advices on what to think about when engaging in physical activity of any sort. Below the advices, different exercise sessions based on the personas and created in collaboration with physiotherapists are listed. Since users have different

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**Figure 4. a) The start page of ‘The Heart Companion’ and b) ‘Settings’.

**Figure 5. a) ‘Good advices for thirst’ and b) first page of ‘My exercises’ with advices to keep in mind and various exercise sessions listed below.**
levels of HF, and other factors affecting their condition, various exercise sessions are developed to accommodate the range of personal needs of typical users. Some sessions could be done at home, with items already there, some could be done with elastic bands that can be bought at the pharmacy and some at the gym were exercise tools and machines can be used. By providing different types of exercise sessions the user can select the session most suited to their personal needs and abilities. Aside from the exercise sessions, all exercises can be reviewed one by one in a list. Users can choose to either engage in an exercise session, personalize the sessions by building their own one based on their accumulated self-knowledge or just keep the general advices in mind while engaging in other types of physical activities e.g. taking a walk. The user can also access the logbook where they can review and reflect on data produced during previous sessions to navigate towards a healthier living.

Exercise session
When having selected to start an exercise session instructions about correct procedure and how it should feel are presented together with an animation (see Figure 6b). The animation makes it easier to imitate the movement and conduct it in a correct manner. The user can see how many exercises there are left in the exercise session in the progress bar. Each exercise in this example is supposed to be done during a certain amount of time and the progress bar makes it easy to see how they are doing. The session can be cancelled by the users at any time to give them control over the situation.

Evaluating the exertion
After engaging in an exercise session the user can fill in the level of exertion felt on a scale from “no exertion” to “very, very hard” i.e. the Borg-scale [2] which is commonly used in physiotherapy. They can also add a comment about the day or how they felt to complement the information. This makes the data easier to review and make sense of later. By completing this, the user will get instant personalized feedback to help them exercise at a good level and make this into a regular habit. The personalized feedback consists of advices on how to exercise during the next session based on perceived exertion.

Logbook
In the logbook (see Figure 6b) the user can review the data and information to see what date they conducted the session, which exercise session they selected, how exerted they felt, contextual information and feedback advices. The Borg scale is shown in a compact form in the logbook so that users easily can see if they are on the right exertion level.

DISCUSSION
The purpose of the project was to investigate how a tablet application could be designed to support and empower HF-patients in their daily lives. This was investigated using a research through design approach. Through the design process the most important themes for achieving empowerment were identified and designed for. These were physical activity, dieting and social connectedness which is supported by the work of Socialstyrelsen and Ekberg and Lindström [9,23]. All themes were incorporated in the design but only those developed specifically with the personas situations in mind or those relating to personalization were presented and discussed in this paper. Further, it is discussed why a social forum was not included in the design. Tools to support the themes for empowerment were identified as: 1) Support for exercising correctly e.g. personalized feedback and actionable advices. Input from patients during the design process suggested that this was important to incorporate for the application to fulfill its purpose. Personalized feedback could also be an important step for promoting regular usage and in extension autonomous training, this is supported by Kranz et al. [13]. 2) Reflection of personal history to improve self-knowledge, which is implied by research by Ferreira et al. [11]. 3) At the same time as it was vital to incorporate support for correct personal behaviour concerning physical activity and dieting it was important to keep in mind that social connectedness is affected as well by the condition and changes in behaviour as Bentley et al. mention [1]. HF can e.g. result in fear of physical activity and also decreased
activity in everyday life and when needing to change the diet, to increase one’s well-being, feelings of isolation could arise. According to Ekberg & Lindström as well as Heo et al. the problems usually revolved around insufficient support and understanding of diet restrictions from family and friends [9,12]. This shows that it is important to address social connectedness and let friends and family take part of the situation and information as this in extension could reduce feelings of isolation, which is in line with the work by Heo et al. This indicates that it is important to consider the full picture and include not only the patient but also their support network, when designing for people diagnosed with chronic diseases. In the cases were patients are lonely it could be important to help them meet people in the same situation e.g. in support groups.

The Heart Companion
Patients vary in their personal needs and living situations, so the application had to be created with a number of different potential users in mind (see Figure 1). The observations, interviews and statistics made it clear that at least parts of the patient group could range from retired, to still working and younger individuals. Because of their different living situations, abilities and levels of HF they could make use of the resources provided by the healthcare, e.g. physiotherapy and educational support groups, to a varying extent. The concept of the application was developed with this in mind in order to bridge the gap by empowering the patients in their everyday lives.

General information: Personalizing the content
Making the content interesting and relevant enough for the user group was a challenge as some users, such as the persona Marie, want to get access to extensive information while others just want to learn the basics. Part of the information, such as what HF is, is applicable to most users. But other parts, such as certain specific symptoms, only to a few. ENOPE stated that an empowered patient understands the condition and takes better care of themselves and their treatment [10]. During interviews with specialist nurses it was clear that symptoms and advices on how to counteract them are an important part of the knowledge spectra for empowered patients, as this advice users how to navigate to better health. But, not all patients experience the same symptoms. Thus, it was important to in some way make it easier to sort out the information relevant for the specific user. One idea that manifested during the design process was to sort out the relevant information based on the level of HF a patient has. But making the information more personal using this specific strategy was viewed as problematic during one of the feedback sessions with master students of interaction design. As mentioned before, some information is applicable to many independent of what level of HF they have and some information is highly individual and cannot be strictly divided into the different levels. Instead of using this strategy the choice was made to enable personalization of the content by providing the possibility of sorting out and bookmarking relevant content. This could, for example, be used by the personas Kim and Marie. They often experience self-doubt and worry about not remembering the information correctly. By bookmarking the general information and pages about symptoms, such as ‘retaining fluid’, that relate to Kim and Marie’s partner they can quickly access the information whenever they want and become empowered as well as feel safer in everyday life. As Kim often repeat the same questions and worry about the same aspects, her specialist nurse Eva can help her to bookmark the information she would benefit from reading, making the experience of the application more personalized. In fact, the system was overall designed as much more user-driven, providing possibilities for personalization but not forcing automatic personalization that could risk excluding information that could be relevant further on. Other than providing possibilities of personalizing the content, it could be important to provide the opportunity to customize or personalize the form of the content as well. Some aspects such as adjustment of the font size, selection of language and the choice to add a text-to-speech function could extend the use of the application across a wider range of the patient group, as various abilities and age groups are taken into account.

Physical activity: Skill assessment, feedback & reflection
When designing for this theme the main challenge was how to empower patients to become more confident and feel more secure when engaging in physical activities. When looking back to the preferred state of the persona Albin this is accommodated in three different ways by the application. Firstly, he reads through advices to keep in mind to learn what to except and how to act during exercising and feels safer in the process. Secondly, as he can play animations for each exercise he easily conduct them in a correct manner and when he is in doubt if he is doing it right he can read the description accompanying the animation to know how it should feel. If he is unsure about if the exercise he has selected is good for him he can discuss this with his specialist nurse and personalize the exercise session further. Thirdly, Albin gets personalized feedback after conducting an exercise session and assessing his exertion. This helps him to exercise on a good level as he is provided with the tools necessary i.e. personal advices and strategies on how to exercise based on the exertion he felt. To make it easier in reviewing the information later and get a good holistic picture of his individual improvement he also adds a comment about how he felt that day. He is empowered by this as he is provided with the means of understanding his personal situation and the tools of improving it. Initially it could be hard for the patients to know how to rate their exertion. By combining use of the application with discussions with specialist nurses at the HF-clinic this knowledge can be built and enable correct skill assessment which in turn leads to suitable personal feedback. Aside from helping various users who find themselves in the same situation as Albin, the application could also be beneficial
to users such as Samir. Samir feels excluded from the support groups as not many contain or focus on patients his age. By making use of the exercise session guide he can exercise in a safer manner, for example in the gym, and by doing so increase his well-being and at least to some extent reduce his feelings of isolation. To accommodate for various types of users (mainly the personas) ‘My exercises’ incorporated different types of exercise sessions so that diverse exercise situations, abilities and needs were met. For example, both Albin and Kim were insecure about how to engage in physical activity. Albin could engage in exercise sessions but needed strategies and guiding in how to conduct them in a safer manner. Kim, on the other hand, had a more severe type of HF and needed to learn how it should feel and what to keep in mind when taking her walks. They have varying needs and will use the application in different ways. Albin makes use of the exercise sessions and personalized feedback, while Kim relies of the advices to feel safer. Aside from that, users that are interested in taking a more active role when engaging in physical activity can build their own personal exercise sessions, by picking the exercises most suited to them based on their preferences and accumulated understanding of the condition. If users have any questions they can always consult their healthcare contacts, such as specialist nurses or physiotherapists and discuss it. Thus, the application has taken a step away from only being an interactive sheet of instructions to becoming a dynamic addition, an exercise companion and guide that can empower users. Since the application provides advices, exercise sessions, the possibility to build personal sessions and personalized feedback, by incorporating personal informatics, the user gets added value by using it regularly instead of only sporadically. This could motivate the users in the long run to reach self-directed exercising by regular usage, as is supported by the work of Kranz et al. [13].

The use of personal informatics is an area of controversy. The criticism mainly concern situations where this is used to control the user’s options too strictly and as an effect exclude personal reflection and discovery which is important for developing a sense of control as e.g. Purpura et al. [20] flag for in their work. In the interview with the physiotherapist it was mentioned that perceived exertion is an important aspect when building or adapting exercise programs. To remove the risk of excluding personal reflection the choice was made to let the users assess the level of exertion themselves rather than using system driven tracking. Rooksby et al. mentioned that we use data to navigate to the future [22] and by allowing the users to estimate the exertion themselves they could possibly get a better picture of their abilities as they are provided with personalized feedback as cues on how to exercise well later on. This can guide their intuition when choosing either a suitable pre-defined exercise session or when building their own. The users could also write down contextual information to make sense of the collected information later i.e. the exertion level felt and advices provided. This collected history could be viewed in the logbook to enable sense making of the user’s situation and help them find patterns in their behaviour to learn what works for them. This is based on research by Ferreira et al. [11] were they discovered that by itself physical data is of little value. It achieves value when it is complemented by contextual information. They also noted that short-term history together with real-time history helps users make sense of their own state.

**Social connectedness**

Other than supporting physical activity and dieting, social connectedness, e.g. the possibility to form personal connections, is of major importance for the well-being of HF-patients such as the persona Kim. Many patients can experience fear of exerting themselves and get more isolated in the process. The same applies for having to change their food habits as mentioned earlier. The application could counteract these detrimental effects by supporting the patient in their exercising, making them less afraid of the situation and enabling a more active, social life. But trying to counteract this in regards to dieting is a bit more challenging. Heo et al. [12] mentions that it is important for patients to feel secure and supported by friends and family when trying to adhere to a diet, but some may not have as good a social support depending on various circumstances. What could be of interest is for example enabling contact between different patients in equal situations. However, this in not as simple as only providing a forum for them to meet in. Since the application would be created in collaboration with Karolinska University Hospital it is crucial that the content and information in it is correct and credible to counteract possible malpractice. If a social forum should be included in the application the healthcare providers would possibly need to administrate the forum, to make sure the information shared is relevant and true. This would probably demand time resources that might not always be available. In the proposed design exemplar the idea of a forum was rejected because of these reasons. Also, there are already many established patient organizations working on the issue of social support. The National Heart-Lung Association already provides social support through different activities and support groups. If social support would be incorporated in the application this should be done in collaboration with patient organisations to grant a better understanding of how such an implementation could function. However, the credibility of the information and source should always be a focus.

**Method discussion**

Using research through design as a method proved to be a fruitful way of exploring the design space and enabling continuous improvement of the design solution. Research through design essentially helped to continuously redefine the problem and create a suitable solution. Letting personas, current- and preferred state guide the design choices helped keep the design process on track. Combining observations
and interviews worked well when it came to exploring the situation. The observations of patient/nurse meetings at the HF-clinic served as a starting point from which the main problem areas could be discovered along with what was lacking in the situation of the patients to make them feel empowered. Involving users, both patients and specialist nurses, granted insights into different stakeholder perspectives and the healthcare domain.

Making use of personas while developing applications and systems where human-computer interaction takes place is not entirely without problems. Chapman & Milham [5] mentions that personas are hard to validate and while the intention could be to get to know user needs and abilities better, we can almost never be sure enough as to how many per cent of the user group they truly represent. This could compromise the relevancy of using personas in design processes and, in turn, the relevancy of designs that are based on them. We must, however, consider the pros and cons and decide whether they can add something and channel more knowledge of the specific domain into the design process or not. Bodker et al. [4] writes about using personas as masks to see the situation from different perspectives and that they can activate and reframe prior knowledge leading us closer to the use situation. This is an approach that goes hand in hand with using research through design were the problem constantly is reframed in order to arrive at a suitable solution. Although it would have been beneficial to get access to more specific and extensive statistics the personas, in this paper, helped focus the prior knowledge gained of the domain in the design process. It is hard to state exactly how many per cent of the patient group the application is designed for and applicable to, but by making use of the early observations and extensive prior knowledge of healthcare professionals the use of personas still held value. Aside from this, the personas could also have been productive to use if planning for further participatory design. What could have benefited the study more would have been to get in contact with dieticians to get more expert insight into this area and open up for a more personalized approach concerning dieting. Likewise, it would have been advantageous to meet representatives of a patient organisation to gain more knowledge about the social aspect of the situation and grant further insights into how the social situation could be improved with the help of an interactive empowering application.

General learnings

Applications supporting patients diagnosed with chronic diseases could benefit from focusing more on promoting empowerment by providing the tools and strategies needed. Depending on the individual it may have to be personalized in different ways, and this can be better achieved by following a user-centred approach were well defined personas are developed and supported with statistics and prior knowledge. When incorporating physical activity in a system it can be valuable to explore what patients can use as a control measure to know if they are conducting the exercise correctly. Personalized feedback together with reflection of short-term history can also be empowering when learning about oneself. Social connectedness can be important to address when treating patients with chronic diseases, as many may have to change habits and risk becoming isolated.

CONCLUSION

The field of mobile health is constantly expanding as healthcare practices are changing and starts making use of this technology. We are bound to see a lot of interesting efforts and approaches into this field in the years to come. This paper focused on how to create an empowering application, with the help of personas and personalization, to accommodate for the varying user group that heart failure patients are part of. The contributions from this study and design process consist of three things. First, three themes were identified as important to incorporate when designing for better understanding of the situation, based on findings from research on HF and interviews with patients and specialist nurses. These were physical activity, dieting and social connectedness. It was also investigated what made heart failure patients feel empowered. The findings suggest that they need tools for changing their situation such as: personal advices on how to counteract symptoms and personalized feedback to enable correct exercising and strategies for dieting. Secondly, personas representing different patient types were created based on observations, interviews with patients, the experience of specialist nurses and statistics when it was available to define the span of possible users. User scenarios of the current and preferred state granted additional understanding of the problem areas and highlighted how an interactive application could empower HF-patients in their situation. Thirdly, ‘The Heart Companion’ was developed as a result of the design process. It incorporated the findings and insights about the user group and the notion of personalization with the purpose of empowering different heart failure patients in their self-care and increase their well-being. To create valuable design contributions for healthcare it is important to explore the holistic picture to see where technology and human resources can co-operate to increase self-knowledge and provide patients with the tools needed for empowerment.

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REFERENCES


