The Healthy App

Development of a Personal Health Record for chronic cardiac patients

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Preface

This thesis is a result of my graduation internship for the study ICT & Media Design at the Fontys University of Applied Sciences in Eindhoven. This report describes the process, challenges and the final outcome regarding the development of a Personal Health Record (PHR) system designed for chronic cardiac patients.

Project

I started with this project on September 1, 2011 and finished the internship at the end of January 2012. The project was conducted within the Health and Information Management group of Philips Research at the High Tech Campus in Eindhoven. This project will be part of a European project called "VPH-Share", where the aim is to develop an infrastructure to store, share, access and process bio-medical date in an efficient and secure manner.

My task was to develop a working and well structured PHR system for use by cardiac patients.

Acknowledgements

In this section I would like to thank some people who had an important role in the completion of my graduation project.
First of all, I want to thank my two mentors at Philips Research, Gijs Geleijnse and Gert-Jan de Vries. You gave me the trust and confidence when i needed it and your feedback on my work was extremely helpfull. I learned a lot in my time here at Philips, thank you both!

Secondly, I want to thank my tutor from Fontys, Frank Roosen, for the support during my internship and his feedback on the thesis. Thank you very much!

I also want to thank all the participants of my interviews for their time and valuable data they provided.
And last but not least i want to thank my family for supporting me during my graduation period.

Contents

Summary

The objective for this study at Philips Research is to create a useful system built upon a PHR system for use by chronic cardiac patients to facilitate them in keeping track and recording their medical data and providing added value for them.

During the research phase of this project, the investigated PHR systems provided lots of information about which features are available in current PHR based applications and what is important to focus on when developing a new PHR based application. The main consensus from this research is that it is important to focus on a simple layout (well arranged), personalized information and keeping medical information as simple as possible.

The interview sessions with cardiac patients provided a view on what the behaviors and conditions of the target group are. From the interviews it has been found that chronic cardiac patients want to be as independent as possible. They want to keep doing the things they still can do themselves, to gain a sense of independency. The participants also indicate to want some more information about their medication in a simple and clear way.

The information gained in the research and interviews phases has been used in the concepting phase to generate concepts based upon this information. Two concepts have been created focusing on weight measurement and medication information. Requirements have been created for each concept.

In the development phase of the project these two concepts have been realized into a functioning demo application on the iPad. Which has been user tested by four chronic cardiac patients.

The results of this study are that systems built upon PHRs can easely be used by elderly people when the interface is designed to be easy to navigate and use by this group. It has also been found that interacting with an interface on a tablet computer is no problem for them. It has also been found that PHRs can provide the user with a sense of independence, something that many chronic cardiac patients long for.

1. About Philips

Royal Philips Electronics

Royal Philips Electronics is a diversified Health and Well-being company, focused on improving people's lives through timely innovations. As a world leader in healthcare, lifestyle and lighting, Philips integrates technologies and design into people-centric solutions, based on fundamental customer insights and the brand promise of "sense and simplicity".

Headquartered in the Netherlands, Philips employs over 120,000 employees with sales and services in more than 100 countries worldwide. With sales of EUR 22.3 billion in 2010, the company is a market leader in cardiac care, acute care and home healthcare, energy efficient lighting solutions and new lighting applications, as well as lifestyle products for personal well-being and pleasure with strong leadership positions in male shaving and grooming, portable entertainment and oral healthcare.

Mission

"Improve the quality of people's lives through timely introduction of meaningful innovations."

Vision

"In a world where complexity increasingly touches every aspect of our daily lives, we will lead in bringing sense and simplicity to people."

Three businesses

Philips consists of three main businesses focusing on certain parts of the market; Healthcare, Lighting and Consumer Lifestyle.

Healthcare

Philips simplifies healthcare by focusing on the people in the care cycle – patients and care providers. Through combining human insights and clinical expertise, Philips aim to improve patient outcomes while lowering the burden on the healthcare system. Advanced healthcare solutions are a fundamental part of the portfolio for both healthcare professionals and consumers, to meet the needs of patients in hospitals and at home. Philips Healthcare employs approximately 35,500 people worldwide.

Lighting

Philips Lighting is the leading provider of lighting solutions and applications both for professional and consumer markets, transforming how lighting is used to enhance the human experience in the places where people live and work. Whether at home, on the road, in the city, shopping, at work or at school, we are creating lighting solutions that transform environments, create experiences, and help shape identities. We serve our customers through a market segment approach which encompasses Homes, Office and Outdoor, Industry, Retail, Hospitality, Entertainment, Healthcare and Automotive.

For these segments we provide a wide range of offerings from across the entire lighting value chain - from light sources, luminaires and lighting controls to lighting solutions and services. Philips Lighting employs approximately 53,000 people worldwide.

Healthcare

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Philips Research[2]

After the founding in 1914, Philips Research became one of the world's major research organizations. With seven laboratories over three different continents, Philips Research creates breakthrough innovations. The heart of Philips Research's activities is situated at the High Tech Campus in Eindhoven. Here, new concepts and future technologies are tested in the early stages of development. Through the use of Experience Labs for user acceptance, new solutions are introduced which meet the needs of the markets and the end-users with the strong belief that every innovation should start with an insight. Philips Research delivers:

1) Roadmap innovations to support the existing businesses in the field of Healthcare, Lighting and Consumer Lifestyle,
2) Innovations adjacent to existing businesses,
3) Break away innovations to address new markets in line with the strategic direction of Philips.

Philips Research can be divided in three separate programs; Healthcare, Lifestyle and Technology, providing meaningful innovations for the company's three main businesses.

Mission

Improve the quality of people's lives trough technology-enabled meaningful innovations - as co-creator and strategic partner for the Philips business and complementary open innovation ecosystem participants.

Vision

By 2015, we will have a track record of successful co-creation of impactful innovations in Health and Well-being, and be a preferred partner for technology-enabled Innovation.

Healthcare Information Management (HIM)

The Healthcare Information Management group at Philips Research Eindhoven studies innovative software technologies, creates architectural concepts, and develops feasibility prototypes for the future generations of Healthcare Solutions and Personal Healthcare Systems. The group also masters a solid expertise in the domains of Software Architectures for Medical Systems and for Connected Consumer Systems based on its past research activities.

2. Assignment

"In this study, we focus on the potential usage of concepts built upon Personal Health Records (PHR) for cardiac patients. Although such PHRs are commercially available for several years (e.g. Google Health, Microsoft HealthVault), the uptake is limited." (from initial assignment by Philips)

Introduction

A personal health record is a system that enables people to access and manage their own health information and share it with others. Chronic cardiac patients have been chosen as a target group because this group seems to require lots of regular care and checkups.

Objectives

The objective for this thesis is to create a useful system built upon a PHR for use by chronic cardiac patients to facilitate them in keeping track and recording their medical data and providing added value for them. The system that will be developed will work as an interface between the patient and the PHR and will use the PHR as a data storage. This integrated patient and medical information can also be of more use to care-givers because it offers a more complete picture of the status of a patient and to researchers because it provides a big pool of patient data that can be used for research.

The prototype of this PHR based system is to be evaluated with the end-users, a group of chronic cardiac patients. After this evaluation recommendations will be done to further improve on the system for future work.

Current situation

Most people today that come into contact with healthcare providers do so by personal appointments, telephone or sometimes through email. Medical data like the results of a blood-test is mostly provided to patients on paper.

There is a group of early adopters that are already using an electronic PHR. Users of Patient11, for instance, want to keep a record of their current weight, blood pressure, etc. in order to see if they lead a healthy life.

There are also companies that provide a PHR to their employees in order to motivate them to work on their health. The idea behind this is to keep them healthy and reduce sick days and absence.
These systems however are often not integrated PHRs. Often these are stand-alone systems, built for just one use and not connected to other health systems or providers except for the one that provides the system. Data is often not aggregated so patients have to fill it in themselves. So, this may lead to the risk of incorrect or incomplete data entered into the system.

Desired situation

Cardiac patients should be able to always access their medical data safely and easily for reviewing and adding certain data to it. As described, there are already systems available that partially facilitate in this. However, most of these systems still lack things as integration with data sources, features as data processing or some sort of communities where patients can contact each other. To solve this problem a new integrated system will be developed focusing on patient involvement and offering various features like apps that can be added and provide meaningful added value and connection to a centralized PHR database system providing medical data to the new system.

Main question

How can we create a meaningful PHR-based system to fit seamlessly into the life of a chronic heart patient and provide exactly the services that the patient needs?

Process

In order to attain the goals set for this project, a work plan has been made. The first phase in this project is the research phase (Chapter 2). This phase will focus on literature research about PHRs and PHR based systems in order to see what the current systems have to offer. The results from this research will be used in the interview and concepting phases.

The next step is to perform an interview study, which is described

in Chapter 3. The objective of these interviews is to gain insight into the needs, habits and information needs of chronic cardiac patients. The results from this study are used in combination with the results from the desk research to form input in the concepting phase.
The aim for the concepting phase (Chapter 4) is to generate concepts for a PHR based system using the input from the former phases. The most promising concept will be picked out and a demo of it will be made.

3. Desk Research

This chapter will describe current PHR systems from several commercial enterprises as Google, Microsoft and Patient1. It will also explain what a PHR is and what the advantages and disadvantages may be. In order to gather this data desk research has been performed. All the mentioned PHR systems have been examined for functionality and what they have to offer. These systems have been chosen because they are easily accessible (they do not require you to fill in e.g. your passport number to verify that you are a US citizen).

Personal Health Record (PHR)

A Personal Health Record (PHR) is a form of an electronic health record (EHR) with a focus on management and control by the user, and not by the healthcare providers. It enables people to access and manage their own health information and share it with others (e.g. family or healthcare providers). The main focus areas of a PHR are health, wellbeing and a feeling of control over your health information.

There are 3 general forms of PHRs:

- Stand-Alone PHR

A stand-alone PHR requires the patient to fill in and update its own information. These PHRs don't automatically populate themselves from various sources because they are not connected to them. Recorded data can be shared with others. An example of this type of system is Patient1*.

- Tethered PHR

This is mostly an extension of the health-providers IT system, allowing the patient to add upon existing data by providing e.g. information on over the counter medication and diaries on their health status. Tethered PHRs are often limited to what the vendor offers and are often not open to third parties to add upon them with for example apps. Tethered PHRs are connected to the health information known to the vendor of the system. For example, My Health eVet [-3]

- Interconnected PHR

Interconnected PHRs take aspects of stand-alone and tethered PHRs. They provide interconnection between multiple sources of health information for users to control and add upon. They also often provide an IT system for vendors to build upon with external applications that can use health information in order to provide patients with more feedback.

Of the studied PHRs Google Health and Microsoft HealthVault fall into the interconnected PHR category and Patient1 falls into the stand-alone category. Heart360 is a system built upon Microsoft Health Vault.

PHR Review Study

To get an idea of the current commercial offerings of PHR systems, four available PHRs have been reviewed to get an idea what services they offer and how they position themselves.

Google Health [4]
Google Health is a PHR system that offered users the ability to centrally store their medical data. Google Health has been discontinued as of January 1, 2012.

Patient1 [5]
Patient1 is a Dutch PHR system featuring a free and paid service.

Microsoft HealthVault [6]
Microsoft HealthVault is a PHR system primarily meant to provide a stable platform for third party applications to build upon.

Heart360 [7]
Heart360 is a service based upon Health Vault. It has been reviewed to see how a system based upon Health Vault functions and what it offers.

These systems have been chosen because they are readily commercially available and relatively easy accessible. They also offer various uses of PHRs like comparing medication for compatibility, addition of app's and systems building upon a PHR.

There are more PHRs available at time of research but these have been left out of this study because of time constraints and because the current choice of systems seems to be a good representation of what PHRs have to offer.

Google Health

Google Health is a interconnected PHR focusing on managing and tracking of personal health information, setting certain health goals (like how many steps to take daily), sharing medical information with others and using apps to the patients profile to add third party functionalities (reviewing of your medical information, reviewing x-ray images, etc).

Goals and customers

The main goal for Google Health is to offer users easy and free access to a system where they can store, manage and share all of their health and wellness related information. Google Health does not seem to focus on a specific target group. Anyone that is interested in keeping track of and using their medical data is a potential customer.

Third party

There are several healthcare providers like CVS Pharmacy [-8], that can be connected with Google Health. This makes certain data in their systems visible trough Google Health.
Google Health also uses apps called 'Personal Health Services' which can be added to it via its dashboard. These include free and paid services that make use of patient information to, for example, screen medical data for issues. Such as MD LiveCare [-9], which lets patients speak to a doctor or therapist about medical data via a webcam connection.

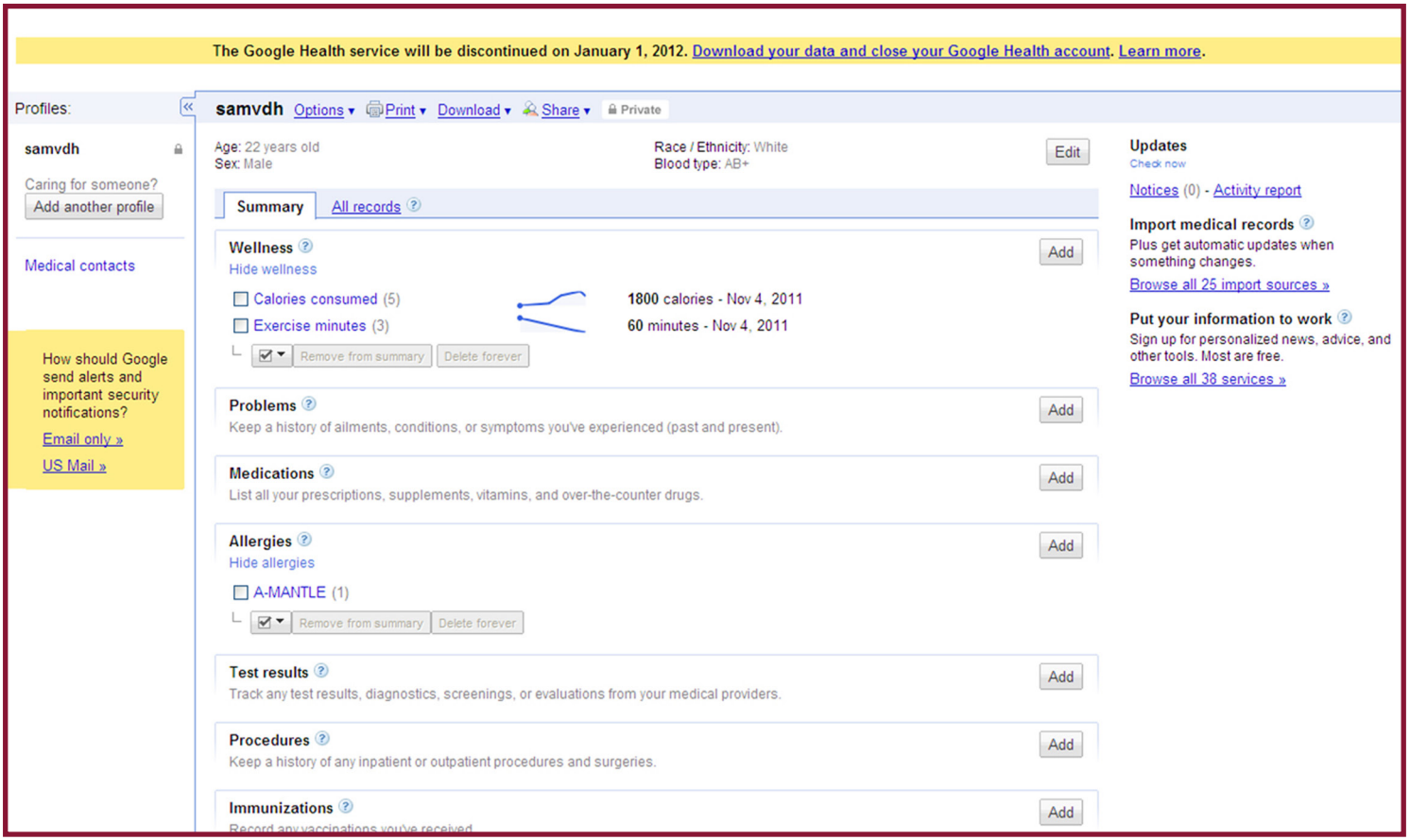
Google Health also uses Google's search functionality to display relevant news and scientific papers next to, for example, the medication that is entered in Google Health. This makes it a very informative system.

Layout and functionality

The layout for Google Health is very simple and easy to understand. Important links and functions are in the right places. Google Health features no deep menus which makes it easy to navigate and hard to get lost. A nice function is the AutoComplete function when entering the names of medication. These names are often written in Latin so mistakes when entering them are easily made. This system solves that by showing names of medication similar to what has been entered.

Entering information into Google Health can be done by importing it from a connected care provider or by inserting this manually. Measurements also have to be entered manually because Google Health does not support medical devices to automatically add this data to your record.

Google Health has been discontinued as of January 1, 2012.



The Google Health Dashboard.

Patient1

Patient1 is a Dutch stand-alone PHR system that facilitates people in storing and comparing medical and lifestyle data for free. Fees are charged if patients want insight in their medical data known to their General Practitioner (GP). This is only possible if the GP is connected to Patient1.

Features

Patient1 features a food-check which compares food routines to the Dutch recommendations for food use by letting the user fill in a questionnaire. It also features Care-plans for diabetics and COPD. Data that can be entered in these care-plans is specific to these conditions. When this data, like weight, cholesterol and blood pressure, is entered Patient1 lets patients graphically track their measurements by the use of charts. Patient1 seems to focus on the target groups of the Care-plans, because this is where most of the functionalities of the system are. However, anyone can use Patient1. There seem to be plans to expand the list of Care-plans to include other chronic conditions as heart-failure.

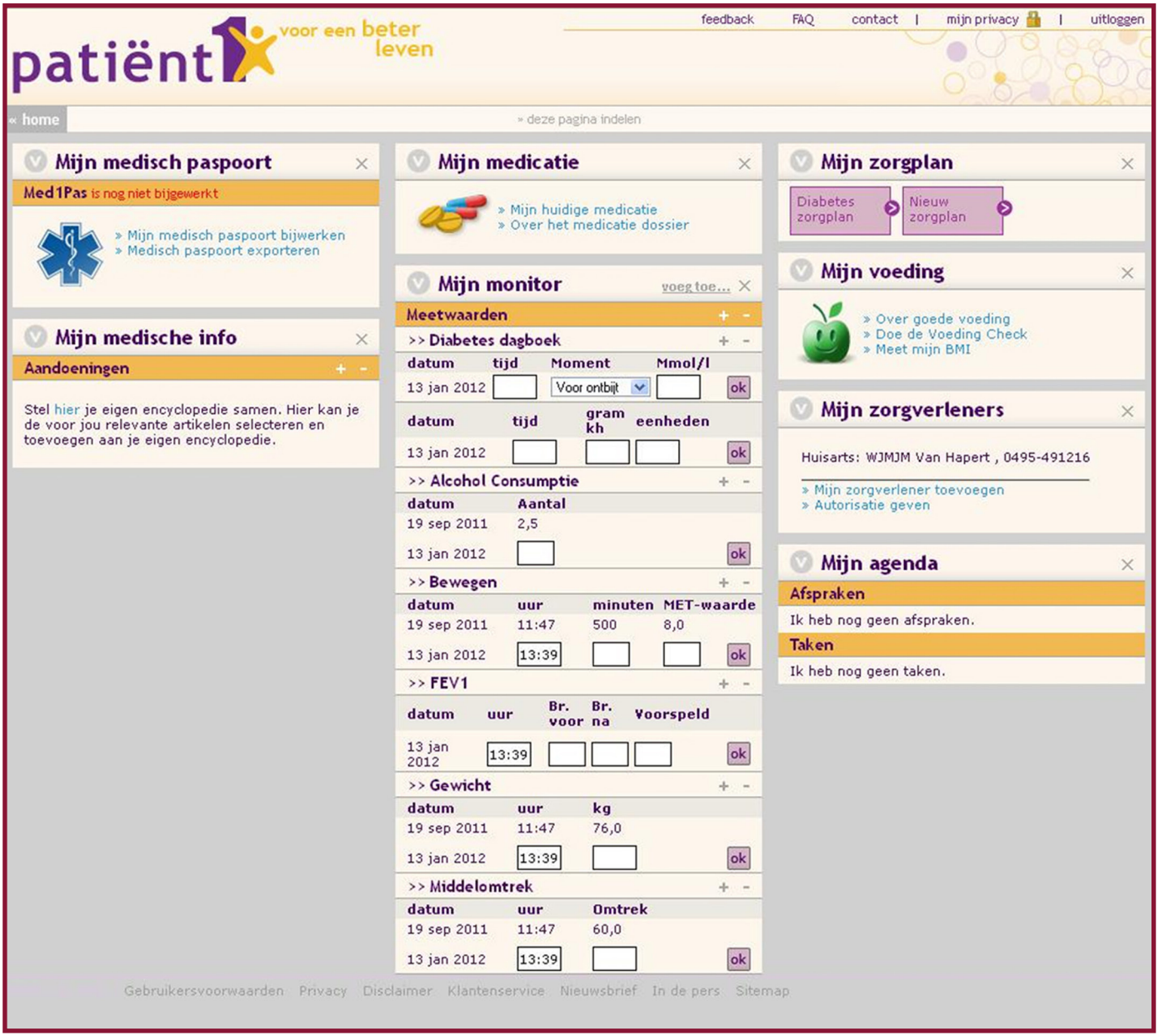
It also provides an encyclopedia with almost all known conditions, providing vast amounts of information about these conditions except for images. These conditions can be added to the personal profile to keep them easily accessible.
It is also possible to order a credit card-sized card that digitally contains all provided medical data about the patient. This card can be plugged into an USB port on the computer.

Layout and functionality

Patient1 features two dashboards from which to enter and access information. This can be confusing at times, especially because the two pages contain some of the same information which might make it a bit harder to see where the actual starting point is. The interface for filling in measurement values is somewhat cluttered. It is not directly visible where values have to be filled in.
Most data like the number of smoked cigarettes or daily weight measurements must be inserted manually into Patient1 which can be quite time consuming. Patient1 does not support devices to automatically enter data into your profile.

Subscription

Patient1 Plus is the paid subscription version of the system. It features access to medical data known to your GP, your prescribed medication files and lab test results. It also allows patients to share information with others.



The Patient1 Dashboard.

Microsoft HealthVault

Health Vault is an interconnected PHR that mainly provides a stable and secure platform to third parties for storing and using medical and personal information. To fully access and use the live version of Health Vault it is required to be an American or United Kingdom citizen because Health Vault requires the user to fill in their passport number to check their identity. Health Vault plans to extend its services to other countries, but it does not mention when this will be done.

Platform

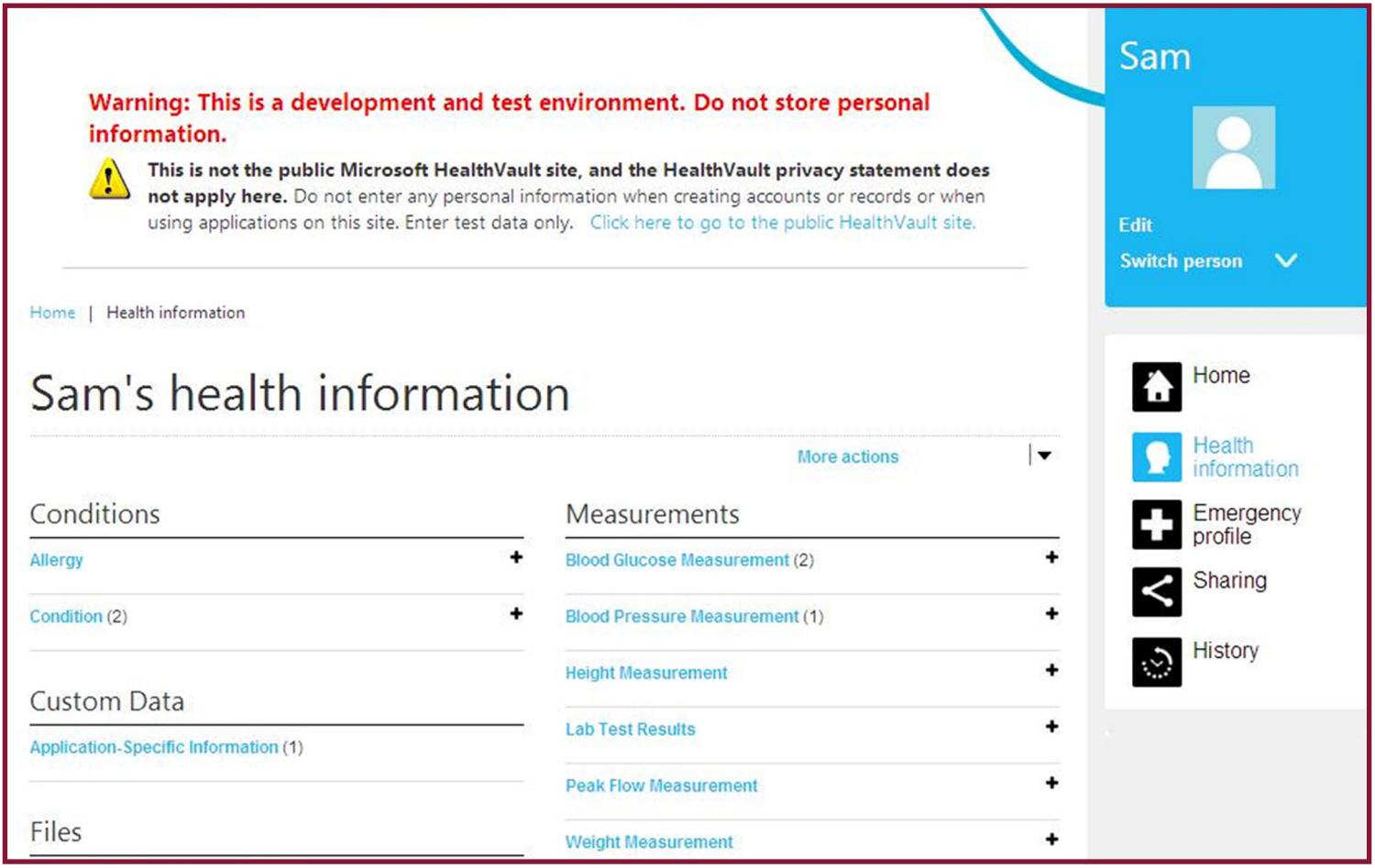
Microsoft HealthVault has a dashboard of its own to access stored medical data and add third party applications like Heart360 to the users profile which can interact with the stored medical data. Microsoft has stated that it will rely on third party developers to provide new applications and uses for the platform.

When an individual starts using Health Vault services they are first asked to sign up for a Health Vault account. When an external service is added to Health Vault it can be specified to only get access to a specific set of data. This keeps information users don't want to share secure. Information can be shared with anyone.

Devices

Microsoft has teamed up with a number of medical device manufacturers to produce devices that can automatically connect to Health Vault to upload the latest measurements. These devices include blood glucose monitors, diabetes instruments, etc.

The Microsoft Health Vault findings are based on the Development version of the system.



The Microsoft HealthVault Development version Dashboard.

Heart360

Heart360 is a program from the American Heart Association based upon Microsoft Health Vault. It functions as an interface between Health Vault and the end user. Heart360 basically uses Health Vault as data storage for medical and personal data. To use Heart360 it is required to have a Health Vault account in order to allow Heart360 to communicate with Health Vault.

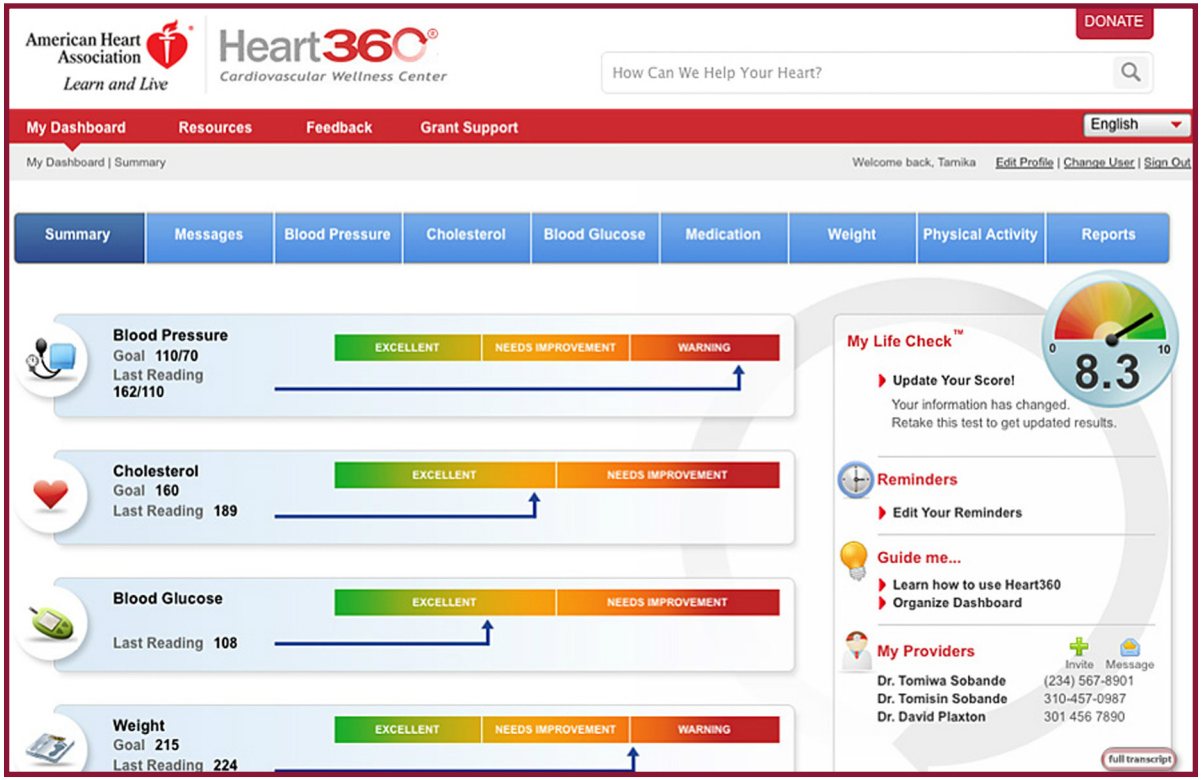
Services

Heart 360 offers cardiovascular patients a place to record and track the status of their condition. It aims to involve patients into the care for their condition by giving them insight into the current status of their heart condition and providing them with info about what they can do to improve their lives. They inform patients about aspects of their condition by providing specific information about e.g. cholesterol and how to keep it low at the moment that patients are looking at their cholesterol measurements.

Functionality

Heart360 also focuses on self measurement and devices for home measurement. On the bottom of each page is information about what devices would be of help for e.g. cholesterol readings of weight readings. Results of tests and measurements are printable to take with you to doctors. There is an option to grant people access to the profile in order to view results. There is also an option to send personal messages.

Medication taken can be entered but only what it is and the doses to take each day. No info can be provided if they are taken. They also don't provide a way to remind people about taking medication.



The Heart360 Dashboard.

Pros and Cons PHRs

PHRs still seem to be in the adoption phase as just 7% of the adult American public has ever used one [-10]. However, this is a significant improvement over a 2008 survey that found that just 2.7% of adult Americans used a PHR1. It is clear that PHRs start gaining a greater interest from the public.

Pros

PHRs can put patients in control of their health. Allowing them to monitor their health status and adapt their lives to it by for example exercising more often. They can also educate people about conditions or medication. Making them better informed and more able to generate better plans for their well-being.

They can also provide caregivers with more fine-tuned information based on patient input in the PHR to offer better and more personalized care. It also gives patients the opportunity to check if their medical records are accurate and see if nothing is missed or forgotten in them. This can also be a way to assure patients in correctness of the medical system as 64% of current PHR user's rate checking if their records are accurate as a very useful feature1.

Data in PHRs may also be used for analysis purposes by researchers. For example, the average weight of diabetes II patients can be determined using an aggregated view.

Cons

It is reasonable to say that the majority of the public is well aware to risks presented by computer systems, especially when their personal information may be in the line of fire. For instance, 75% of non-PHR users agree with the statement that they worry about their privacy of information2. The risk of computer fraud and theft of medical information is also present with PHR systems. Since they can contain vast quantities of personal and medical data these systems could be a main focus for anyone trying to gain this data to do harm or to sell it on. Trojan programs are now commercial available, so anyone using a computer could potentially be at risk of having their data stolen by such programs.

Another security concern are the wireless devices such as a mobile phone or an iPad on which data is viewed and mobile health devices that record and store medical information. These devices often are small and most of the times operate wirelessly. This presents the risk of easy loss or theft because of their small size and the risk to be compromised because of their wireless connection.

Ease of use can be a problem for PHRs. They require you to do several things as turning on your computer and navigating to the PHR website in order to view your data. This could potentially put off people to use a PHR, especially those that are not familiar with computers. This could be a field for further research as it seems that 38% of the people not using a PHR think that it would take too much time to use a PHR and 26% of people not using a PHR do not like computers or the internet [-10].

Health Literacy

Health literacy is not simply the ability to read. It is among others the ability to understand prescriptions on drug bottles, follow doctors directions, understanding medical information and understanding complex healthcare systems.

According to the Institute of Medicine nearly 30% of the American population have difficulties understanding and using health information. [-11] As a result, patients often don't understand instructions on drug bottles, get confused about what medication is what and don't understand instructions from their doctors.

We will take note of low health literacy when developing the PHR-based system in order for it to be usable by as many people as possible.

Technology Adoption

The adoption of technology among elderly has increased the last few years. For instance, the use of smartphones among people aged 55-64 has almost doubled between 2010 and 2011. [-12] So has the use of tablet computers among people aged 55-65. [-13]

This will be taken into consideration when choosing a platform for the PHR-based system to be based upon.

Conclusion

Four PHR or PHR based systems have been reviewed for this study to get a better idea of what services current commercial PHRs offer and how they position themselves.

All of the reviewed systems offer the possibility to view and fill out measurements and medical information into the system. These measurements are often made visual trough the use of charts displaying measurements over time. Patient1 has a somewhat cluttered layout for filling in and viewing data, so users can have some trouble finding where to fill in measurements at first. This becomes clear after a while but patients could be put off by this. Good practice would be to design the layout of a system so that it is directly visible where the important aspects of the system can be found.

Personalisation

Something that enables the user to personalize the system is the apps that can be added to Google Health and Health Vault. These offer added value because they facilitate in using stored data to e.g. draw conclusions about your current health or judge stored x-ray images. These apps are actually the main aspect of Health Vault. It almost completely relies on third-party developers to use the system as data storage for health related information. Access to health related information in Health Vault is regulated by the user who can grant or reject a request from an app to access certain data. This is a powerful feature because it can give the user a feeling of being in control of his or her information even more.

Heart 360 is a system that acts as an interface between the user and the PHR and is built upon Microsoft Health Vault. It uses Health Vault as data storage for medical data.

The system of using Health Vault as data storage is a great feature for developers of PHR applications because it eliminates the need for them to design a secure storage system because it is already present in Health Vault.

The downside to this is that it makes the user dependent of Health Vault. This means that if Health vault stops working, the Heart360 application will do so too. This has to be taken into consideration when developing a Health Vault based system.

Lastly, when developing a PHR based system it should be taken into account that health literacy among chronic cardiac patients could be low. Therefore it might be required to simplify medical information where possible to a degree where it is still medically sound but easy to read.

4. User Study

In order to get insights into useful data for use in the concepting phase it is necessary to conduct a user study. The main goal of this user study is to gain insight in the behavior and medical condition of chronic cardiac patients. It is vital to get to know what the target group can and can't do anymore. How they are cared for? How do they deal with their medication? And so on. This information can help to fine-tune the final application to the needs and uses of the target group and will be combined with the data gathered from research in the previous chapter for use in the design and development of the demo application.

Interview

The chosen target group for this study is chronic cardiac patients of all ages because this is what the initial study focuses on.
The user study has been conducted with four people, 68 to 90 years of age, with a chronic cardiac disease that still affects their lives. All interviews were conducted at care home Peppelrode. Two of the interviewees lived here at the moment of the interviews and two came to Peppelrode twice a week for day-care. These people were chosen because of their heart related problems and because they presented a nice mix of people with different backgrounds.

Participants

The four interviewees for this study were people with varying personalities and care needs.

S1: Interviewee one has had a stroke and got a new heart valve some three years ago and spent six months in the hospital and eight at Peppelrode for revalidation. She still can't really cope with her condition psychologically. She still has times she gets depressed when she thinks about how she got ill and how it affected her life. She became very forgetful after she had a stroke. When someone says something to her and she turns around she often already forgot what was told to her. For this reason she writes everything down in an agenda. She lives on her own in a regular house.

S2: Interviewee two has had a stroke that left her paralyzed on one side of her body. She can't really care for herself anymore. Her husband, who is still very fit, looks and cares after her. She takes anti-depressives and regularly bursts into crying. She still lives at home with her husband.

S3: Interviewee number three got a new heart valve. He is an eager conservationist and interests himself in many things from literature to medical devices to history. He is diabetic and does his own measurements of blood sugar levels. He also self-measures his Acenocoumarol levels for his blood thinners and communicates these values to his doctor trough an internet portal. He knows how to use computers. He lives on his own in an apartment at care home Peppelrode.

S4: Interviewee four became hospitalized after a transaction. In her time in hospital she suffered from a cardiac arrest and bad personal care. She is rehabilitating in Peppelrode as she couldn't walk anymore after the cardiac arrest. She is single and the youngest of the interviewees, owns a scoot mobile and owns a computer. She can't really work with the computer but is interested in learning to when she gets back home because of her lessened mobility which forces her to be at home more often. Has a house of her own which is currently being adapted to her condition for when she returns from revalidation.

Method

Contextual interviewing is an ethnographic interviewing technique that is used to gather qualitative data. [14-15] It has been chosen to make use of Contextual interviews in this study because it allows to observe users and patients in their natural setting. Questioning patients in their natural setting can bring important details of their behaviors to light.

Interview design

Categories for information gained from the interview consist of:

- Current situation (what do they still do at home, help with housekeeping, etc..)
- Heart condition (how long, complaints)
- Changes in lifestyle (what can they / what can't they do)
- Medication (what medication, knowledge of medication, how is it refilled)
- Caregivers (what caregivers, family and care)
- Medical information (what is measured, do they look into their test results, sharing information with others)
- Diet/fluid (are they on a diet, what do they know about their diet, do they monitor what food they eat and drink)
- Physical activities (what do they do to keep fit, what can they / what can't they do)
- Drinking/smoking
- Use of technology (use of computer / internet, would they be willing to work with computers)

This information is needed to establish how much or how little difficulty people had when performing certain tasks as taking medication, to determine what they miss and would like to see in their care and to gain insight into their information and communication needs for their cardiac condition. This information will be taken into account in the concepting and design of the demo application.

Interview Results

General

- All but one of the interviewees seemed to have an urge to be as independent as possible. They accept help if they really need it but try to do as many things as they can by themselves. They want to have something to do. One of the interviewees (S2) left almost everything up to her husband.
- None indicate to have had any serious physical problems with their heart condition after being treated for it. But when they would have any, they indicate to contact a doctor about it.
- Two interviewees seemed not to cope with their condition very well psychologically. They indicated to have times they felt listless and had to cry a lot. They indicated this had to do with their condition and the long times they spend in the hospital. One person (S2) takes anti-depressives.
- All became less mobile after being treated for their heart condition. Ranging from paralysis on one side of the body (S2) to not being able to walk long distances.

Medication and hospitalization

- None seem to have problems taking medication. They indicate not to forget it because it has become part of their daily routine. All indicate to keep medication in special boxes labeled with the days of the week and the morning, afternoon, and evening.
- Two persons could identify their medication; two did not know what medication they took. One of those indicated she would like to know what they are and what they do (S4).
- One person arranged and re-filled his own medication (S3). The other three have this arranged and re-filled for them (one by her husband (S2), two by home-care providers). All had prescriptions from their GP or hospital.
- For 3 interviewees the number of blood thinners they had to take daily related to the weekly measurements of the INR-ratio by care-providers.
- One person always carried a list of her medication with her because she can't remember them.
- Two people (S1, S4) seemed to be very much busy with being as independent as possible. Possibly because of their long hospitalizations and experiences with hospitals.

Measurements and information

- All indicated to have measurements like blood pressure and blood tests done by their care-providers or by themselves. Three indicated to have it done for them (ranging from once a week to once a month), one person (S3) measures his own blood sugar and INR-ratio levels (for blood thinners) daily. This self-measuring person seems to be the most intelligent and bright person of the interviewees. Also taking an interest in medical technology after he got a new heart valve. He perceives self-measuring as not disrupting and a good thing to do. The other interviewees see the measurements as something that has to be done.
- None of the interviewees (except S3) knew what their measurement values are. They only got to hear anything of it if the measurements required changing medication or doses.
- Only S3 kept a record of measurement values. One interviewee indicated not wanting to keep a record because that would only remind her of her illness (S1).
- One person indicated that she did not want to know more about it because that would only remind her to much that she is ill (S1). One person didn't know anything about her medication and is ok with it (S2). One person already knew all he wants to know about the medication (S3). One person would like to know more about the medication (side-effects etc..) (S4)
- None searched for additional information about their condition. If they want to know anything, they ask their doctor.

Care providers and family

- All were satisfied with their care-providers. They perceive the received care as good and like the personal attention they get.
- All could ask questions at their care-providers about their health. One person indicated it took long to get an answer from her doctor. This was not perceived by her as a bad thing because she indicated to understand that her doctor is busy.
- Family seems not to be involved very deeply in care. People indicated that family took over their administration when they were in the hospital and that family would join them when they visit the doctor. They did not mention any other tasks that their family would do. One person was completely cared for by her husband (S2).

Diet and exercise

- None received a special diet from their care-givers. All indicated to eat what they like to eat. Two interviewees indicated they kept themselves to a diet to keep their weight under control because they are not able to exercise (S2, S4). This is not prescribed to them by care-givers. They did sometimes deviate from this whey they had a party etc.
- Three interviewees indicated they found it a bit weird they did not receive a special diet from their doctor. None found it disturbing.
- One person mentioned she regularly does some exercise, one sometimes takes part in gym class. Two didn't indicate to do any exercise probably because of their condition.
- Two interviewees indicated to drink alcohol. One drinks a glass of wine before she goes to bed (S1). Two indicated to not drink any alcohol (or VERY incidental). None got an advice from their doctor not to drink alcohol. This is of no great concern to them.
- None kept a record of their diet or fluid intake because their doctors did not mention this to be necessary.

Technology

- One person really never used a computer and sees nothing in using it except when the doctor wants her to. (S1)
- One person indicated that she doesn't work with a computer but her husband does. She does not know what internet is and is most probably not competent or willing to use a computer at all. (S2)
- One person uses a computer for communicating his self-measured results to doctors and for looking things up on Google and typing letters and such. (S3)
- One person has a computer at home but does not really know how to use it. Has no internet. Does intend to use the computer more because her illness has made her less mobile and she wants to have something to do.(S4)
- One person indicated to have heard of the EPD (electronisch patienten dossier) and seems interested in it (S4). However she has concerns about the safety of data. These concerns were easily taken away by telling her it was an encrypted system that was secured by a username and password.
- Three out of 4 people mentioned they would use the computer if it had advantages for their medical condition and if the doctor would like them to use one because of health benefits. One person mentioned not to be interested in using a computer; she left this up to her husband. (S2)

Interview Conclusions

Measurements

It has been found in the interviews that measurements as blood pressure, heart rate, weight, blood glucose and cholesterol are done weekly to monthly by care providers, depending on the condition of the patient. It has not been found that patients experience these measurements as distracting or unwanted. Regular measurements are very important to keep track of the patients' health and monitor changes that could indicate problems.

Physical activity

From the interviews it seemed that the least mobile person was the most physically active. She indicated to exercise regularly in order to stay active. One other interviewee indicated to attend gym class incidentally if she felt fit enough to exercise. The two other interviewees did not do any type of exercise, but indicated they would do so if their doctor wanted them to. All interviewees were less mobile so their physical ability to exercise was mainly limited to slow walking.

Medication

Findings in interviews indicate that patients have developed strategies that allow them to remember to take medication. All interviewees for instance have systems like a medication-box to help them remember to take their medication. However there are people that indicate that they would like to know more information like what the medicine does and why it is good for them. Health literacy also seemed to be a problem as two interviewees could not identify what medication they take and what the medication is for.

Diet

No specific information about diet has been received by three of the interviewees from their doctor. Two indicated to somewhat keep themselves to a diet in order not to gain weight. They do this on their own initiative because they do not want to grow fat. They indicated that they find it strange that their doctor did not inform them about a healthy diet.

Technology

Use of computers and internet among the interviewees was quite high. Two people owned a computer; a third person had a computer in the house that was exclusively used by her husband. Two people indicated to use the internet. Also, three out of the four interviewees indicated that they would make use of a computer or device when their doctor indicated that he would like them to use one because of health benefits.

5. Concepting Phase

In this chapter we present some initial ideas on how to solve certain problems that were found in the literature and mentioned by patients.

To come up with additional ideas on how to deal with problems and topics of interest found in the research, the topics of interest have been structured to get a clear view on what is involved in each topic.
These topics have been selected by reviewing patient information for cardiac patients and heart failure patients in particular [Duke Heart Center/ NHS patient leaflets].

Topics of Interest

Blood pressure

High blood pressure is a condition that can lead to coronary heart disease, heart failure, stroke, kidney failure and other problems. Measuring blood pressure regularly is often done when the doctor deems that it is necessary to record blood pressure levels due to a higher or lower than average blood pressure. As we focus on chronic cardiac patients, regular measurements are required to control blood pressure levels with appropriate medication. Blood pressure testing is either done in the clinic or at home. Nowadays, blood pressure measuring devices are widely available for home use without a doctor's prescription. [16] A blood pressure monitoring device consists of an inflatable cuff that is placed around the upper part of the arm and measures the blood pressure. Some of these devices that feature a computer connection to transfer data to health care providers.

The initiator for blood pressure monitoring can be the doctor or the patient. The measuring frequency for blood pressure depends on factors as the current conditions a patient might have and how high their measured blood pressure is. It can range from once every six months to multiple times a day. [17] Blood pressure can be entered into all studied PHR systems and into HealthVault by means of a computer connected device.

Blood glucose

Blood glucose is the primary source of energy for the body. [22] Measurements of blood glucose are usually done by doctors to screen if a person might have diabetes, and by diabetics to keep track of their blood glucose levels throughout the day. Since 20 to 25 percent of all cardiac patients are diabetics and have even more chance of experiencing complications with their condition, this is a topic to take into account. [23]

Blood glucose can be entered into all studied PHR systems and into HealthVault by means of a computer connected measuring device.

Heart rate

The heart rate can be a good indicator of the medical condition of a patient. Any change in heart rate can indicate a change in the medical condition, this is the reason why cardiac patients should keep regular measurements of their heart rate. Measuring your heart rate is an easy thing to do at home with the finger-on-the-wrist method. [18] However, this method cannot be used for definitive measurements as the measured time can be a little longer or shorter than a minute and heartbeats could be missed or miscounted.

At a checkout at the doctor the heart rate will be measured by use of a heart rate measuring device. These devices are widely available for purchase by the public. Including devices that feature a computer connection to transfer data to health care providers.

Initiation to perform heart rate measurements can come from the doctor at a checkout or from the patient that wants to monitor his/her heart rate. Heart rate in rest can be checked on any time of the day after 10 minutes of rest. Heart rate during exercise can be checked when exercising. Heart rates can be entered in all studied PHR systems and into HealthVault by means of a computer connected device.

Weight

Weight measurement can support an everyday healthy life. Maintaining a healthy weight may lower the risk of getting various conditions like type 2 diabetes, coronary heart disease and stroke. [19] Weight monitoring is vital for cardiac patients because rapid changes in weight may indicate a problem with their condition. These weight changes can be the result of the body retaining fluids because the kidneys are not getting enough blood. [20] Therefore they should regularly check their weight to observe sudden weight gain due to a build-up of fluids in the body.

Weight is measured on a weight scale. These scales are offered in analog and digital varieties and also come with wireless connections to transfer data to a computer. [21] Because weight measurement is such an easy thing to do it is mainly the patient that monitors its own weight. Weight can be entered into all studied PHR systems and into HealthVault by means of a computer connected scale.

Follow-ups

When diagnosed with a heart condition it is necessary to have follow-up appointments every three to six months. To confirm the follow-up appointment, the patient can either get a note that states the data, time and place of the appointment, or the doctor/hospital can call to confirm an appointment. Some PHR systems like Patient1 feature an agenda that allows users to fill in appointment data. It is not automatically retrieved from the doctor's schedule.

Cholesterol

We need cholesterol to transport blood glucose throughout the body. However, excess cholesterol can cause arteries to clog up. This could lead to a heart attack or a stroke. [29] Cholesterol is measured by determining the value of the LDL-cholesterol (the harmful cholesterol). This is done by analyzing a blood sample in a lab.

While there are home testers for measuring cholesterol, it is said that these are not reliable enough to be clinically valid. [30] Therefore, most cholesterol tests are done by the doctor. All studied PHRs offer the possibility to enter cholesterol levels.

Physical activity

It is proven in studies that physically more active persons tend to have a smaller chance of developing conditions as coronal heart disease or developing another cardiac event such as coronary heart disease. [24] It is preferable to perform at least 30 minutes of modest activity daily to decrease the chance of developing complications with a heart condition. This can be e.g. walking, cycling or yard work. So even the least of activities, like shopping, can be good for your health.

Physical activity can be measured by the patient by measuring the heartbeat or counting steps and the time of the workout with a step counter. Step counters are widely available including devices that can be connected to the computer in order to upload data. This is also the way that physical activity is measured and entered in the studied PHRs.

Medication

For chronic cardiac patients, medication may be needed to control their heart disease and reduce the risk of e.g. a heart attack. Many medications must be taken with regular intervals and in strict doses. It has been found in the interviews that people take their medication in the morning at breakfast and/or in the evening at dinner. It has also been found that people are not sure about what to do when they forget to take their medication. It depends on the medication what to do when it has been forgotten. Forgetting to take medication can be very dangerous to patients with heart failure. They often need to take medication that keeps their blood from clotting up. When they forget to take this medicine, their blood can start to clot up which can lead to complications or even death. [-25]

The use of medication is initiated by the doctor but daily use of medication is done by the patient.

Current PHRs offer the possibility to enter medication that is currently being taken and the meditational history. Google Health offers a service that automatically displays any side effects when certain medication is taken in conjunction with other medication. Google Health and HealthVault also offer a connection with CVS and Walgreens pharmacies to automatically input your medication in your profile trough a secured connection between their databases. In the case for CVS pharmacy it works like this. Firstly, an account needs to be created at the CVS website. When filling in prescription information on the CVS website it will allow you to link the CVS account to the HealthVault account. When this link has been created by the user, the used medication will automatically be synchronized between CVS and HealthVault.

Smoking/drinking

Smoking and drinking are two habits that should not or moderately be done by cardiac patients because they can further enlarge or present health risks because of the nicotine and alcohol. [-26-27] It has been shown in studies that people who smoke more than one pack of cigarettes each day have more than twice the risk of heart attack than non smokers.

Alcohol can also have a good effect on e.g. cholesterol levels because when consumed in limited quantities it can raise the HDL cholesterol ("good" cholesterol) in the blood. It can also lower blood pressure and inhabit the formation of blood cloths. However, these effects are made undone when too much alcohol is consumed.

It is possible in some PHRs, like Patient1, to fill in how many alcoholic drinks or cigarettes are consumed daily. This data is presented back to the patients in a table or graphic so they can easily keep track of their drinking or smoking habits and set goals for themselves to achieve.

Diet

Maintaining a healthy diet can reduce the risk of heart disease or further complications of an existing heart disease by eating fewer fats, less sodium and more fibers. [-28] This may lower blood pressure, help losing weight and might decrease the chance of having complications with heart disease.

There are current PHRs, like Patient1, that offer a feature like a food-check to calculate if your food use is in line with the standards or not.

Rating Topic Importance

The table on this page shows a quick overview of the various subjects and their initiator that instructs when to start the measurement, if there is a specific fixed routine involved when the measurement should be done and the clinical importance of these subjects to patients with heart failure. The aspects to judge the subjects on have been chosen because they are relevant to the decision of which subjects to choose for developing an concept. The initiator of the measurement is important because it defines who is actually starting/ doing the measurements. If this is done by the doctor, it will probably mean that the measurement is not easily doable by the patient himself. If it is done by the patient the chance of the measurement being doable at home might be higher.

The routine that might be involved with certain measurements as weight and heart rate are important for the concept generation because they define if it is relevant to measure these subjects at home. If measurements have to be repeated it is more feasible to do this with a special device or application than when it is a one-time measurement.

	Initiator		**Fixed Routine?**	**Importance**
Subject	**Doctor**	**Patient**		
Blood Pressure				+
Heart Rate				+
Weight				++
Blood Glucose				+
Cholesterol				+
Physical Activity				++
Smoking/Drinking				+
Diet				+
Medication				++
Follow ups				o

Discussion and Conclusions

Based on both the literature review and the interview studies, we decide to focus on two self measurement concepts: weight monitoring and medication intake adherence. As a main requirement was to develop a simple, easy to use application, we want to restrict the functionality by offering only high priority behaviors.

Weight

From Heart Failure literature review we found that weight monitoring is essential to detect worsening of their condition in an early stage. However, this was not a theme for the patients we interviewed, as they suffer from a different cardiac condition.

We consider weight monitoring of vital importance for a number of reasons. On the one hand, it helps HF patients (a large group) to detect deco mpenationsa worsening of their condition. If the patient gains weight in a short amount of time, this might mean that fluids are built up in the body. Eventually, this might lead to breathlessness, pain and other symptoms of worsening heart failure.. On trhe other hand, it helps the patients in general to detect sudden weight loss which may signal a worsening of their condition.

Finally, it can help people to stay on their current weight levels. By implementing a weight tracking functionality, we believe that such a mechanism can be reapplied for other self-management behaviors such as blood pressure monitoring, heart rate, glucose etc.

Medication

Proper Medication intake is vital for patients' health. Currently, they use low-tech solutions to adhere to their medication regimen. The literature review confirms that there is a low knowledge on medication.

The interview study indicates that there is a need for more easily understandable knowledge about medication. There also is a need to know what to do when missing a dosage.

Further Requirements

Weight monitoring

Below is a list of requirements that the application should take into account. This list has been generated by constructing a persona and describing the daily routines of this person and the acts that this person has to take in order to weigh him/her with this concept in mind. This persona will be described in the chapter User Test. These requirements will be used in the chapter Realisation.

- The application should be available when the patient just got up from bed. It is best to monitor weight when just out of bed after a visit to the toilet.
- Application should give a welcome message
- Application should instruct patient to stand on the weight scale and instruct them to stand as still as possible.
- Application should instruct patient when they can get off the weight scale again.
- Measured weight should be reviewable after patient steps off the scale.
- Application should show a few of the previous readings in a simple manner
- Inform about what a patient should do if weight has changed rapidly
- Patient should be able to instruct application to do measurement again.
- Patient should be able to send a warning to their care provider.
- Patient/partner should be able to check data before it is sent to the PHR.
- The application must have a clear and to the point interface
- It should be able to send feedback to nurse, patient, partner
- Making sure data entered is actually from the patient. Control mechanism
- Contact information for caregivers should be available in the application

Medication reminders and Information

Below is a list of requirements that the application should take into account. This list has been generated by constructing a persona and describing the daily routines of this person and the acts that this person has to take in order to weigh him/her with this concept in mind. This persona will be described in the chapter User Test. These requirements will be used in the chapter Realisation.

- Present patients with what to do when they forgot to take medication.
- Provide images that show what the medication looks like.
- Provide information about at what times and how the medication should be taken.
- Provide information about possible side effects of medication
- Provide contact information for caregivers.
- Patients should be able to send a warning message to their care givers through the application
- The application must have a clear and to the point interface

6. Realisation Phase

In this chapter we present the development of the two concepts mentioned in the previous chapter into a demo application. This demo application will be used in the usability test to determine what the patients' visions and experiences are in relation to these two concepts. Based on these insights, we will present recommendations for future work.

Work on the development of the demo application can be divided into two main areas:

- Graphical design
- Information architecture and technical realization

These two subjects will be explained further in this chapter.

Data Flow

The previous chapter concluded with the Weight monitoring and Medication information concept ideas to work upon. Both these concepts have a list of requirements that, for a large part, defines how the information structure of the application will be. These requirements can also be found in the previous chapter.

To create an overview of data flows in the two concepts, a graphical representation of the data flow of both concepts have been created based upon the two usage scenarios that have been detailed out in use cases. The graphical representation can be found on this page. The numbers on the data flow graphic correspond with the numbers in front of the use cases found on the next page.

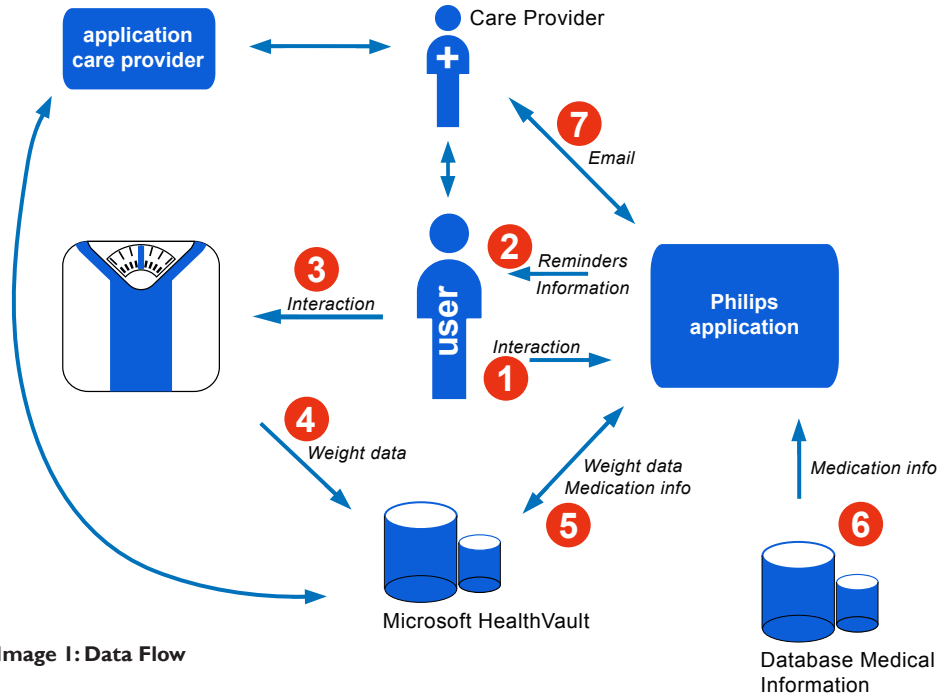


Image 1: Data Flow

Weight monitoring

This use case describes the interactions and steps that the system will go through when the user's weight is measured. The number before each step corresponds with image 1 on the previous page.

1. The user interacts with the application and navigates to the measurements.
2. The application instructs user to use their Health Vault connected weight scale in order to measure their weight.
3. The user interacts with the weight scale.
4. The weight scale uploads weight data to Health Vault.
5. The application downloads weight data from Health Vault.
2. The application presents weight data to user and presents the question "Have you been standing still during the measurement?…" as a control question.
1. If the user answers yes then the data will remain in Health Vault.
1. If the user answers no, data can be deleted and a new measurement can be done.
7. If the application notices that the user's weight is structurally too high, the user has not measured his/her weight for a few days or the user's weight goes up 1.5kg in 1-2 days or 3kg in 1 week; the application will send an email to the user's care provider. This email will ask their care provider to view the user's data in Health Vault and contact them about the situation.

Medication information

These are the interactions and steps that the system will go through when the user requests information about their medication. The number before each step corresponds with image 1 on the previous page.

1. The user interacts with the application and navigates to the 'Medication' tab.
5. The application requests user's medication list from Health Vault
6. The application requests information about these medicines from the Medical information database.
2. The user now sees which medicines are taken and sees basic information like how many doses to take daily.
1. The user can tap on a medicine to see more detailed information about it like a photo of the medicine, on what time to use the medicine and information about side effects and what to do when forgetting to take a dose.

Databases

Two databases have been included in the application. The Microsoft HealthVault database and the Medical Information database.

The Microsoft HealthVault database holds all the medical data (weight measurements, medication name, medication dosage, contacts) of the patient. Because of time constraints during development of the demo, the actual HealthVault database has not been used but has been simulated. HealthVault does have an SDK available that allows developers to use the HealthVault database as a data repository for HealthVault connected applications. However, to use this service, the application must have been approved by Microsoft.

The Medical Information database holds all the information concerning information about medication. What to do when a dosage has been forgotten? What are the side effects of this medication? And an image of the medicine are information that has been stored in this database.

Weight scale

No actual weight scale has been coupled with this demo because no weight scale was available at the time of development and because of time constraints to the development phase. It has been chosen to also simulate weight measurements. Users of the demo do not have to stand on an actual weight scale but can take a weight measurement that has been randomly generated. This random generation of weight will happen in the range of 71 to 74.5 kilograms.

Care providers

In the ideal situation, care providers will have a separate application to monitor patient weight, as can be seen on page 48. This application has been left out of the scope of this demo application and may be included in future implementations.

Interface Design

When designing the interface for this application, it has been taken into account that the majority of possible users will be elderly people. Older people often suffer from visual and cognitive impairments, often restricting them in using a computer or the internet. [31] For this reason, the information structure, layout and color scheme have all been tailored to be as user friendly to elderly as possible.

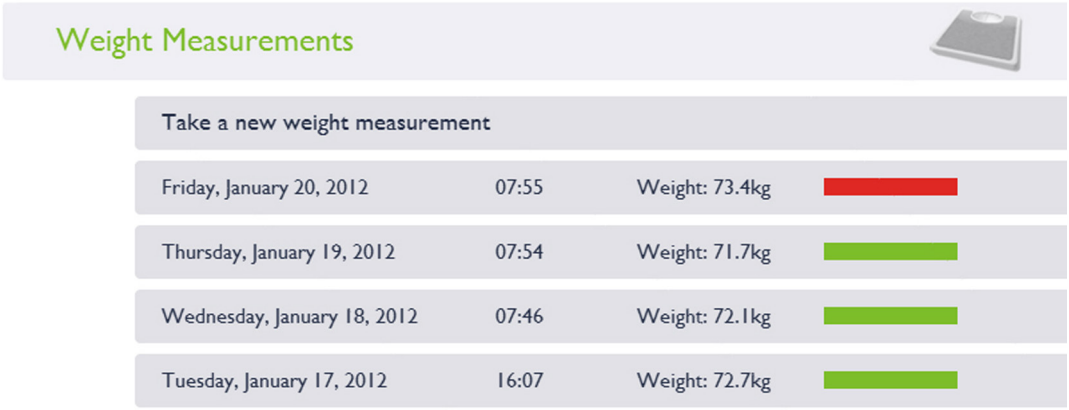
Information structure

The application features a two-level information structure. Only two levels of information are provided to keep the application as straight forward as possible so that users won't get lost in endless menus. These two levels of information provide enough room and capability to provide the needed information to the user, whilst remaining straight forward and easy to navigate.

The first level of information will be visible on the main page and will consist of basic information to quickly inform the user about the weight measurement or medication. This basic information for weight measurements will consist of the date and time of the measurement, the measured weight in kilograms and a quick color indication informing the user if the weight measurement is within or out of the safe weight range.

The basic information for medication will consist of the medication name, dosage to take and the time to take the medication. Also, when the time to take the medication has passed, the basic information visible on the main page will be lined-through. This will inform the user that the time to take the medication has passed. A functionality that allows users to indicate that they have taken the medication may be included in future implementations.

The basic information for measurements and medication will be displayed on the corresponding buttons. These buttons can be clicked to get to the second information level. This second level consists of more detailed information about weight measurements and medication such as weight warnings and side effects of medication.

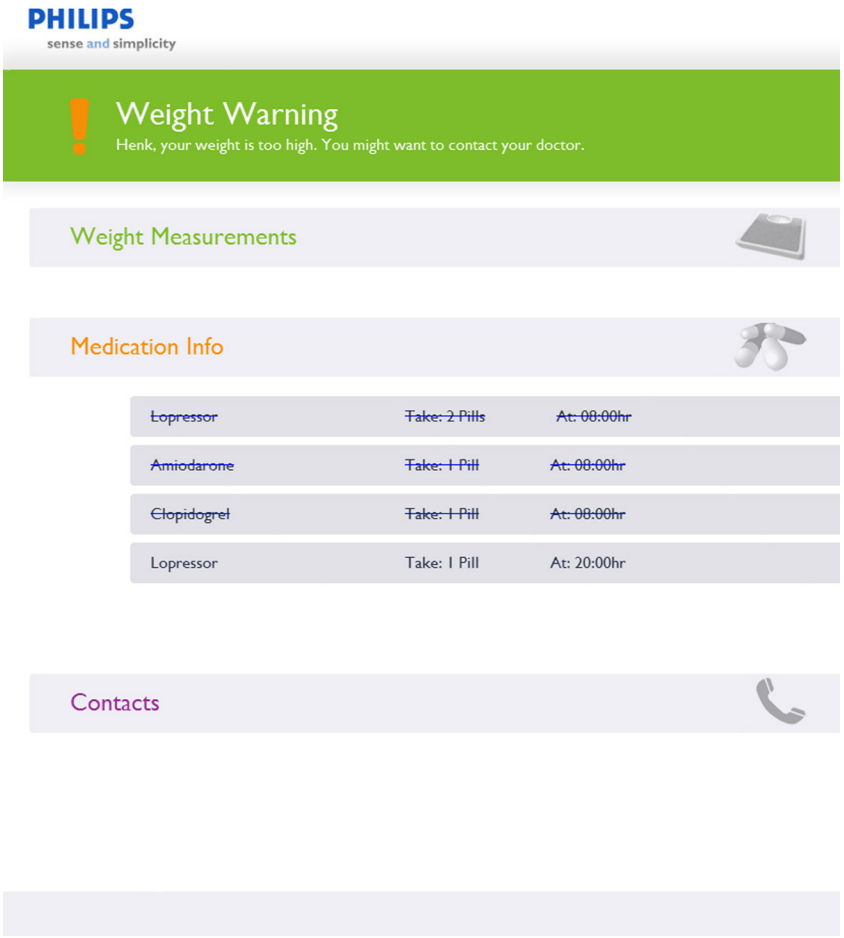


Layout

In order to keep the layout of the application simple it has been chosen to implement a Header-Middle-Footer layout. The header will be used to permanently display the Philips word mark. The header will also be used to display short warning messages for when there is something wrong with the user's weight. It will also display messages from care providers directed to the user.

The middle section of the application will hold the drop down menu from which the user can access the weight, medication and contact services. A drop down menu is a simple and easy to understand menu structure that allows the user to expand and collapse menu items.

The footer currently holds no data and acts like a buffer between the application and the screen edge. This way, the buttons will not abruptly end in the screen edge when all the drop-down menus are expanded.



Color usage

In order to design the application to meet the Philips design guidelines the official Philips color palette has been used. [32] According to the usability web design guidelines for elderly it is best to avoid the blue spectrum of color because elderly people make the most errors in this range. [31] Elderly people tend to have a reduced transmission of blue light trough the lenses in their eyes. [33]
This information has been taken into account and the following colors from the Philips color palette have been chosen:

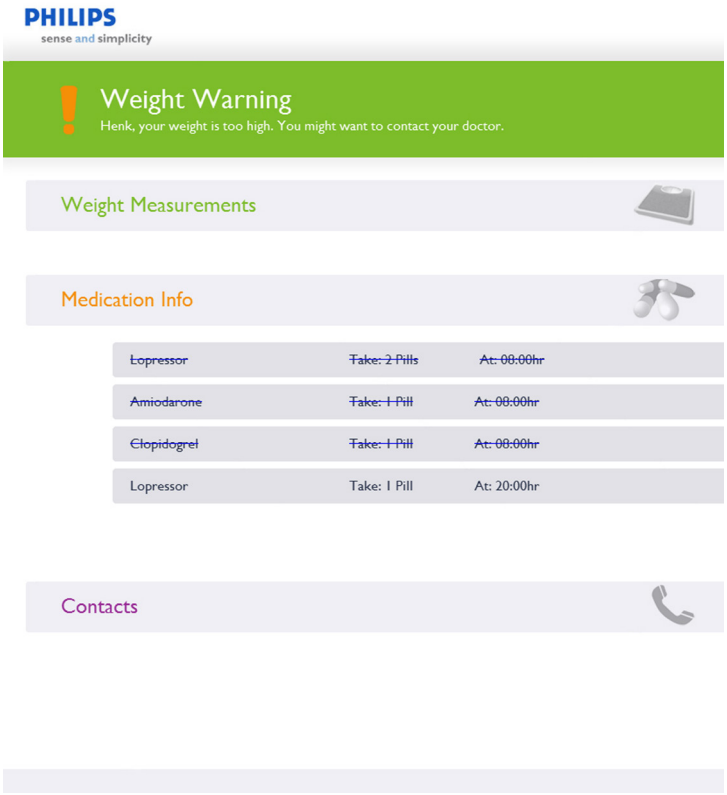
- **Green** (Weight measurements, also used to indicate a good weight measurement)
- **Orange** (Medication information)
- **Purple** (Contacts)
- **Red** (used to indicate a bad weight measurement)

The Philips color palette consists of vibrant colors which are easily identified with the Philips brand. Colors will be used to make the application visually more attractive and to provide clear separation between the different subjects. Color will also be used to visualize good (green) and bad (red).

Demo Development

As a platform on which to develop the demo application a tablet and more specific, the iPad has been chosen. The iPad has been chosen because a touch screen provides for a very user friendly way to interact with an interface. Moreover Philips Research has iPad 2's readily available.

In order to maximize compatibility with the iPad it has been decided that the demo will be programmed in HTML/CSS/PHP/JavaScript, such that the demo application will be demonstrated using the iPad's web browser. Flash will not be used because this is not supported by the iPad. Databases will be used to simulate the HealthVault storage of weight and medication data.



Framework

In order to provide a stable framework on which to build the demo application in the set time I have chosen to use an existing framework. After a Google search I chose to use the IScroll Lite [34] and HW Accelerated Accordion [35] scripts. To display more detailed information, but to keep the layout of the application simple it has been chosen to work with overlay pages. These pages open on top of the main page. The Shadowbox [36] script has been chosen to perform these overlays.

IScroll Lite

This script provides a stable and lightweight framework for mobile devices. It enables scrolling and a fixed header and footer with a scrolling central area on the iPad. Which is exactly what the design of the demo called for.

Accelerated Accordion

This lightweight framework provides a smooth drop-down menu needed in the demo application.

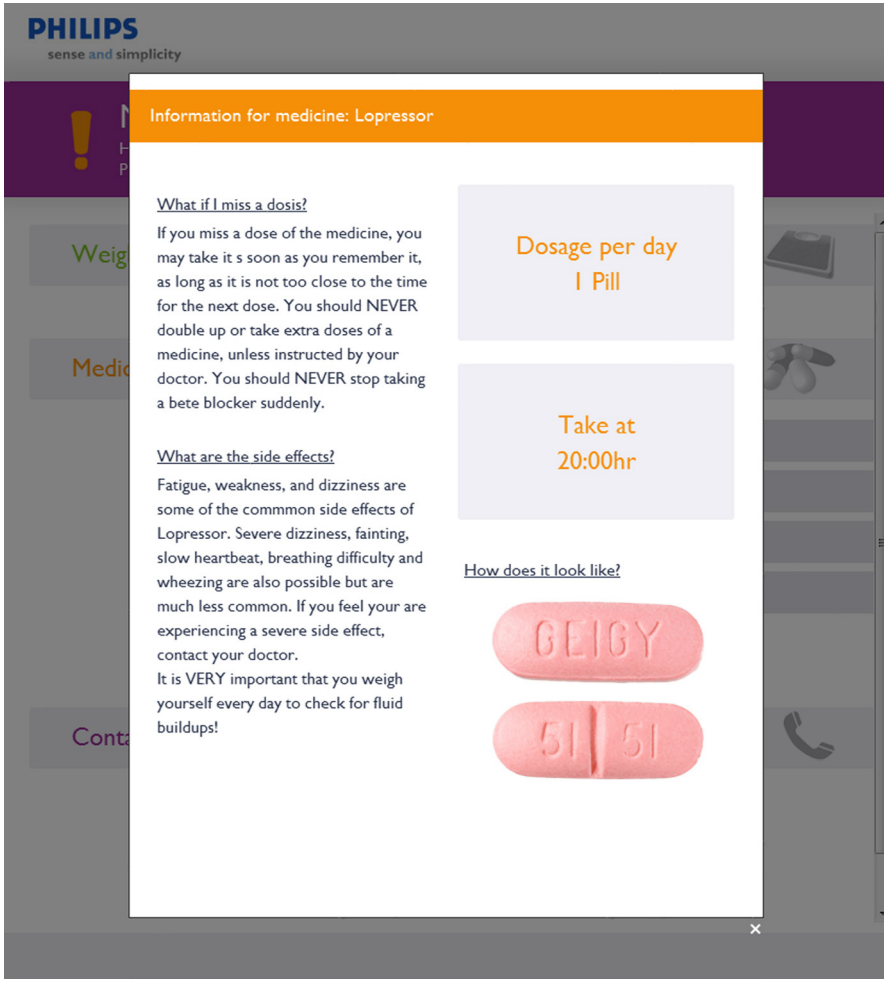
Shadowbox

To display the second layer of information it was needed to open a new overlay window on top of the main page. To do this, several overlay scripts (including Shadowbox and Fancybox [37]) have been tested on their compatibility with the iPad and the framework.

Many of these scripts have been found to only work when displaying images, but Shadowbox and Fancybox are also able to display pages.

These two scripts have been tested and in the end, Shadowbox has been chosen to implement in the demo because it proved to be the most stable and fastest working script of the two.

Shadowbox is an easily implementable script and no problems have been experienced when integrating it into the demo.



7. User Testing

In this chapter we will present the results of the user test done with the finalized demo application. We present why and how this test has been done, and present the results of this user test. In the next chapter we will present conclusions and recommendations based on the results of this user test.

The Test

This user test has been done to gain insight in how the target group reacts to the demo application. We want to know:

- How the target group reacts to the iPad
- If they are able to interact with the demo application
- If they are able to find the relevant information
- If the provided weight and medication information fulfills their information need
- How and where they would use this system
- How they feel about their privacy when using this application
- How they feel about the application in general
- If the text is readable
- If they understand the layout and color usage

This information can help to further fine tune the application to the needs and requirements of the target group. The information gained from the user tests will provide input for the final conclusions and recommendations in the next chapter.

Method

This user study has been conducted with four chronic cardiac patients that also took part in the first interview session. All participants live in their own homes. One person (P2) lives together with her husbands, the three others live on their own. All receive home-care multiple times each week. Their home-care providers also take care of refilling their medication. In the results, participants are indicated with P1, P2, P3 and P4. It should be noted that none of the participants has to take daily weight measurements for their cardiac condition. One patient (P2) is paralyzed on the right side of her body.

The demo application has been filled with pre-defined Weight measurements, Medication information and Contacts for testing purposes.

In order to make this information more lively, a persona (Henk) has been created. All predefined data found in the application belongs to this persona. The objective of this is to create more involvement of the participants with the demo by making the information come to life. And to make clear to them that the information in the demo is not their own health information.

Persona

The persona created for this user test is Henk. This is the story told to the participants before the user test started:

> Henk is 73 years old. Two years ago, Henk has been diagnosed with chronic cardiac failure. This illness has caused that Henk ended up in the hospital twice this year. Right now, Henk is back in his apartment in Woensel.
>
> Henk has three children that come to visit him in the weekends. This is his favorite moment of the week. Seeing his children and grandchildren inspires him to try and maintain a good health for as long as he can.
>
> Henk is a little forgetful though and this has been a problem. Henk has to weigh himself each day in order to check if his body isn't retaining too much fluids. He always wrote the measurements that he did on a piece of paper, and then checked if his weight was ok. A few months ago, this went wrong. Henk forgot to check if his weight was ok, and ended up in the hospital because of that.
> This is why two months ago, Henk was given this system. This system will help Henk measure and record his weight. And if something is not right with his weight, this system automatically contacts Henk's doctor. This system also helps Henk when he is looking for information about his medication. He can see exactly which medication he has to take.

iPad

After the persona had been explained the participants got to see the iPad. The demo application was already opened. All four participants got an explanation that the iPad works by touching the screen and got a short explanation about how the demo application works. After this, the assignments and questions started.

Assignments and questions

The user test itself consists of a set of fourteen assignments and questions.

An example of an assignment is: Could you please find where Henk can see how much he weighed yesterday?

An example of a question is: Where do you think you would weigh yourself using this system?

The full list of assignments and questions can be found in the appendix.

Results

iPad

The participants reactions to the iPad are positive and all four participants were able to navigate and use the application with little to no help needed. None of them indicated to have ever used an iPad. But within 10 minutes all the respondents were able to easily control and navigate through the application. One person (P2) even asked where she could buy an iPad, because she would like to have a simple computer.

Finding information

All participants were able to find the requested information from an assignment with little to no help. The two participants (P1 & P4) that needed a little help did not require this anymore after 10 minutes of using the application. They indicated that they were starting to get to know how it works and where certain information could be found after the test ended. Three participants (P1, P2, P3) also indicated that the layout was clear. One person (P3) indicated that the colors helped her remember where to find certain information. Two participants (P2, P4) did indicate that they think it would be helpful if the 'Contact' button would be changed to 'Medical contacts'. This would make it more clear to them that their medical contacts can be found there.

How and where would they use the app?

One participant (P4) indicated that if she would use the application to measure her weight she would do this in the bathroom. Two participants (P1, P3) would measure their weight in the living room. One participant (P2) would measure her weight in the bedroom. All four indicated that these are the places where they have their weight scale.

Two of the participants (P1, P2) indicated to keep track of their weight for diet reasons and would also be interested in using this application for that purpose. All of the participants indicated that they would be interested in using the medication information to look up side effects, see how a medication looks like. One participant (P4) would like to check if she is taking the right pills by visually checking them next to the medication images. One person (P3) indicated that she would use the medication information before going to bed to check if she has taken all her pills for the day. This person also indicated that she likes it that the medications basic information is lined trough on the main page of the application when this medicine should already have been taken.

Information needs

All participants indicated that they found it helpful to get a quick overview of how their weight varied over time. They also all indicated to like the provided images of the medication because it sometimes happens to them that they get confused between certain medications. One person (P2) indicated that she would like to see the differences between medications if a medication is replaced by something else.

Color and text

All participants could easily see all used colors and separate them from their backgrounds. White or black text on a colored background was also easily readable. One participant (P3) indicated that they think the colors can help them navigate the application more easily by mentally connecting a color to a certain usage.

Participants also found the text to be well readable. Two people (P1, P4) indicated that they could read the text, but wouldn't mind the font to be just a little bit bigger to increase readability.

Privacy

Fear about privacy of weight related information did not seem to be a problem. All participants thought it is a good thing that their care providers know their weight. They felt safer when they know that they are being actively monitored.

Conclusions User Test

The demo application has been user tested with chronic cardiac patients. The conclusions of this test are as following:

- The iPad provides a well functioning and easy to use platform for this application. Participants in the user test were all able to use the iPad with little to no problems.
- All participants were also able to navigate the interface of the application within 10 minutes after starting the test. From this we may conclude that the interface is simple enough to understand and navigate without needing any previous experience with computer interfaces.
- The application proves to be user friendly when searching for information. All participants were able to find the information they needed on their own after 10 minutes of working with the demo application. They did indicate to rename the 'Contacts' button to 'Medical contacts' in order to make the contact information more clear.
- People will use the weight monitoring functionality of the application in the room where they also have their weight scale. People will use the medication information functionality of the application in the room where they have also stored their medication.
- The information provided about weight and medication in the app is enough. People especially liked the image provided with the medication information.
- The used colors in the application are easily separated from each other and their background by the participants and seem to be well chosen.
- Text in the application was readable by all participants but should be made a little bigger in order for everyone to read it with ease.
- Privacy issues are none apparent. Participants found it a good thing that their care provider would constantly know their weight.
- Participant 2 (P2) is paralyzed on the right side of her body. She however has had no problems caused by her paralysis when using the iPad and application. This, again, shows that the iPad is a user friendly platform for this application.

8. Conclusions and Recommendations

The main research question we stated at the start of this project is :

“How can we create a meaningful PHR based system to fit seamlessly into the life of a chronic cardiac patient and provide exactly the services that the patient needs?”

Conclusions

We have chosen to focus on elderly cardiac patients, a group that is technologically challenged. So, it's been quite a challenge to come up with a suitable application that serves their needs.

From the literature study we have found that the current uptake of PHR systems is very limited.

We have spotted two meaningful themes (Weight Measurement & Medication Information) that fit the context of PHR and help cardiac patients to manage their conditions on a daily basis. These two themes have been realized into a functional demo application. This application has been user tested in a small experiment with promising results.

We have found that the use of technology is acceptable as long as it is easy to use and meaningful. In contrary to our expectations/fears, the participants in the user test perceived the iPad as an easy to use device. They even very much liked to work with it.

We also found that PHRs can empower the patients by giving personalized medication information in an easy-to-use manner. They also can help to communicate with the caregiver at the right occasion and also can provide a feeling of independence to their users.

Using applications such as the one developed in this thesis may be realistic, but initializing these applications may be a challenge because of the involvement of various different parties' (clinician, patient and partner). The application also requires a commitment from the general practitioner/doctor.

Recommendations

Further testing

The main recommendation based on this project is to further test this application in real use situations. This should be done to gain further information on how the application will be used and gain user data based on more time and experience of the user with the application.

It is also recommended to further test the weight monitoring function of the application with a real weight scale coupled to the system. And test this with patients that need to take daily weight readings for their cardiac condition.

Another recommendation is to investigate how clinicians think of this system and if they are willing to commit to using it. This is vital for the system to work properly.

Changes to application

It is advisable to revisit the way that the warning messages are displayed. It has been found in the user test that these are not visible enough and were overlooked by the users.

It is also advisable to slightly enlarge the font size of all text in the application to increase readability. And to change the name of the 'Contact' button to 'Medical contacts' because it will make it more clear that users can find their medical contacts there.

9. Evaluating

Process

The start of my internship at Philips Research on the 1st of September didn't went as smoothly as I'd hoped it to do. There were administrative problems concerning my ECs which eventually were resolved. But because I had to do an extra assignment for my study, I lost a month time that I could have used for this internship.

Eventually, everything worked out well and I got to start working on my project here at Philips Research. Everything started off with a fair bunch of literature research. What are PHRs? How do they work? Do cardiac patients use them? This were just a few questions that required me to read lots of articles and studies about PHR systems and how elderly people use them. This proved to be harder than I thought, especially because the high level of English writing in these articles required quite some concentration in order to understand what the articles were about.

In these first weeks of reading and studying I gained a basic understanding of what PHR systems are about, and how chronic cardiac patients currently use them. And now, it was time to put it on paper! This also proved to be harder than I had imagined it to be! And when I now, at the end of my internship, look back at the texts I wrote at the start… I can proudly say that my English writing skills have definitely improved. Fortunately, during my entire internship, Gijs and Gert-Jan reviewed all of my texts, which has helped me enourmously.

When the research phase ended it was time to see some actual chronic cardiac patients to gain insight in their lives. I really enjoyed talking to them but it was also exciting because I had never done a real interview session before. I'm very thankful that Gijs and Gert-Jan helped me set up a proper interview study. It showed me how to set up a questionnaire in order to gain the data that you are looking for. This proved to be really helpful in the user testing phase later on in the project.

After the research and interviews were done it was time to start concepting in order to generate ideas on how to use PHRs for cardiac patients. This required me to do some more research into the medical side of chronic cardiac diseases. This also made me realize that this is a very broad subject that one application most probably won't be able to cover on it's own. So, we decided to focus on two main subjects for cardiac patients. Weight monitoring and Medication information. Trough the weekly meetings with Gijs and Gert-Jan, and some brainstorm sessions with fellow students, these two subjects were filled in.

The realization of these two concepts into a demo application on the iPad took me a little longer than expected. This was because I had to tie a lot of loose coding together into one functional application. But in the end, it works very well. And the final user test proves that the elderly seem to like it!

Reflections

My internship at Philips Research was a great but challenging experience. I've learned, seen and experienced many things that not everyone gets to enjoy. The environment at the High Tech Campus can be a little intimidating at first, with lots of people carrying titles longer than their last names. But it proved to be a very open and friendly environment. I've also had lots of good times with fellow students with all kinds of backgrounds and I participated in various tests and experiments for Philips. All in all, I'm very glad I got the chance to experience the things I did.

At the start of the project, the goals were fairly clear. However, the road to get there was not. This did present challenges because it wasn't always clear when to stop a phase and to start a new one. I found it hard to see the point at which I had gained enough knowledge in the research phase in order to move on to interviewing and concepting. It proved to be easy to get lost in too much research.

English reading and especially writing did also prove to be more difficult than I had imagined. Before I started this internship I thought my English skills were quite good, but this project proved me wrong. I am however grateful that I did write this report in English because it helped me improve my English reading and writing.
All in all, I enjoyed working on this project. It could be somewhat stressful at times, but I do feel that I learned a lot about doing this kind of research, working in a professional environment and designing interfaces for elderly.

I hope that the results of this study are usable for Philips, and it would of course be great if this study would be the first move on the road to an actual 'live' application! But before this can happen, there is more research and development to be done. The clinician side of the application has not yet been explored, so this would be something that future work could aim at.

ICT & Media Design (IMD)

After having stopped with my study to become a elementary school teacher, IMD appealed to me as the ideal study combining IT, design and communication. During the study it proved that the study was meant to be a foundation, providing the basic building blocks on which the students could expand upon themselves. This seems like a solid plan, but at times I did miss some depth in the assignments we got. It would also have been nice if research would have been part of the study. I really missed some basic knowledge of doing solid research when I started with this project at Philips. If research would be part of the study, this could help a lot of students in their final internship.

I am however glad that I chose this study, and have learned many things and made many friends in my years at the Fontys.

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Appendix

The Appendix can be found digitally on the attached disc on the next page. The Appendix contains the following products:

Project Plan
Time Schedule
Thesis

Articles

Questionnaire interview sessions
Interview sessions

Interface Mockups

Demo Application

Questionnaire user test

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