Towards blended care:
Tailored and adaptive coaching for Cardiac Rehabilitation

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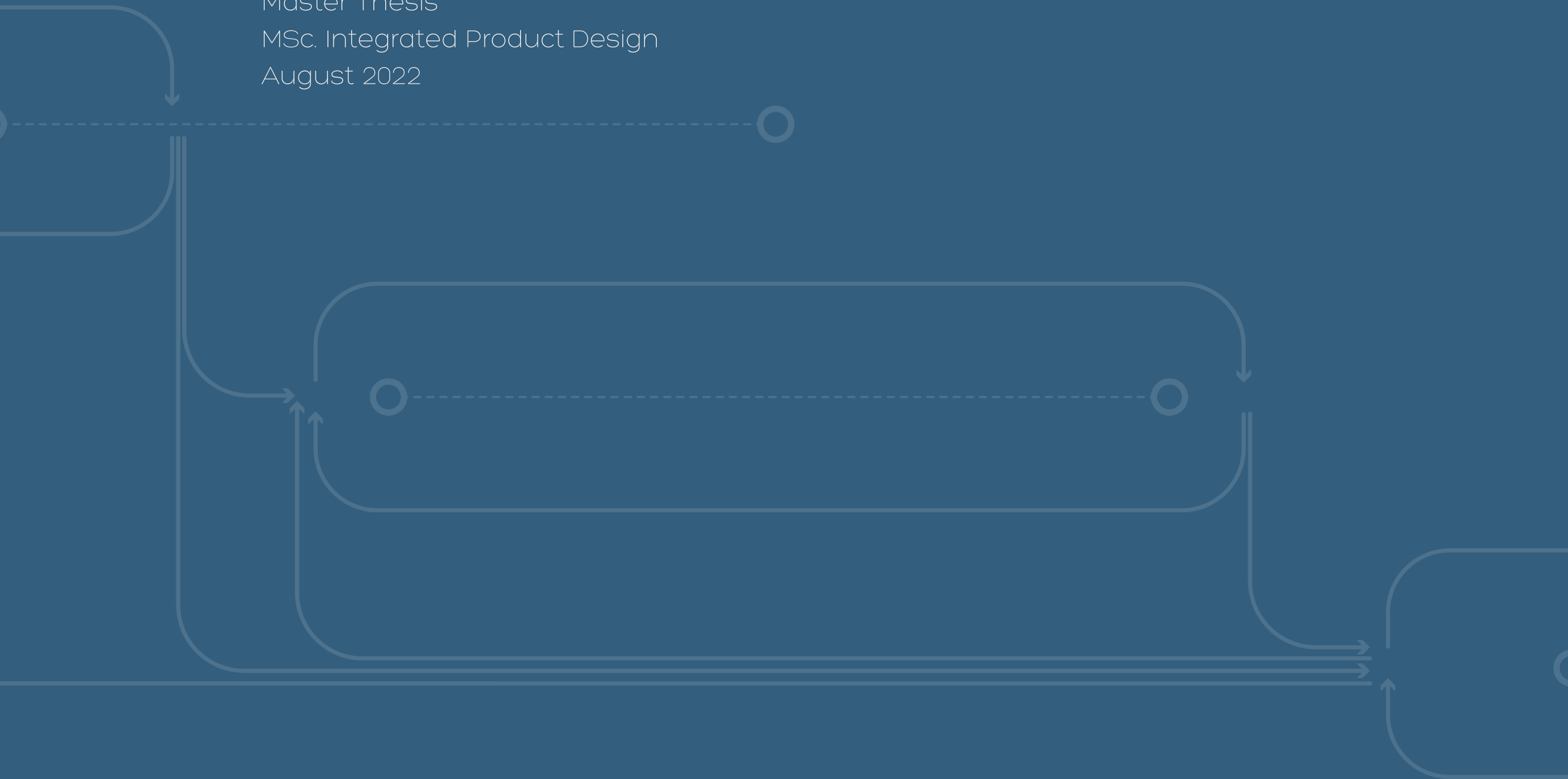

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Executive Summary

The number of cardiac patients (people with heart problems) is growing all the time.Given that any person who encounters a cardiac condition should undergo cardiac rehabilitation (CR), a program to rehabilitate the heart and learn to manage it in daily life, it is expected that the health system will also grow exponentially in order to meet the high care demand. However, this is not the case. Currently, only 28 percent of the eligible patients get referred to CR because the health system does not have the capacity to include all of them (Van Engen-Verheul et al., 2012). Moreover, the full take-in and supervision of the cardiac patients in CR lead them to find the transition to their daily life after finishing CR quite hard.

One solution to tackle this problem is to delegate some of the care parts at home, called blended care, so that more patients can enter CR while learning to manage their condition early on.

However, there are two main problems concerning this structural change in CR care. First, because of the loss of frequent contact with health professionals, implementing blended care risks losing personalization in care.Secondly, when delegating care at home, health professionals lose insights and feedback into the care delivered at home. Therefore, patient health outcomes might become compromised.
In this regard, this project proposes a design concept to support the blended CR care for the patient (with an app) and physiotherapist (with a dashboard) by homogenizing the care delivered at home and the CR center while centralizing the patients by making them active and responsible for their care. Moreover, it personalizes the CR care path, not in terms of exercises or changes in the workflow, but in a way that makes sense to the patient following their CR interests. The concept is composed of an intelligent solution with three different modules that utilize the feedback loops integrated into it to understand the patients' input and adapt to them, realizing the personalization effect.

The first module concerns the personal goals that patients need to set as they enter the care path and explains the motivation and type of the goal the patient wants to achieve. The second module aims to engage the patients with their exertion data during the care path (a subjective score from six to twenty with which patients report how heavy they find an activity) by helping them actively reflect on their performance and goals to take necessary actions. It realizes this effect by understanding their exertion zones and asking patients subsequent questions to make sense of the data via a quick check-in after rehabilitation. The third module uses the outcomes of the previous modules to provide personalised insights and advice.

Abbreviations

CR	cardiac rehabilitation
CVD	cardiovascular disease
PSS	product service system
DED	data-enabled design
RtD	research through design
NLP	natural language processing
ML	machine learning
AI	artificial intelligence
ADL	activities of daily living
PI	personal informatics
RPE	rate of perceived exertion
HR	heart rate

Table of Content

Chapter 0

INTRODUCTION

This chapter aims to introduce the project by first presenting an overview of the CR care pathway and the project's focus on it. Second, it presents the problem at hand in the introduced scope and the solution space envisioned to explore in order to tackle the problem.

0.1 Cardiac Rehabilitation

0.1.1 Care Pathways

There are several definitions for the term Care Pathway, one of which provided by Vanhaecht et al. (2007) is as follows:

“A care pathway is a complex intervention for the mutual decision-making and organization of care processes for a well-defined group of patients during a well-defined period.

Defining characteristics of Care Pathways include an explicit statement of the goals and key elements of care based on evidence, best practice, and patients’ expectations and their characteristics; the facilitation of the communication among the team members and with patients and families; the coordination of the care process by coordinating the roles and sequencing the activities of the multidisciplinary care team, the patients and their relatives; the documentation, monitoring, and evaluation of variances and outcomes, and the identification of the appropriate resources.

A care pathway aims to enhance the quality of care across the continuum by improving risk-adjusted patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources.”

Care Pathways (as defined above) are inherently integrated, meaning that fragmented care pathways cannot exist (Schrijvers et al., 2012).

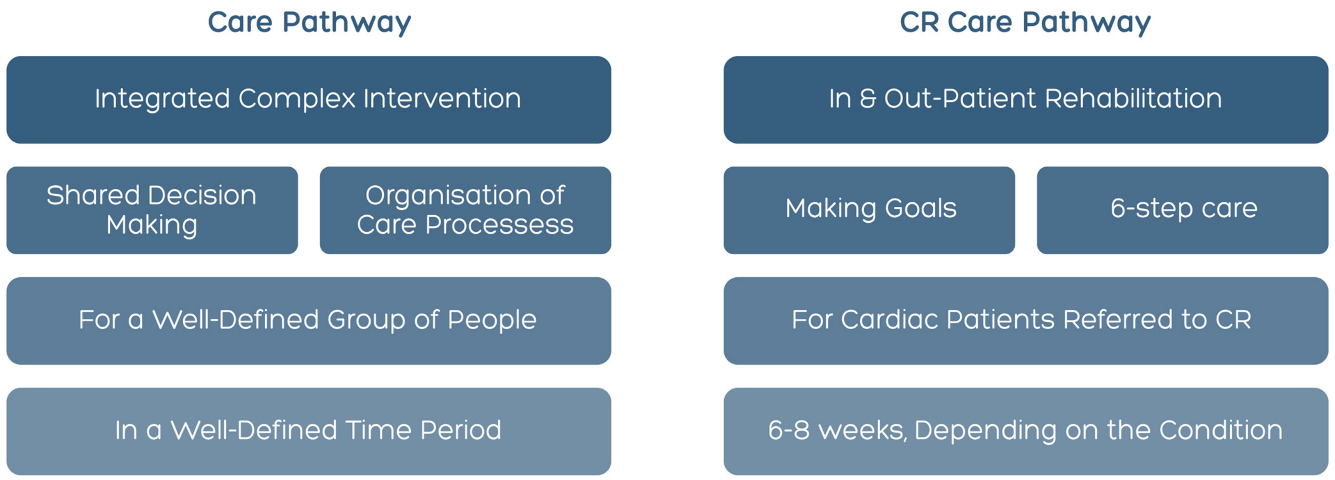


Figure 0.1 : Care Pathway & CR Care Pathway Definition

0.1.2 CR Care Pathway

Cardiac Rehabilitation (CR) care pathway is a supervised program and a complex intervention for people with cardiovascular (CVD) diseases such as heart attack, heart failure, cardiac arrest, atrial fibrillations, etc. It contains different care components, namely health education, cardiovascular risk reduction advice, physical exercise, and stress management (Dalal et al., 2015) (figure 0.2), which is aimed to help patients recuperate, build confidence and become stronger after the cardiac condition.

CR is considered an important part of the recovery of cardiac patients to help them become more competent and prevent another cardiac event by understanding their condition, making changes to their lifestyle, improving heart health, and dealing with the psychological aspects of living with a heart condition (Cleveland Clinic, 2022).

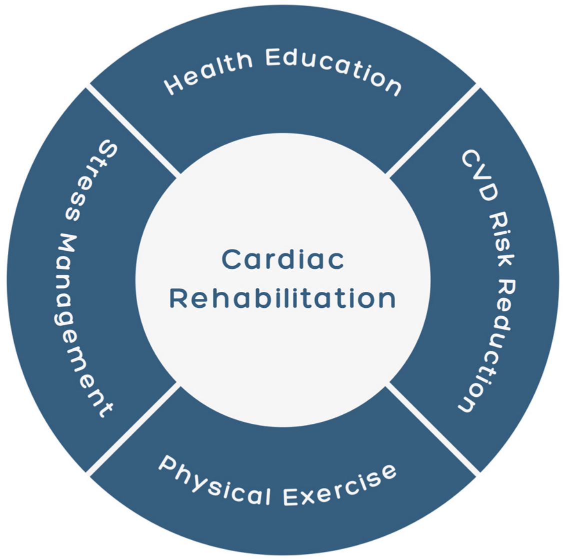


Figure 0.2 : CR Care Components

CR Phases:

According to the Dutch CR guidelines (Multidisciplinaire richtlijn hartrevalidatie, 2011), the CR care pathway has three main phases:

Phase 1 (clinical phase):
Starts immediately after the cardiac event in the hospital, where the cardiologist refers the patient to CR.

Phase 2 (after discharge):
Takes place in the CR center which is an outpatient clinic, under the ultimate responsibility of the cardiologist.

Phase 3 (post-rehabilitation/aftercare):
As a link to the previous phase, the aim is to maintain the activities done in the second phase. Here the care transfers to the GP (from the cardiologist).

These phases in total make the complete CR care pathway, together with the steps that occur in each phase. According to Cowie et al. (2019), the complete CR care pathway has six distinct steps which can be seen within the aforementioned phases, starting from referring and recruiting patients.

Figure 0.3 shows an overview of the phases and their comprising steps in the CR care pathway.

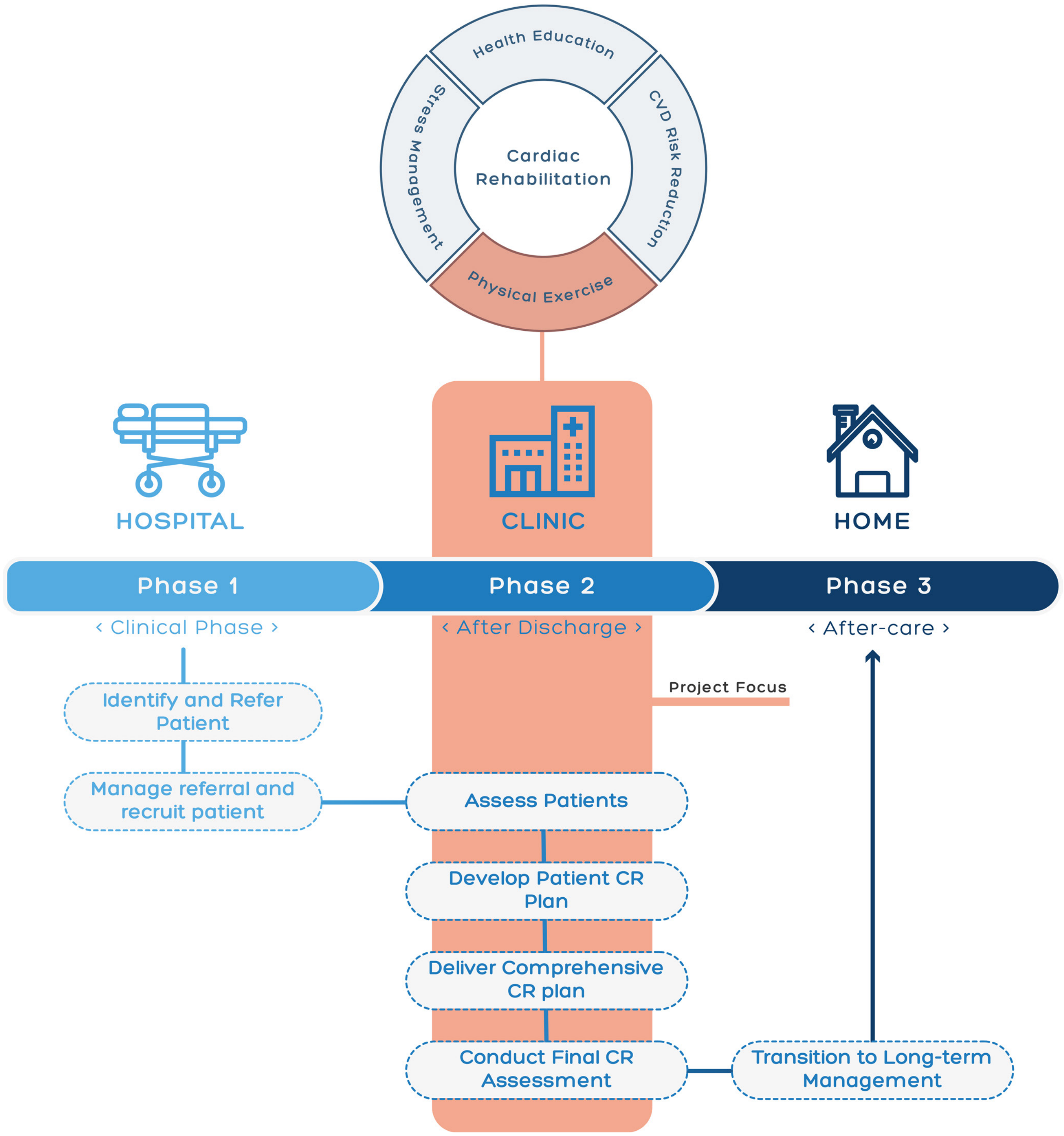


Figure 0.3 : CR Phases & Steps, with the project focus in the orange highlight

0.2 Project Focus

This project started with the main focus on Phase 2 of the CR care pathway taking place at the CR center as an outpatient clinic. Therefore, the CR care delivered in the center in the second phase and its comprising steps is chosen for the scope of this project which is researched in the set-up of Basalt Rehabilitation Center (Hartrevalidatie - Basalt - de kracht van revalidatie, 2022).

This center, being one of the leading rehabilitation clinics with multiple branches in the Netherlands, offers different types of rehabilitation, including cardiac rehabilitation. Thus, it was chosen to be the clinic in which the research and the design solution in this project are envisioned to be implemented.

The scope of the project with regards to the big picture of CR already introduced can be seen in figure 0.3 (with orange highlight). As seen in the figure, the care component at focus in this project is Physical Exercise because it is the most integral part of the CR care pathway to which other care components are added based on the needs of the patients.

Figure 0.5 : Basalt Logo


Figure 0.4 : Basalt Entrance, Delft Location

0.3 Problem

As mentioned earlier, this project explores the second phase of CR in which the care is delivered to cardiac patients in the CR center. In this form of care delivery, patients follow the cycle of visiting the center 2 or 3 times a week to receive the care (exercises, education about risk factors, etc.) and going home for 6-8 weeks, depending on their condition and comorbidities. Although super beneficiary for the patients' recovery, this type of care delivery has brought up multiple problems for both the patients and the healthcare system and professionals in place:

> **Patients:**
> Patients find the transition from care at the CR center in the end of phase 2 to home care in phase 3 very difficult because of being fully supervised, guided, etc. while in the center. Therefore, they reach a sharp finishing point of the program, which might leave them clueless and helpless about how they should proceed after rehabilitation.
>
> **Healthcare professionals and the healthcare system:**
> Delivering the CR care physically at the center for 8 weeks per patient is a heavy workload on the healthcare professionals and the system, meaning that fewer patients obtain the chance to enter the program in the first place. Therefore, the referral rate of eligible patients to cardiac rehabilitation is 28.5% (Van Engen-Verheul et al., 2012), with one of the causes being the low capacity of the healthcare system and the ever-rising number of cardiac patients.

Because of the two aforementioned problems, the concept of blended care, which in the context of CR means deploying some of the care at home for patients has received much attention recently. Blending the care received at the CR center and home allows for potentially more patients to enter the program by reducing the load on the healthcare professionals and the system and also helps patients to have a smoother and a more gradual transition to phase 3 of CR which is about managing their condition at home by being more responsible and active in their care.

This type of care (blended care) has had an early initiation in Basalt due to the COVID-19 Pandemic, during which patients could not visit the center to rehabilitate but had to do it at home instead. Although a brilliant initiation to tackle the aforesaid problems, it has brought new challenges because of not having a support system in place for transitioning to this care to assist the patients and the healthcare professionals with various needs.

> **Patients:**
> By transitioning parts of the care to the home context, patients have the risk of not receiving as personalization as if they were to be in contact with the health professionals most of the time at the center.
>
> **Healthcare professionals and the healthcare system:**
> By transitioning parts of the care to the home context, health care professionals have little insight into what happens in the context of the home or if the patients follow the care plan because they cannot constantly supervise them. Therefore, they cannot ensure the quality of care they deliver and the outcomes the patients will have.

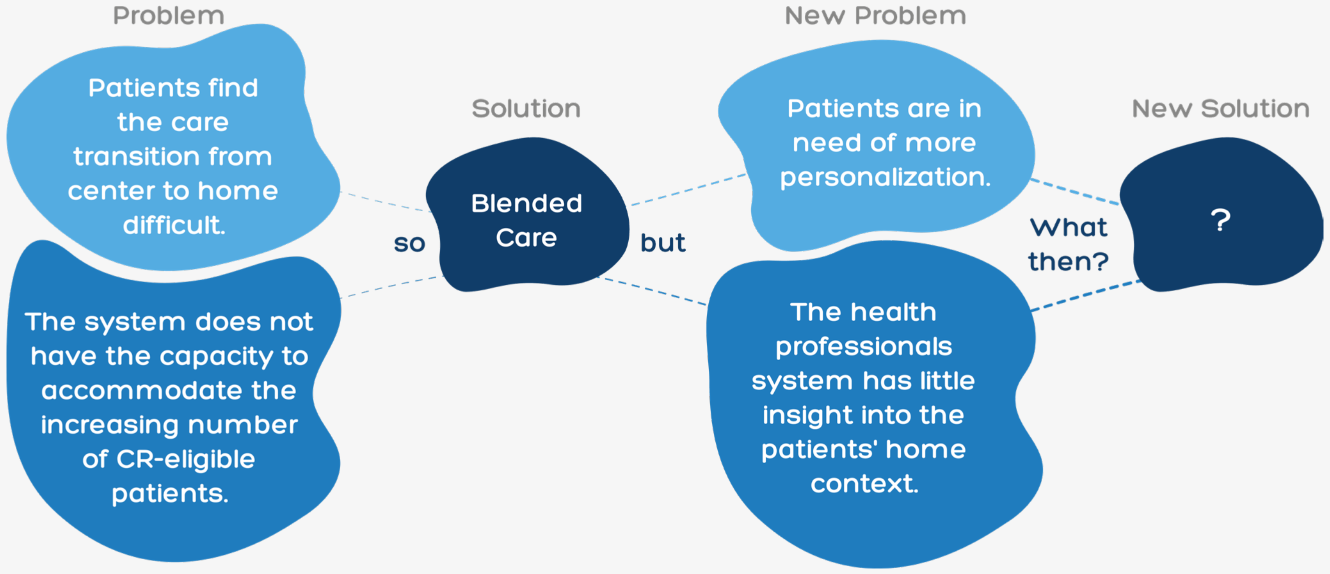


Figure 0.6 : The problem space of this project

Thus, in this graduation project, I will explore how to support the transition of blending the care at the center and home while increasing the level of care personalization by having insights and feedback about how patients are doing in the home context.

This is envisioned to be done by integrating the solution into the current ecosystem in Basalt Rehabilitation Center.

In this regard, the role of data and the potential value it could bring to the stakeholders involved will be explored to tackle problems.

0.4 Solution Space

The envisioned design solution is a product-service system (PSS) that falls under intelligent solutions, which are the systems that can perceive and respond to the world around them (Nevada, 2022). The design will follow the work of the data-enabled design (DED) department of Philips (as an involved party) in which intelligent solutions using data and artificial intelligence are used to gain a detailed understanding of the users and their context to personalize solutions (Figure 0.7).

To simplify the overview of such a system, two main feedback loops are needed, being Understand and Adapt, enabling the solution to learn to Understand and Adapt to the user and their context in order to personalize. (Van Kollenburg et al., 2019)

The Understand loop facilitates the system to learn about the context, behavior, and experience of the users. While the Adapt uses the output of the previous loop to learn what to return to the user in terms of content, interaction, and role (Figure 0.7).

In the scope of this project, the solution revolves around the context of home and CR center with the main focus on the patients themselves.

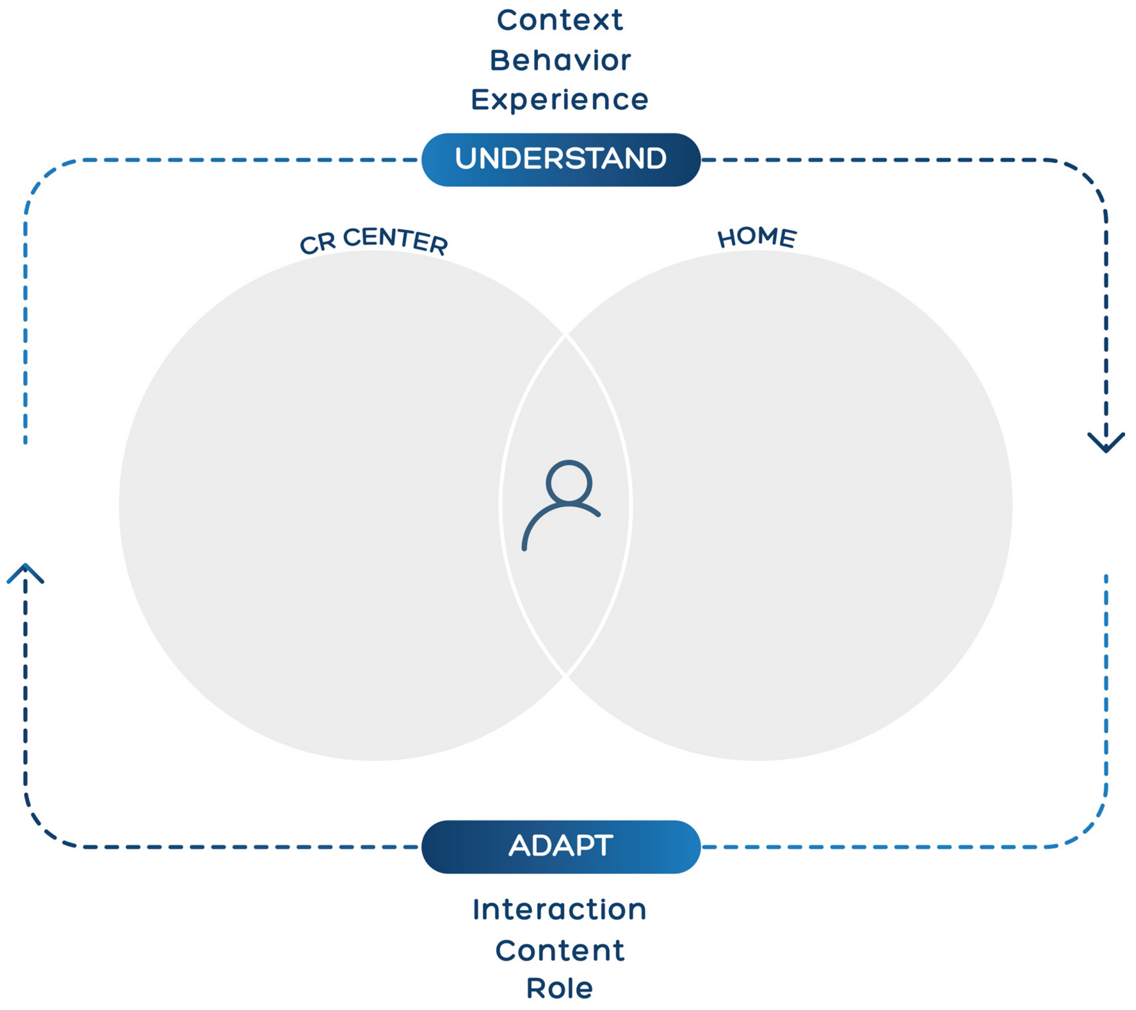


Figure 0.7 : Intelligent solution space

Chapter 1

METHODOLOGY

This chapter aims to present the main research questions with regards to the problem and solution space introduced in the previous chapter, and the methodologies implemented to answer the questions.

1.1 Research Questions

As explained in the introduction chapter, in this project, I aim to support the blended care in CR while increasing the level of care personalisation using an intelligent solution for patients by allowing the healthcare professionals to have insights in to the care delivered at home so that more patients can enter CR while receiving good care resulting in good health outcomes.

Therefore, the following research (sub) questions were formulated:

Supporting the Care:
(1) Which parts of the CR care in the CR workflow should the intelligent solution support?
(2) Since CR is delivered in a multi-disciplinary team, which health professional stakeholder(s) should be involved in the solution?
(3) What data from the patient should be communicated to the health professional to support blending the identified care part?

Personalisation:
(4) What is the desired and relevant personalisation level in CR care?
(5) What should the intelligent solution learn from the patient to adapt?
(6) What should be adapted based on the identified nuances?

1.2 Methodologies

This graduation project has one predominant design and research methodology, research through design (RtD) which is an approach aimed to generate new knowledge through design practice and processes. Nevertheless, other data-centered methods were used to some extent as well.

All of the methods were implemented while working agile, in which the project was divided into multiple iterations seeking to provide continuous improvements by involving stakeholders. Figure 1.1 shows the overview of the methodologies throughout the project.

A total of 7 iterations took place in this project. The first iteration sought to be an introduction to the topic and the project scope by exploring the patient experience and relevant literature.

Iterations 2 and 3 used the outputs of the previous research inquiry to come up with concepts and design opportunities to address and discuss with the health professionals. Since the previous iteration only focused on the desirability aspect of the project scope, this iteration aimed to dive deeper into the context of CR and the ecosystem in place to deliver care to patients.

After this stage, I created the project’s design goal which was the result of having an understanding of the desirability of the first iteration and the viability of the second iteration.

Iterations 4 and 5 brought the focus back again to the users after unraveling the CR ecosystem and the workflow in the center by conducting sessions with patients as well as health professionals to validate or reject design directions to address the design goal.

Finally, after gathering all the necessary information and evidence regarding different concept elements and parts, the last two iterations focused on developing the final concept with patients.

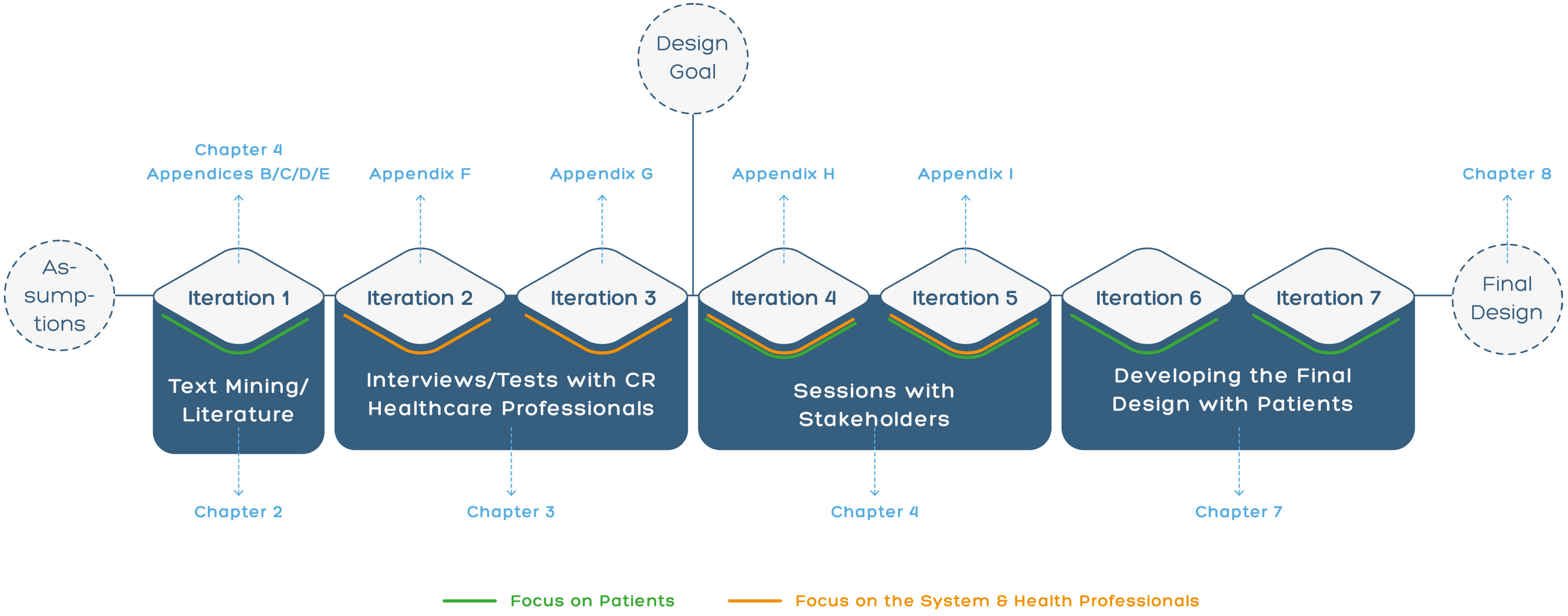


Figure 1.1 : Methodology Overview

2.1.1 RtD & DED

Since the initiation of this project was by the collaboration of the Data-Centric Design (DCD) lab in TU Delft, and the Data-Enabled Design (DED) department of Philips, exploring the role of data in the design (process) and adopting data-centered methodologies, such as DED itself (which is about using data as creative material in the design process) and text mining (using text as the creative material) were used as well.

It is important to note that RtD (figure 1.3) and DED (1.2) are not mutually exclusive methodologies. In fact, they both have the concept of practice-based research at heart, where RtD focuses on creating knowledge by speculative prototypes and artifacts that can be used as generative materials for the sessions with stakeholders. On the other hand, DED follows the same vision but centralizes data in this process and brings it even further by deploying prototypes into the context of the users so that their behaviors can be captured. Remote data collection in the DED method allows researchers to analyze and learn from a distance remotely in their workspace, enabling them to send updates to the design interventions.

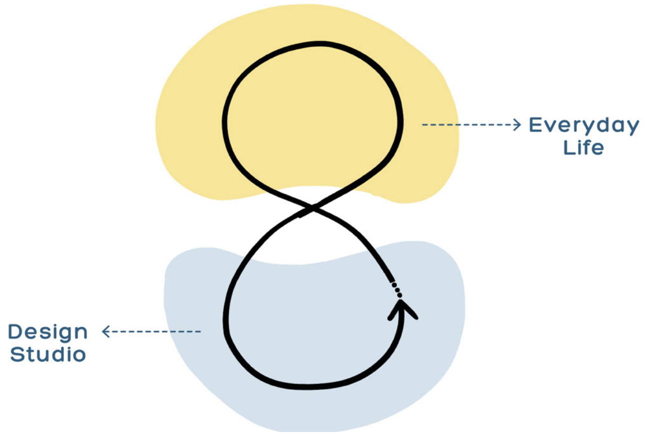


Figure 1.2 : DED Methodology

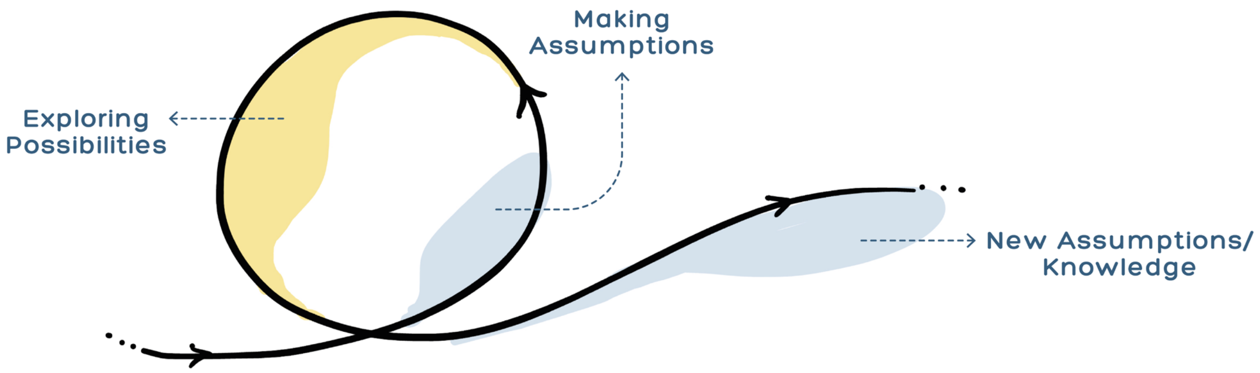


Figure 1.3 : RtD Methodology

2.1.2 Agile

Because of adopting RtD in the project as the design methodology, I started working following agile principles (figure 1,4) in which the project is divided into multiple phases where each iteration explored a certain part of the project. In each iteration, I explored different possibilities based on assumptions at that certain moment in the project and set out to get feedback from the collaborations with stakeholders resulting in continuous improvements at every stage. This way of working not only accelerated the project in a way of understanding the context and making faster design decisions but also generated new and unintended knowledge around the topic which shows the value of such a working manner.

Weekly Retrospective

Part of the agile working manner is to have retrospectives for the week. My retrospectives included 'what went well', 'what needs improvement', and 'next steps' for each week (figure 1.5) which helped me reflect on the past week and make tiny improvements. This technique also helped me mentally at the end of some weeks when I thought that I did not have that much progress seeing what went well already reassured me enough.

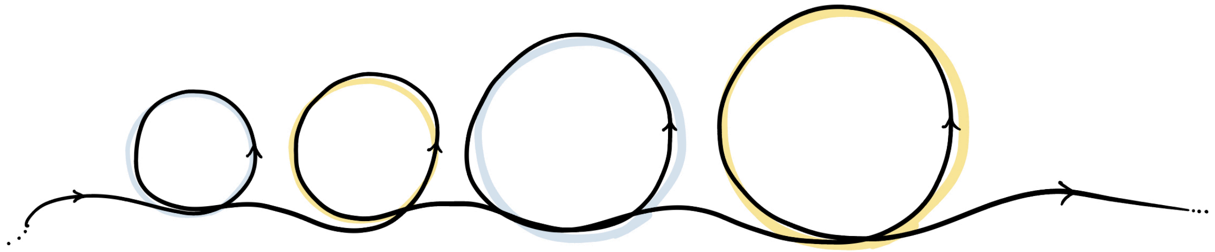
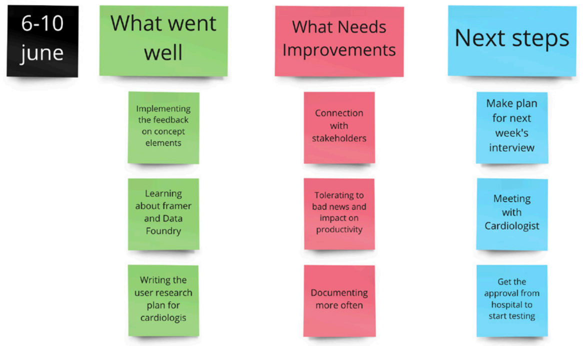


Figure 1.4 : Agile way of working



6-10 june	What went well	What Needs Improvements	Next steps
	Implementing the feedback on concept elements	Connection with stakeholders	Make plan for next week's interview
	Learning about framer and Data Foundry	Tolerating to bad news and impact on productivity	Meeting with Cardiologist
	Writing the user research plan for cardiologis	Documenting more often	Get the approval from hospital to start testing

Figure 1.5 : Weekly Retrospectives

2.1.3 Text Mining

As explained earlier, aside from the overarching introduced methodology throughout the project, I used other methods more centered around data, such as data mining which was used to gain insights into the experience of cardiac patients by analyzing a dataset of online patient stories using NLP techniques and using relevant datasets to do explorative data analysis. This was done because of the inaccessibility of patients and the fact that this method had the potential of quick embracement of the topic so early in the project.

Text mining could be defined as a process of analyzing a large collection of documents to uncover new information to help answer the formulated research questions (Linguamatics, 2022). Thus, I utilized this analysis method specifically to gain insights into the experience of the cardiac patients to accelerate the discovery process of the project. This analysis was conducted via artificial intelligence (AI) using Natural Language Processing (NLP) which transforms free and unstructured data (in this case, the text of the patient stories) into normalized, structured data suitable for analysis (Linguamatics, 2022).

In order to do this analysis, first, a dataset (of the stories) was collected manually according to the selection criteria. Then a Proportionate Stratified Number of the stories was chosen as the representative sample of the population dataset to be analyzed by qualitative coding. Finally, the identified codes were used as “targets” to train a supervised ML algorithm following the NLP pipeline to classify the rest of the patient stories using Python to gain the desired insights.

Figure 1.6 shows this procedure flowchart containing the NLP pipeline (Morioh, 2022).

The complete procedure of the NLP pipeline can be found in Appendix B.

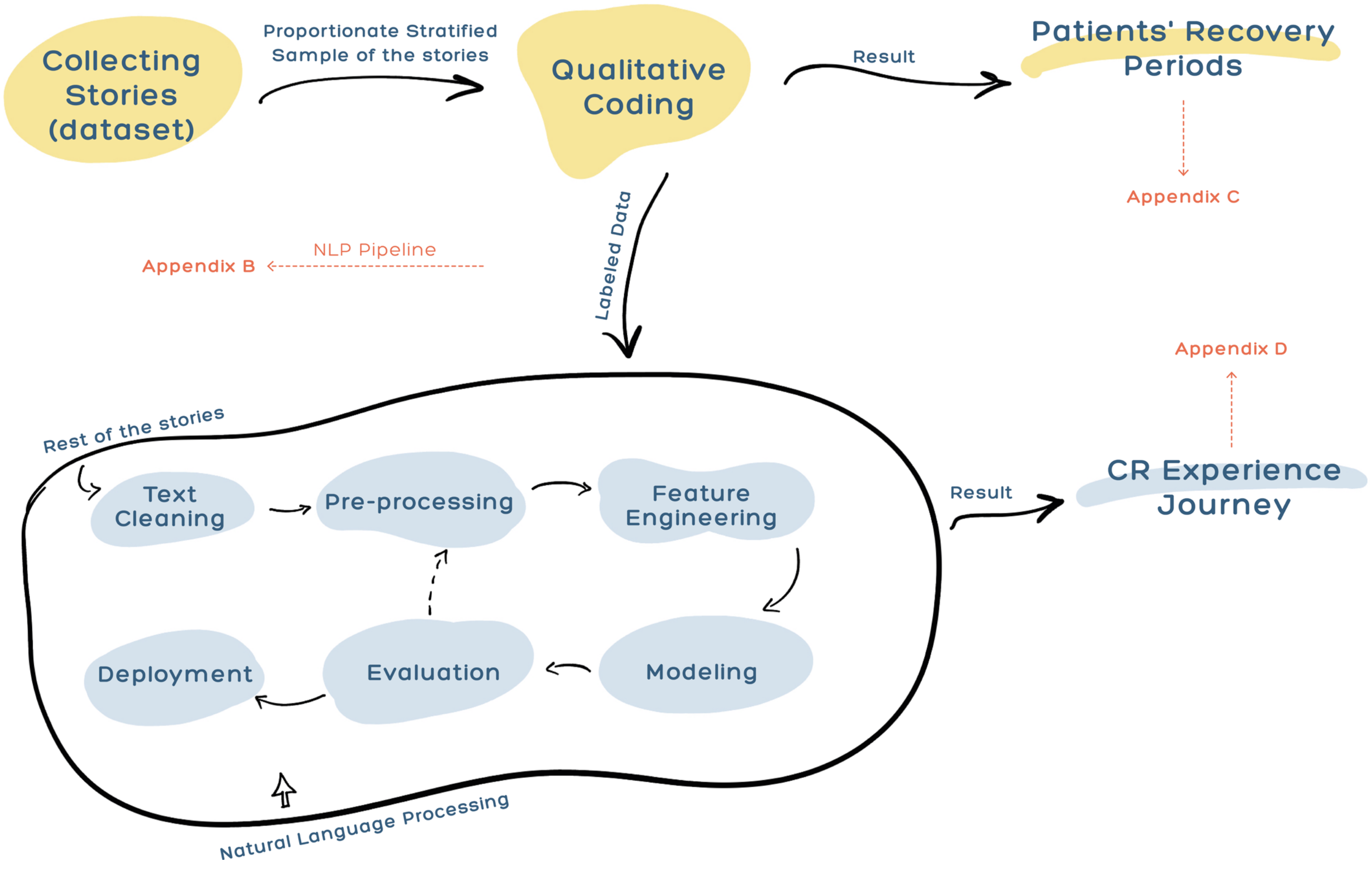


Figure 1.6 : Text mining procedure

Chapter 2

LITERATURE

This chapter aims to present the relevant terminologies and literature that are used throughout the project. It starts with elaborate information regarding blended and the vision that Basalt has developed for implementing it in their rehabilitation center. Then, it presents some notions in place for care personalization concerning Patient-Centered Care, the role of different types of data in the medical domain, and their analytical methods that could be potentially utilized for personalizing the blended CR care path.

2.1 Blended Care

Chronic diseases are broadly defined as conditions lasting for at least a year, requiring continuous medical attention, and limiting the patients in activities of daily living (ADLs) (Chronic Diseases CDC, 2022). The number of patients suffering from such diseases is ever-growing due to the longer life expectancy and the rapid aging of the population. In the Netherlands alone, thirty-two percent of the population were chronically ill in 2014, which is predicted to reach forty percent by 2030 (RIVM, 2014).

Cardiovascular diseases (CVD) are chronic conditions affecting the patients' hearts that are not exempt from this continuous rise in numbers. This means that more and more people are becoming eligible to rehabilitate their heart in CR because of their condition while the capacity of the healthcare system and health professionals are not keeping up, leading to a high workload on the system (López-Campos et al., 2015), and low CR referral rates of patients (Van Engen-Verheul et al., 2012).

Moreover, because of the long-lasting effect of the chronic disease (in this case, CVDs), patients need to learn to manage it themselves, meaning that patients should take more responsibility and be more autonomous. In this regard, CR is envisioned to help patients learn to manage their condition in the long run. However, currently due to the high supervision of the CR program at the center, patients find the transition from center care to home care quite sudden, which could be because of their impaired sense of self-efficacy throughout the program (Carlson et al., 2001).

All in all, Because of the rising number of cardiac patients, the low capacity of the healthcare system and health professionals, and especially the fact that patients find the transition from CR center care to CR home care currently difficult, an emerging need for structural changes in the care delivery for chronic patients, in this case cardiac patients rehabilitating in CR, is needed to ensure the reduction of workload on the healthcare system and more personalization by placing the patient in the center of the care they receive.

In this regard, blended care, which is a combination of traditional and online care (Blok, 2022) with the use of digital tools known as eHealth and other web-based platforms, seems to be a solution to the aforementioned problems.

Although blended care seems to be a promising solution, introducing such a transition in the healthcare system has challenges of its own. Firstly, such care has a high probability of adoption by the stakeholders only if it is perfectly integrated into the usual(traditional) care that is being delivered to patients requiring personal assistance and coaching of the patients. Secondly, the allocation of time to introduce such a change should not be neglected for the patients to be able to use it and the healthcare professionals to change their role to fit this type of care delivery (Talboom-Kamp et al., 2018).

2.1.1 Vision of Basalt

Basalt, as the rehabilitation center which is interested to implement blended care, has set its own vision and desires for such a change in care delivery which are the following:

> **We want our patients to gain more control over their recovery.**
>
> **Since we are facing a growing number of patients, we want to cope with the increasing complexity of care demands and staff shortages.**
>
> **We want to offer the patients the best possible care in a way that is personalized, suiting them in terms of place and time, needs, and abilities (Borging blended care - Basalt - de kracht van revalidatie, 2022).**

The vision of Basalt highly corresponds to the literature introduced earlier, which substantiates the need for such a transition in the CR care pathway in which the healthcare professionals and patients are supported and receive personalized care while not being in immediate and constant contact with the healthcare professionals.

2.2 Patient-Centered Care

Healthcare is currently shifting towards delivering care following patient-centered models instead of disease-centered (paternalistic) models in which the decisions made regarding the patient were centered around clinical expertise, medical tests, and evidence (Moustafa, 2021).

Patient-centered care models are one of the ways of care personalization, which is realized by centralizing the patient in the care they want to receive. It concentrates specifically on the patients themselves and their particular health needs seeking to empower them to become active participants in influencing their care rather than passive ones only receiving it (Reynolds, 2009). Thus, following patient-centered care models can be of help when trying to personalize cardiac rehabilitation for patients so that they receive services focused on their individual needs and preferences, informed by advice and oversight from their healthcare providers.

One of the challenges of care personalisation by putting patients in the center falls on the shoulders of the healthcare professionals because they need to address the specific patient needs accordingly, which might take more time. This becomes even more challenging in blended care, in which some care parts are delivered remotely at home. In this case, patients expect the coaching and received advice to be still highly personalized because they are concerned about losing interpersonal contact with healthcare professionals (Gabay et al., 2022).

2.3 Data & Personalization

Whether the medical data at hand is objective or subjective, different data-driven approaches can bring value to the personalization of healthcare. For instance, the big data approaches process a huge amount of data for personalization by analytical techniques, or even on a more personal level, personal informatics (PI) can be of use to personalize the care for patients.

2.3.1 Data in Medical Domain

In the medical domain, objective data is defined as the information that healthcare professionals can either obtain via the five human senses or measure/observe from the patients (DuPont, 2021), for example, heart rate (HR) and blood pressure. On the other hand, subjective data is defined as the information told from the patient to the healthcare professionals that cannot be measured or observed (DuPont, 2021). Another definition by Mosby's Medical Dictionary (2022) describes subjective data as the information collected from a patient in the patient's words.

The data type (objective/subjective) assists healthcare professionals and patients in different ways, such as decision-making. In paternalistic care, mainly objective data is used for making decisions, while in patient-centered care models, subjective ones play a bigger role because the patients are positioned in the center of their care.

Regardless of the type of the data, they have the potential to be used as the base upon which the personalization of the care takes place for the patients.

2.3.2 Big Data

Recent development in the field of Big data and analytics have facilitated technologies detecting correlations from multiple sources, which has given rise to Big-data-driven approaches to personalized healthcare contributing to patient- centered outcomes.

Big data in healthcare refers to the collection, analysis, and leveraging of multiple clinical data about the patient that is complex to be understood by traditional means of processing. Thus, the analysis is conducted with different ML algorithms bringing many benefits, one of which being improvements in care personalization and efficiency using comprehensive patient profiles (Mercury Healthcare, 2022).

Mustafa (2021) describes the personalization using big data as making models acting like recommendation systems currently used for movies or books. This means that similarities across large pools of patients could be leveraged to personalize the care plan.

2.3.3 Health Data Analytics

Big data in the healthcare domain has introduced challenges in its management and analysis that inhibit the use of traditional methods to analyze them. Therefore, analytics methods from the big data domain are to be used in this regard which is divided into four categories descriptive, diagnostic, predictive, and prescriptive (El Aboudi & Benhlima, 2018) (figure 2.1).

Descriptive Analytics: Describes current situations and reports on them. Different techniques of data visualization are used in this type of analytics such as histograms or scatter plots.

Diagnostic Analytics: Explains why certain events occur and identifies the triggering factors. This analysis aims to understand the reasons behind certain behaviors.

Predictive Analytics: Predicts future events, and helps with the identification of trends and determination of uncertain outcomes. This analysis utilizes ML techniques to make predictions.

Prescriptive Analytics: Proposes suitable actions leading to optimal decision-making which also uses ML techniques.

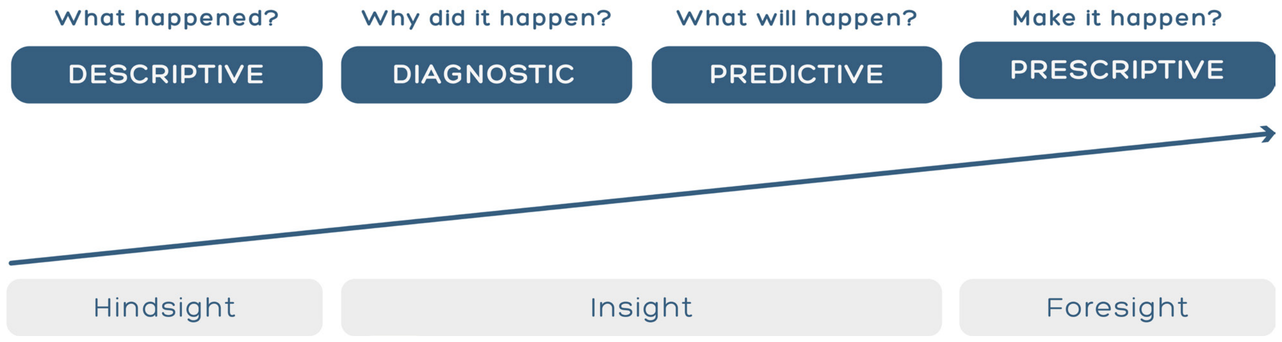


Figure 2.1 : Data Analytics

2.3.4 Personal Informatics

Personal Informatics(PI) is an area of study in human-computer interaction (HCI), allowing people to collect and review personally relevant information to create self-knowledge and self-reflection. These systems help people understand themselves and their behavior better, and that is the reason why they are in contrast with many other technologies that are designed to inform people about the outside world.

Li et all. (2015) defines PI systems as a five-stage model consisting of Preparation, Collection, Integration, Reflection, and Action, with Collection and Reflection being the core components of any PI system (Figure 2.2).

Such systems can help users gain self-knowledge by facilitating the collection and storage of personal information for users and enabling them to explore and reflect on the gathered data.

Reflection, as a prominent component of PI systems, can be done both in the short and long term. Short-term reflection occurs immediately after the collection of data, whereas long-term reflection can occur after days or weeks, which will enable the revelation of trends and patterns through the comparison of the data.

Reflection can also be described as Reflection-in-action or Reflection-on-action with regards to the action from which the data is collected. According to Schön (2017), Reflection-in-action occurs while still in the activity, helping the person modify it for completion. Whereas reflection-on-action is about recalling the experience in retrospect in order to see what things went the way they did.

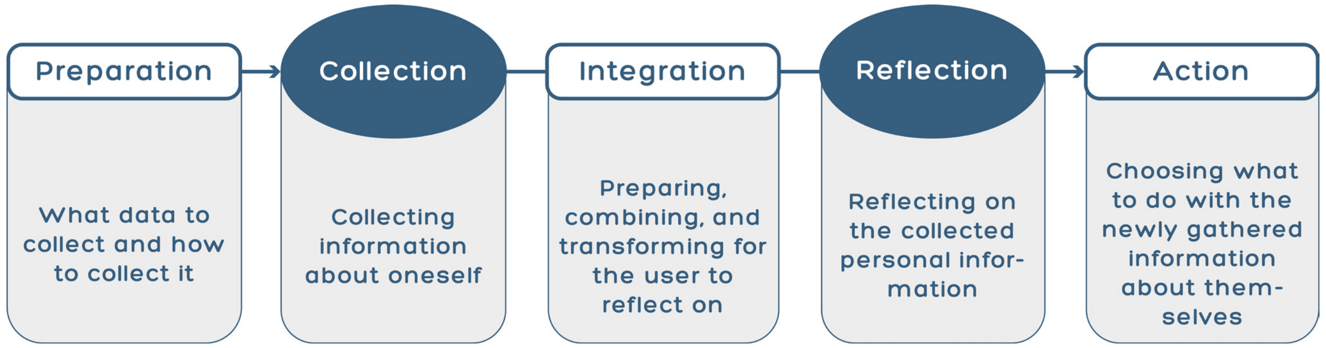


Figure 2.2 : Personal Informatics Framework

2.4 Takeaways

The information found in the literature substantiates the earlier introduced need of implementing blended care in the CR care path.

However, it was argued that such a transition has the potential of less personalization of the care because of fewer contact moments with patients, which were expressed by the patients as well.

One method to introduce more personalization in the care is by utilizing the data in place in the medical domain (in this case, CR) that potentially can be done remotely through big data and its analytical methods or even by following the framework of personal informatics.

All in all, centralising patients in the care they are about to receive is a general of method of personalisation envisioned to make them as active participants in their care, but has challenges for the health professionals regarding time and effort.

Chapter 3

CR ECOSYSTEM AT THE CENTER

This chapter aims to present information related to the context of CR to devise the ecosystem in place in the center. It starts with an explanation of the different stakeholders delivering the care, the medical data used in the care path, and finally, an overview of the workflow. The discussion section brings the information together to make conclusions and translate the gathered information back into the project scope to answer the formulated questions.

3.0 Introduction

This project started with the notion of understanding how to support the transition to blended care while making the care more personalized for patients by exploring the potential role of the data in CR and leveraging that for care personalization.

As said in the previous chapter, the integration of the solution to the aforementioned problem aiming to support blended care is of utmost importance for the uptake of the solution. Therefore, prior to having a design proposition, it is needed to uncover the current ecosystem in place at Basalt. This ecosystem consists of different CR healthcare professionals complementing each other and interacting in the workflow, providing care and value to the patients.

The discovery of the current system is needed to also unearth the current level of personalization in care, the type of data, and the role they play in the care.

Therefore, this chapter aims to provide more information about the CR context and the current care delivered at the center.

3.1 CR Health Professionals

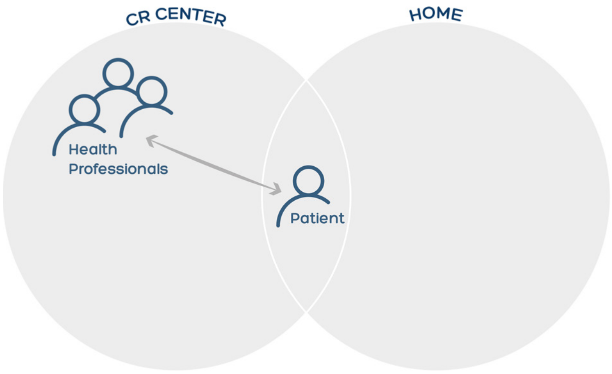


Figure 3.1 : Health Professionals in the CR Ecosystem

CR is delivered by a multidisciplinary team due to the complexity of the care and the different expertise playing a role in it, namely the cardiologist, physiotherapist, dietician, etc. (Mayo Clinic, 2020). They have different roles and interactions with each other and other patients throughout the CR program, which makes it very dynamic and modular.

The list of main CR stakeholders identified in the study is shown in figure 3.2, together with an overview of their role in the provided care at the center.

As shown, the CR health professionals have different interaction points with the patients throughout the care pathway, although some have conditional or optional roles. The ones with the mandatory roles, are always present in the care pathway for the patients covering more general care components such as physical exercise.

As the project scope had already indicated, the focus of this project is on physical exercise because of its integral role in CR. Therefore, the CR stakeholders present in that part, the ones with a mandatory role, are more of interest to the project.

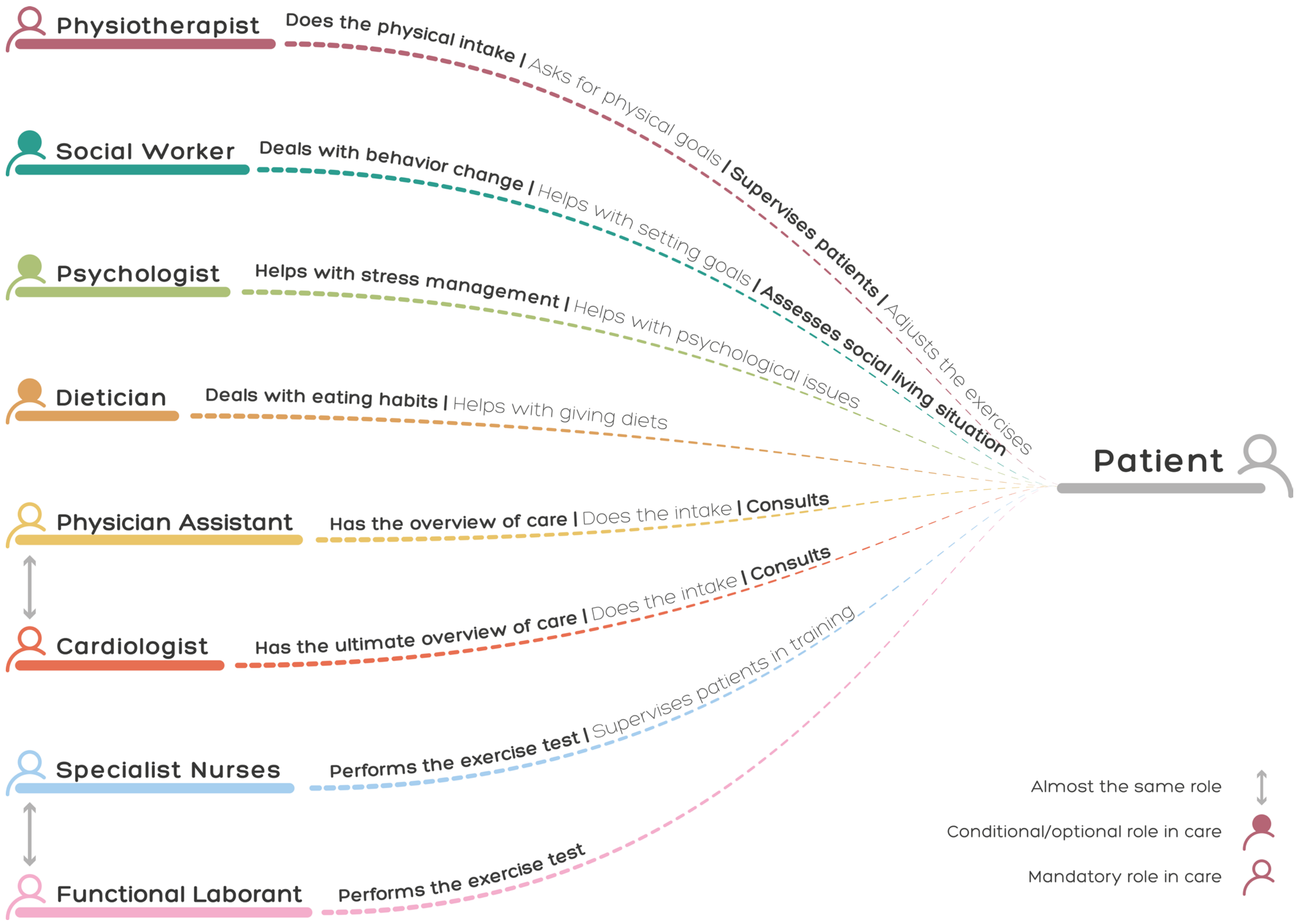


Figure 3.2 : CR Stakeholders

3.2 CR Medical Data

There are multiple data integrated and used in the CR care pathway, either objective (performance measures) or subjective (patient-reported outcomes), all having different purposes. They can range from the data resulting from a test as a measurement tool to assess patients to using scores as indicators of the progress of patients. Figure 3.5 shows the overview of all the tests and scores playing a role in the CR care path with more detailed information.

Figures 3.3, and 3.4 show two of the tests and score in CR, The BORG scale which is a subjective measure for patients to report how heavy they find an activity, and Exercise Test which is used to determine the heart capacity of patients.

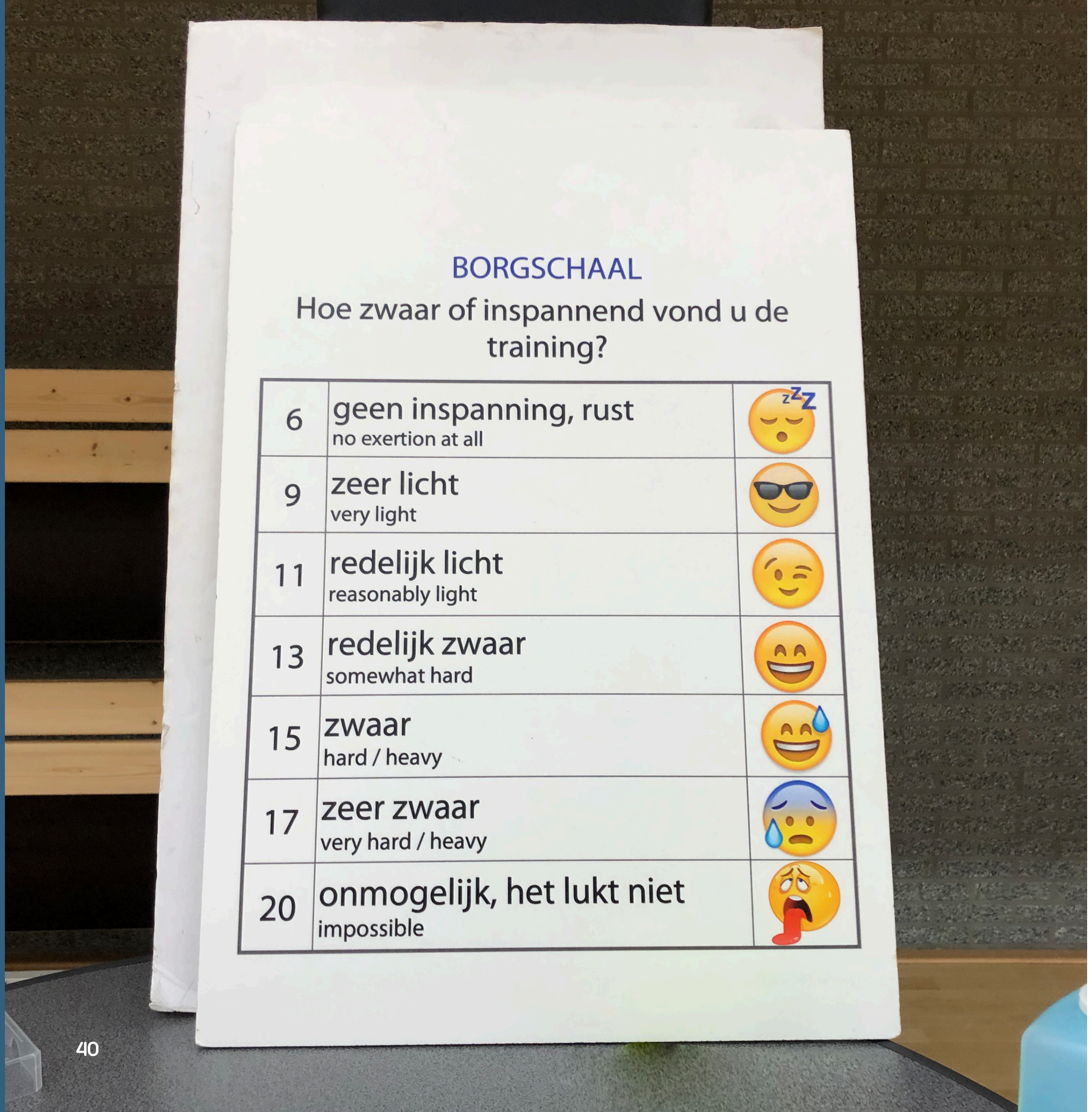


Figure 3.3: The Borg Scale at the rehabilitation center

BORGSCHAAL

Hoe zwaar of inspannend vond u de training?

6	geen inspanning, rust no exertion at all	😴
9	zeer licht very light	😎
11	redelijk licht reasonably light	😉
13	redelijk zwaar somewhat hard	😄
15	zwaar hard / heavy	😅
17	zeer zwaar very hard / heavy	😰
20	onmogelijk, het lukt niet impossible	😫

Figure 3.4: Exercise Test room at Reinier de Graaf hospital

Test/score	What?	How?	Why?	When?
Exercise Test (Krans, 2021) Objective	This test is used to determine the heart's response in high exertion activities in which it is working its hardest.	The test is conducted when patients exercise following a protocol on a treadmill while connected to the electrocardiogram (EKG) machine so that the doctor can monitor the heart.	In order to determine if the heart receives enough oxygen and proper blood flow at high exertion activities. Moreover, it is used to determine the patients' VO2 max, which could be translated into the heart capacity.	This test is done at the start and finishing points of the CR. The purpose at the start is to understand the heart intensity level of the patients to categorize them into the appropriate exercise group. The purpose at the end of CR is to evaluate how the heart capacity has increased during rehabilitation.
1RM (Heath, 2005) Objective	One-repetition maximum (1RM) is an assessment of the capacity of the patient to lift weights using certain muscles.	The test starts with the patient lifting a weight that they perceive as 50 - 70 percent of their capacity. Then the resistance is increased incrementally until they cannot complete the selected repetition. That weight would be recorded as the result of the 1RM test.	In order to examine the strength capacity of individuals in non-laboratory environments, which measures the maximal weight that an individual can lift for one repetition with the correct technique.	This test is done in the physical intake with the physiotherapist prior to the start of the rehabilitation training for the first time.
PSG (Stevens et al., 2017) Subjective	The patient-specific goal-setting method is a scale from 0 to 10 with which patients rate how attainable they find their goals. 0 means not attainable at all, and 10 means already reaching the goal.	This scale is used as a tool for reflection for patients to keep giving a number from 0 to 10 to their goals throughout CR.	In order to reflect on the progress of reaching the goals made in the physical intake with the physiotherapist.	In the evaluation sessions with the physiotherapists at the start, middle, and ends of the CR care path.
BORG (Meetinstrumenten in de zorg, 2020) Subjective	The Borg Scale is a 15-point scale (6 to 20) used to rate subjective experiences during physical exertion, also called Rate of Perceived Exertion(RPE).	Patients are asked to report a number from 6-20 to different exercises they do at the rehabilitation center.	To know howheavy patients find the exercises during rehabilitation training so that exercises can be adapted to their needs and capabilities. This subjective load scale can help estimate load symptoms, such as the degree of exertion, the degree of load, and fatigue. The Borg scale can, among other things, support heart patients in exercising responsibly.	During or after each exercise in the rehabilitation training.
BALANS TEST (Sporttesten, 2022) Objective	This test is used to determine how well patients can stand on one leg, which defines their balance level.	The test is done by the judgment of the physiotherapist empirically by observing and doing examinations.	To prevent injuries during training and determine if patients can do certain exercises.	The test occurs in the physical intake with the physiotherapist at the start of the CR care path.
KARVONEN (Drogespieren, 2021) Objective	Karvonen is a formula used to determine the HR zones in which the workouts should be performed.	The resting HR is used in the formula to determine the different heart thresholds, for example, the anaerobic threshold.	To determine the best optimal HR zone for patients during training.	This is done before starting rehabilitation training sessions at the center.

Figure 3.5 : Overview of CR Data from different tests & scores

3.3 CR Workflow

After identifying the stakeholders and the medical data in place in CR, the workflow is the final item in the CR context bringing the first two ones together by making an overview.

Based on the findings, CR can be divided into three major stages of Pre-program, Program, and Post-Program, all having their own multiple sub-stages, stakeholders, and data involved.

In order to paint a clearer picture, the stages are presented separately but the overview can be found in figure 3.16:

3.3.1 Pre-Program

Prior to starting the actual rehabilitation program at the center, patients undergo a series of quick sub-stages making the pre-program stage. This stage is quite intense because of the multiple sub-stages patients have to go through and the different stakeholders they interact with in a short time (it could be even half a day).

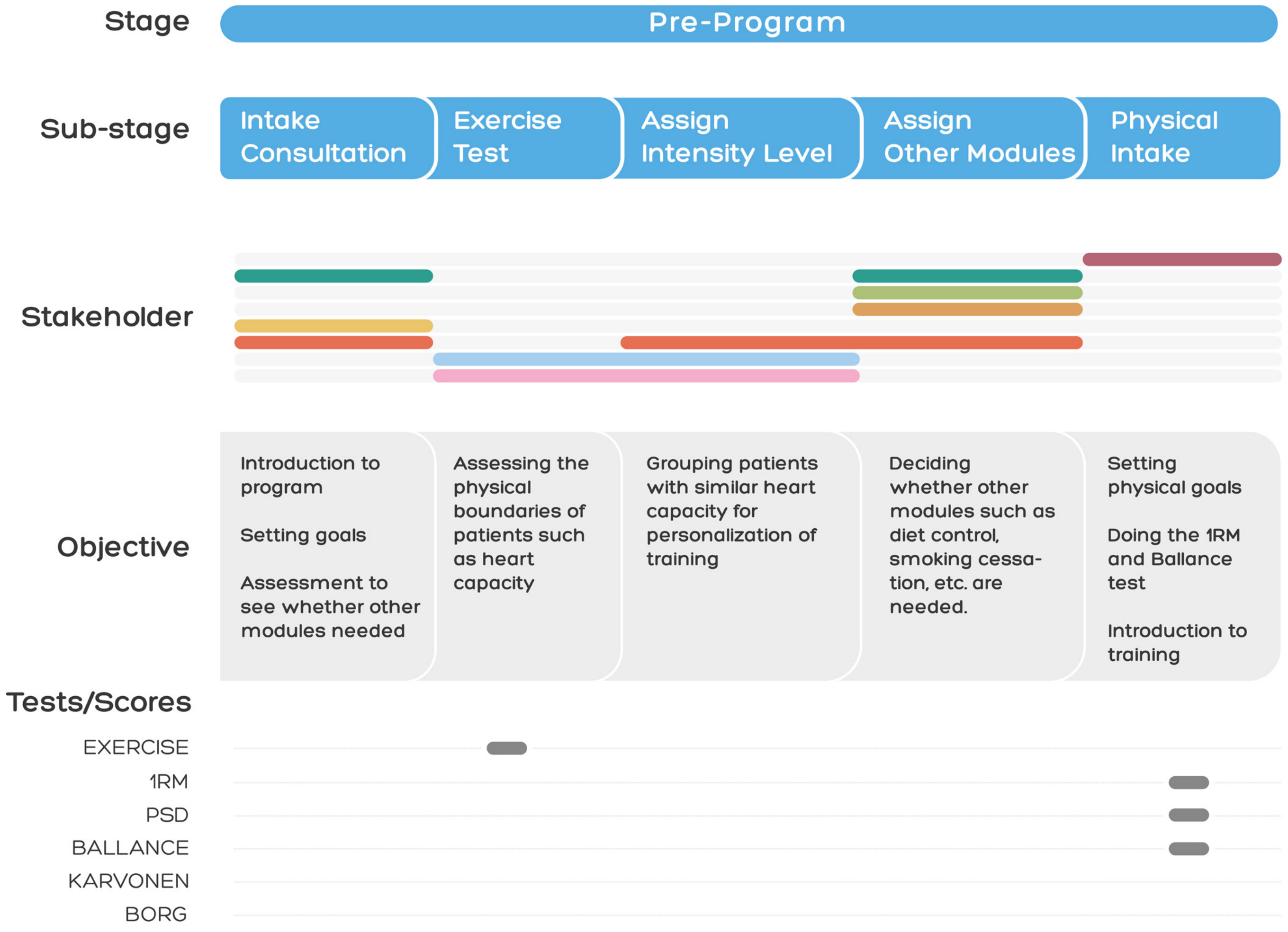
The purpose of this stage is to prepare and assess the patient to personalize the care with the relevant data used in this regard. The details of the workflow realizing this purpose are shown in figure 3.6.

3.3.2 Program

After the pre-program, patients start the rehabilitation training at the center and follow different modules previously assigned to them. At Basalt, where this workflow is based on, patients train at home using a website called Physitrack as well as the center. The cycle of training at home and center lasts for about 8-12 weeks, depending on the condition of the patient (figure 3.7).

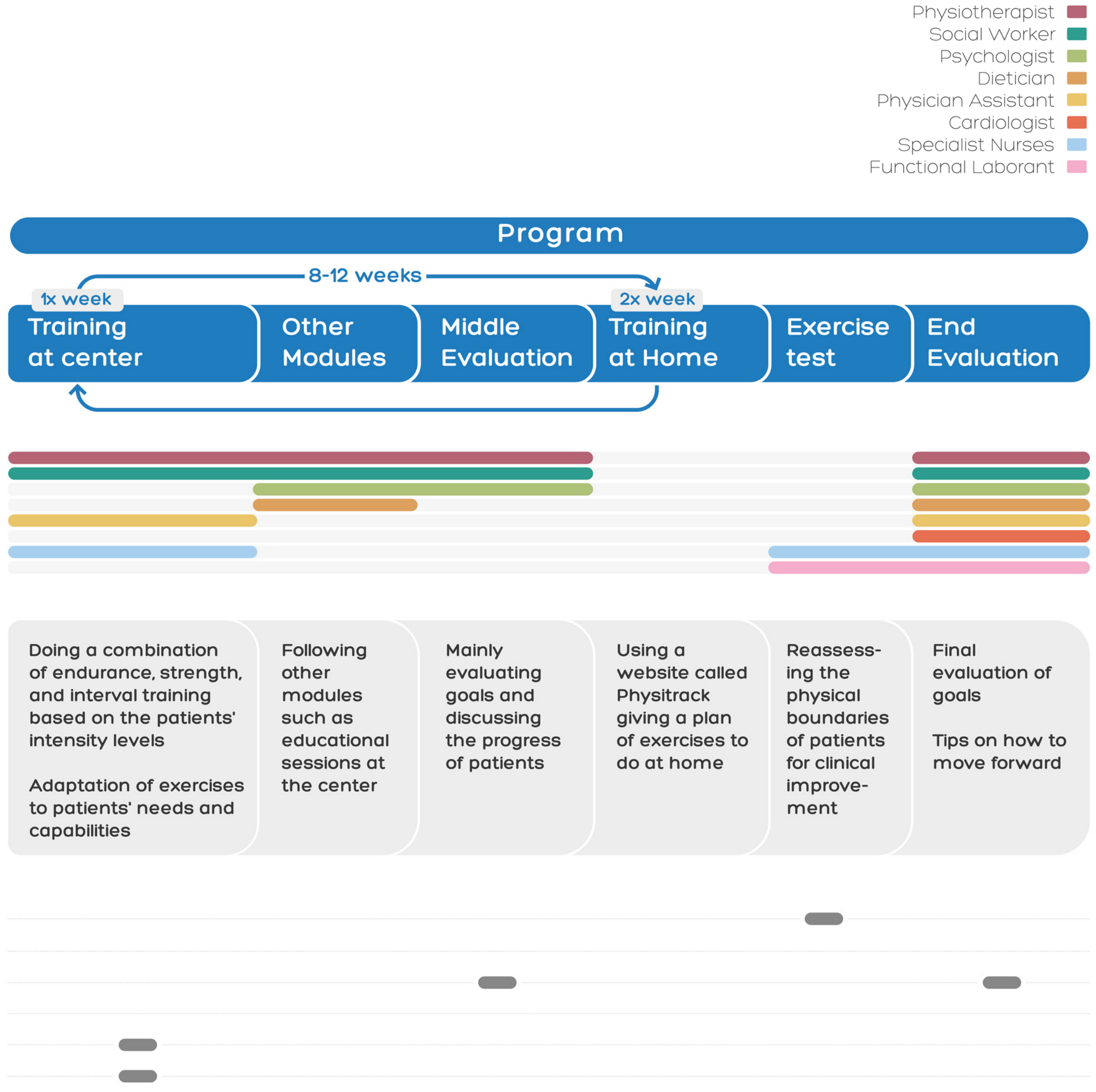
The purpose of this stage is to train the patients to do exercises to enable them to resume a somewhat normal life and deal with the complications of their condition. The medical data are used concerning this purpose and also to adapt the training to the changing needs and capabilities of patients.

In the program stage, understanding the two "training at center" and "training at home" sub-stages are important to have an overview of the context because they are the initiation of the blended care by Basalt. Here, they are presented separately:



Sub-stage	Intake Consultation	Exercise Test	Assign Intensity Level	Assign Other Modules	Physical Intake
Objective	Introduction to program Setting goals Assessment to see whether other modules needed	Assessing the physical boundaries of patients such as heart capacity	Grouping patients with similar heart capacity for personalization of training	Deciding whether other modules such as diet control, smoking cessation, etc. are needed.	Setting physical goals Doing the 1RM and Ballance test Introduction to training
Tests/Scores		EXERCISE			1RM PSD BALLANCE

Figure 3.6 : CR Pre-Program Stage



Sub-stage	Training at center	Other Modules	Middle Evaluation	Training at Home	Exercise test	End Evaluation
Objective	Doing a combination of endurance, strength, and interval training based on the patients' intensity levels Adaptation of exercises to patients' needs and capabilities	Following other modules such as educational sessions at the center	Mainly evaluating goals and discussing the progress of patients	Using a website called Physitrack giving a plan of exercises to do at home	Reassessing the physical boundaries of patients for clinical improvement	Final evaluation of goals Tips on how to move forward
Tests/Scores	KARVONEN BORG		PSD		EXERCISE	PSD

Figure 3.7 : CR Program Stage

Figure 3.9: Strength Training

Figure 3.10: Endurance Training

Figure 3.11: Functional Interval Training

Training at the center

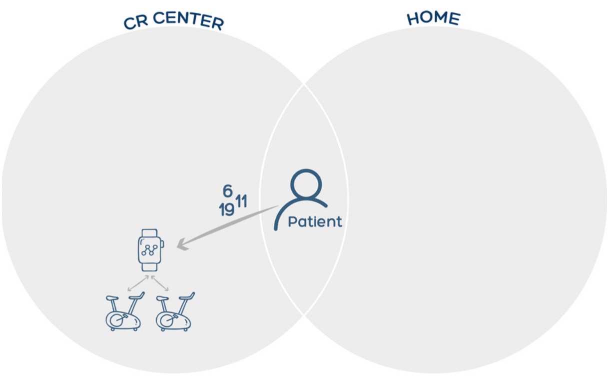


Figure 3.8 :Training at the Center

There are three types of rehabilitation training that patients undergo on the days that they train at the center being strength, endurance, and functional interval training.

Strength training (figure 3.9) concerns training the muscles to become stronger using gym-like equipment. In this regard, the 1RM test is used (in pre-program) to identify the patient's limit regarding the strength and weight they can handle. After that, the Borg scale is used to adapt the exercises to the patient's progress.

Endurance training (figure 3.10) concerns training the heart as a muscle to expand its capacity using fixed bicycles. The Exercise Test (in pre-program) is used to identify the patient's heart capacity and Vo2 max. They start cycling on the 70 percent of their capacity (bicycle's voltage), and the Borg scale is again used to adapt the exercises to the patient's progress.

Functional interval training (figure 3.11) is flexible and includes free and fun exercises such as playing basketball and other group games. In this training, the tests/scores are not used regularly because of its free and flexible nature.

For physiotherapist
The physiotherapist, the health professional present giving the training at the center, measures the patient's HR before and after training to use in the Karvonen test. Thereafter, they adjust the intensity and heaviness of the exercises to match the target HR that was the outcome of the Karvonen. However, Karvonen is not the only thing that the exercise adaptation is based on. The Borg is also used by the patients to adapt the exercises.

For patients
Patients are asked about their Rate of Perceived Exertion (RPE) using the Borg scale during training, which is the ultimate measure based on which the adaptations are implemented.

For the first two training types (strength and endurance) in which the tests/scores are used, there is a flow in place for patients (figure 3.12):

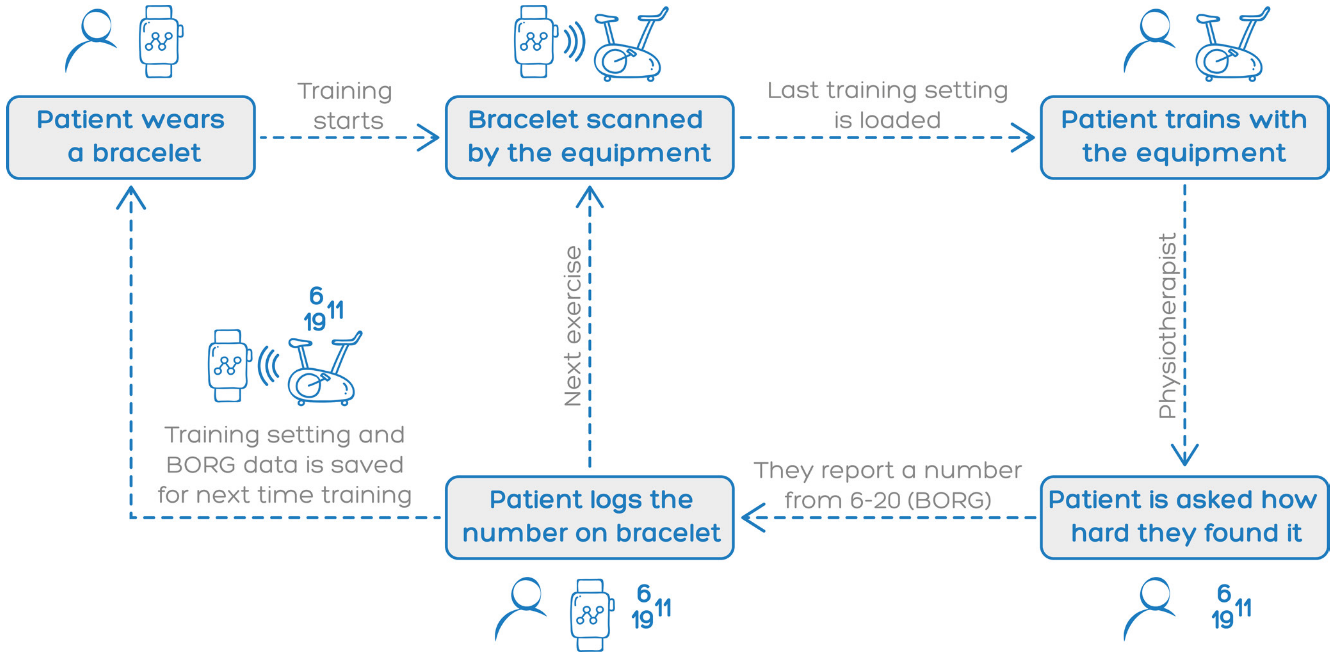
1- Patients wear a bracelet containing their personal identifiable information, as well as the history of their training with equipment and the associate Borg scores reported.

2- In order to start the training, they use the scanner on the equipment to load the last training setting from the bracelet. This can be for instance the voltage on bicycles for endurance and the weight on gym equipment for strength training.

3- After the exercise is finished (and sometimes also during the exercise), the physiotherapist asks the patients to report a number from 6-20 (Borg) indicating how hard they found the exercise.

4- Finally, patients log the number in the bracelet and move on to the next exercise in the training until finished. Then they take off the bracelet containing the new training setting and the associated Borg scores for next time.

Figure 3.12: The flow of reporting RPE while training at the center



Training at Home

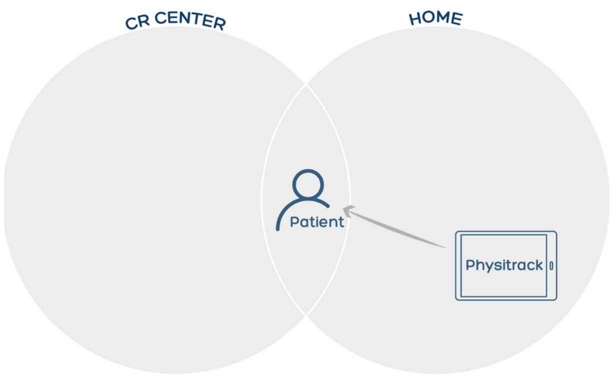


Figure 3.13: Training at Home

Home rehabilitation training is a relatively recent development in the delivered care at Basalt that is initially in place because of the long waiting list of referred patients to CR and the COVID-19 pandemic. However, it is now an official part of the CR care because of the patients' feedback and their adherence to it in the post-rehabilitation stage. The method of delivery of this training is via a website called Physitrack (Physitrack® - The World Leader in Remote Patient Engagement and Telehealth, 2022), which is a service aimed at providing remote care. There are three pre-made exercise programs (low, medium, and high intensity) in Physitrack at Basalt assigned to patients based on their initial assessment in the pre-program stage, which is not adapted throughout the program.

At the moment, Physitrack is mainly used to merely give exercises to patients, but they are not monitored and tracked by any health professional. Therefore, it is mainly the patient's responsibility to keep using it. Moreover, no tests/scores are used in the home training.

Figure 3.14 shows the physiotherapist's dashboard on Physitrack accessed in their office. This view shows the exercises that is set for a certain patient.

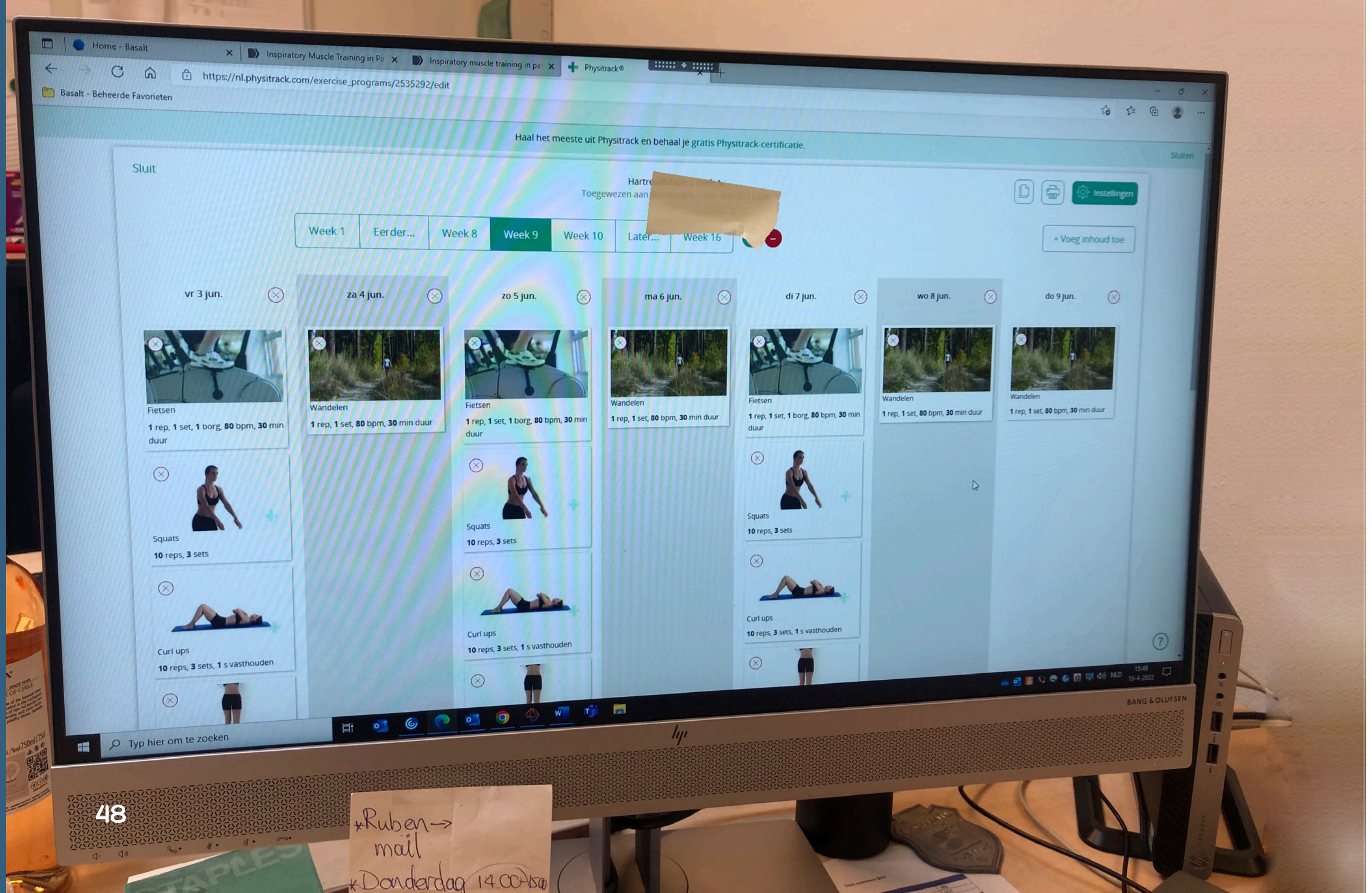


Figure 3.14: physiotherapist's dashboard on Physitrack website

3.3.3 Post-program

After the program finishes (8-12 weeks), patients stop training at the center and the program officially finishes. However, there are options for patients to continue with exercises such as continuing using Physitrack or joining other gyms (figure 3.15).

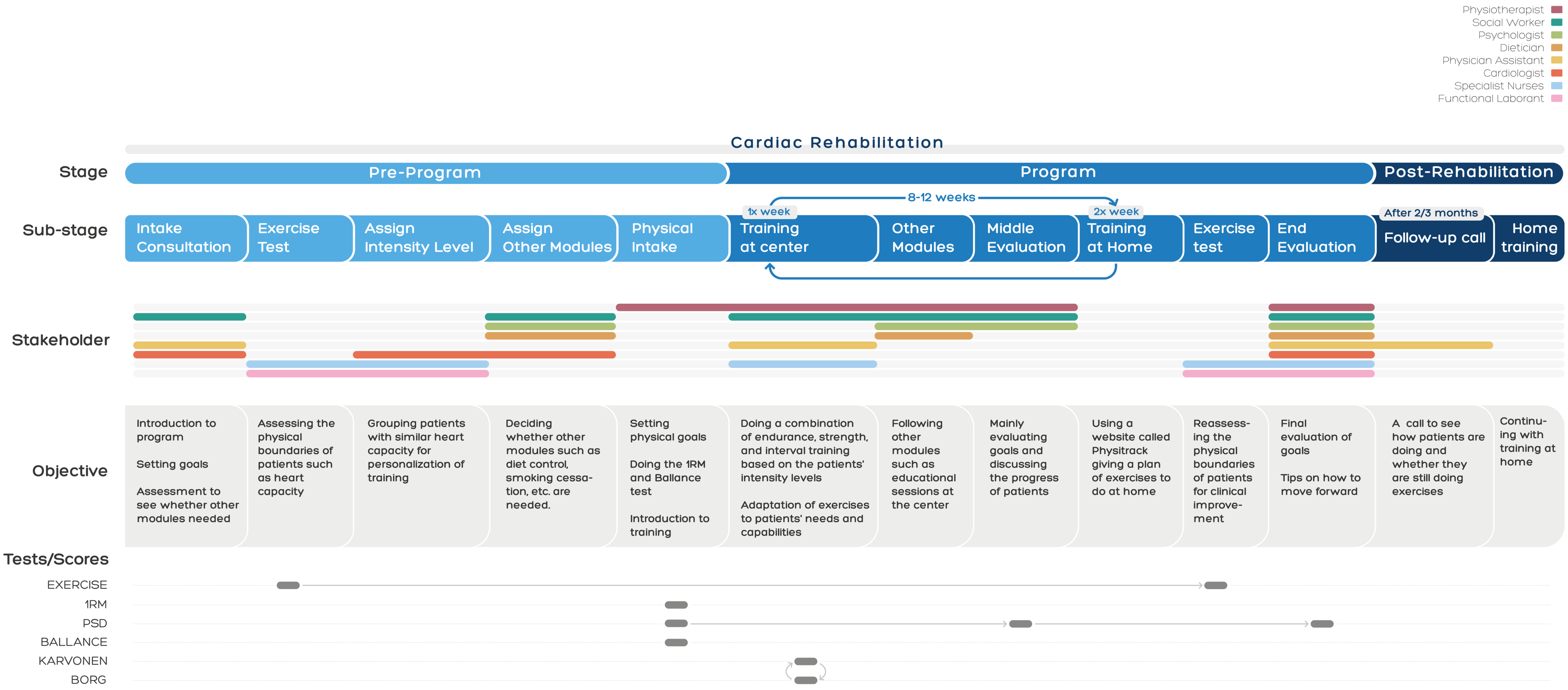
The physician assistant calls the patients 2-3 months after the program to see how the transition from CR to home is going and whether they still continue doing sports.

The most received response is that not many patients continue with it. A few patients join other gyms which offer supervised group lessons similar to what they experienced at the center. Some of them continue with Physitrack, and some stop exercising completely, except for daily activities such as cycling.

All in all, the post-program stage is mainly about the patients themselves and the health professionals are not included as much as before.

This stage is the official start of the third phase of CR in which patients have to be more on their own and managing their condition.

Figure 3.15: Post-Program Stage



Stage	Sub-stage	Objective
Pre-Program	Intake Consultation	Introduction to program Setting goals Assessment to see whether other modules needed
	Exercise Test	Assessing the physical boundaries of patients such as heart capacity
	Assign Intensity Level	Grouping patients with similar heart capacity for personalization of training
	Assign Other Modules	Deciding whether other modules such as diet control, smoking cessation, etc. are needed.
	Physical Intake	Setting physical goals Doing the 1RM and Ballance test Introduction to training
Program	Training at center	Doing a combination of endurance, strength, and interval training based on the patients' intensity levels Adaptation of exercises to patients' needs and capabilities
	Other Modules	Following other modules such as educational sessions at the center
	Middle Evaluation	Mainly evaluating goals and discussing the progress of patients
	Training at Home	Using a website called Physitrack giving a plan of exercises to do at home
	Exercise test	Reassessing the physical boundaries of patients for clinical improvement
	End Evaluation	Final evaluation of goals Tips on how to move forward
Post-Rehabilitation	Follow-up call	A call to see how patients are doing and whether they are still doing exercises
	Home training	Continuing with training at home

Figure 3.16 : Overview of the CR care pathway

3.4 Discussion

This chapter aimed to understand the current CR ecosystem at the center. However, while discovering this context, other topics were also brought up, which are presented in this section.

3.4.1 CR Ecosystem in Center

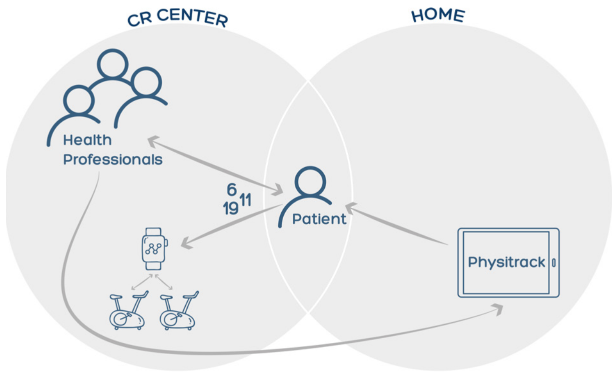


Figure 3.17 : CR Ecosystem in Center

The current ecosystem of CR in place consists of multiple health professionals interacting with patients in the CR workflow using different medical data while they use certain devices to complete their care.

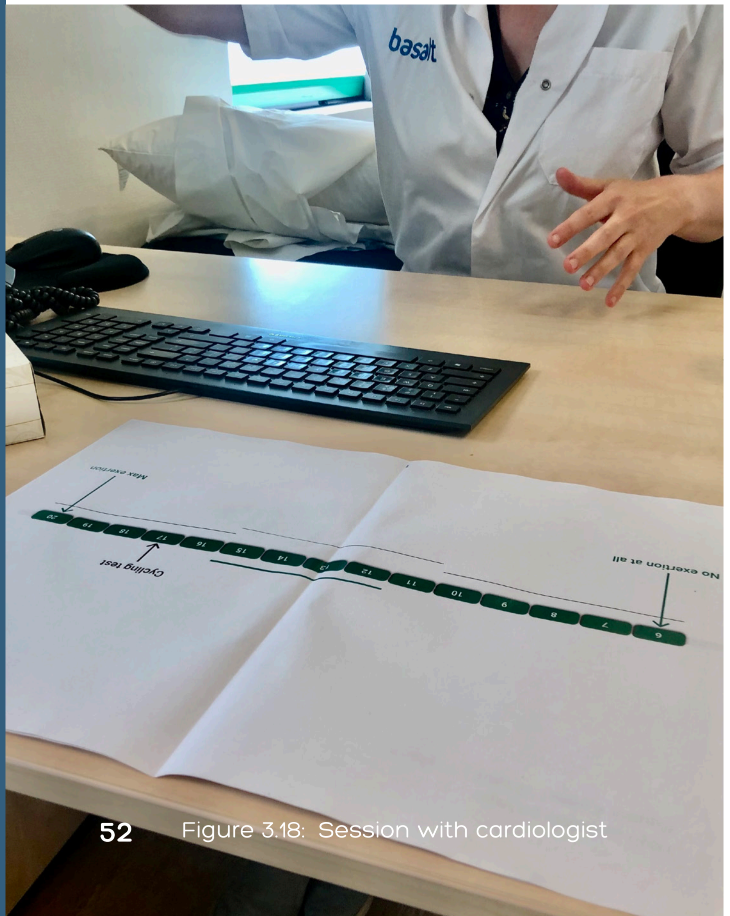


Figure 3.18: Session with cardiologist

CR Healthcare Professionals

The interdisciplinary team delivering CR care consists of the physiotherapist, social worker, psychologist, dietician, physician assistant, cardiologist, specialist nurse, and functional laborants. An overview of the stakeholders with their role in the care can be found in figure 3.2.

CR Workflow

CR can be divided into three major stages. 1. Pre-program is when patients are assessed and prepared to start the CR program. 2. Program is the main stage in which the actual CR care, rehabilitation training and other modules takes place. The purpose of this stage is to enable the patients to resume their normal life with their condition. 3. Post-program starts after the finishing of the actual program, in which patients have to self-manage their condition and continue training if they want to. A detailed overview of these stages can be found in figure 3.16.

(Medical) Data

There are different tests and score in place generating different data in the CR care path, all having different purposes. Exercise test, 1RM, Balance test, and Karvonen are the objective tests, and Borg and PSG are the subjective ones. The detailed descriptions of these tests and scores can be found in figure 3.5, and the sub-stages of the workflow in which they play a role can be found in figure 3.16.

Devices

Different devices and platforms are used by the patients when they train at the center and home. At the center, they use special bracelets with which they report to the physiotherapist how hard and heavy they find certain exercises, after which it is recorded for next time. At home, a platform for exercise called Physitrack is used by the patients to train and rehabilitate.

3.4.2 Supporting Blended Care

(a) What is the current state of the blended care?

Currently, as shown in the workflow, the only element in place in the care path enabling blended care is the Physitrack website with which patients exercise at home. In this care, patients rehabilitate two times at the center and one time at home for a few weeks (figure 3.14).

(b) What is the preferred state of the blended care?

During sessions with the healthcare professionals, their vision for blended care was devised.

According to the cardiologist and as shown in the figure 3.19-b, in the envisioned blended care, patients will have to come to the center less frequently throughout the program with sessions with the physiotherapist. This means that the physiotherapist (from the introduced CR health professionals) would be the one subject to the changes in the workflow and the one interacting with the intelligent solution supporting the blended care.

This gradual transition from center care to home care is envisioned to ensure that patients keep learning how to deal with their condition and its complications at home as early as possible by increasing their responsibility and activeness in the care.

> “We want Physitrack to be not something just on the side (like it is now), but to be something that gives more responsibility to patients. In the future, we envision that patient come to the center less frequently as they go through the CR program. With scheduled sessions with physiotherapists, of course, to see how they are doing at home.
>
> [Cardiologist]”

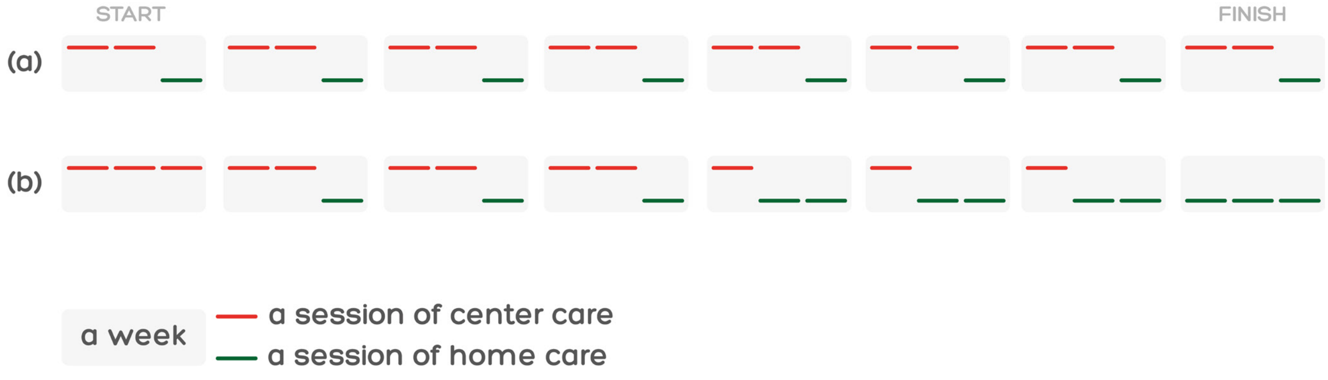


Figure 3.19 : (a) the current state of blended care, (b) the preferred state of blended care

3.4.3 Care Personalisation

After researching cardiac rehabilitation, it was revealed that there are not many personalization points in the care path, especially regarding physical exercises. The main identified personalizations are as follows:

(1) At the start of the care path, patients make personal goals to reach throughout and after rehabilitation. However, this does not change much in the care and exercises they receive, except for the reflection they will have on their initial goals in the middle evaluation sub-stage and the advice received from the physiotherapists.

> Patients come up with SMART goals for their rehabilitation on their own, and we are a bit out of that process because it is for themselves. So, for the training, it does not differ that much, I guess.
>
> [Physician Assistant]

(2) The other personalization in the (traditional) CR care is the intensity group level allocation as the result of the Exercise Test and the assignment of different care components based on the patient's needs in the Pre-program stage.

Other personalizations in place are somewhat empirical and unofficial parts of the care path. They usually take place when the health professionals, especially the physiotherapists who are in most contact with patients during rehabilitation, see and interact with patients so they detect what patients might need.

> Yesterday, I was giving training at the center and told patients to do some lunges with a stick for support. Then we tried to make it look like vacuuming because patients have household goals as well.
>
> [Physiotherapist]

> Some patients are scared and when we see them, they admit it. But if they are scared and do not admit it, they ask a lot of questions from us. But you can see that they are afraid and see the insecurity in their eyes.
>
> [Physiotherapist]

> Sometimes the patient is not doing anything in the household anymore because the partner is all doing it or is taken over by a sister and or aunt or so that is something that we also really try to understand during the training and physiotherapists are playing a big part of it of course because they see them. Then we refer them to psychologists.
>
> [Physician Assistant]

As explained above, many personalization points are implemented by seeing the patients regularly and interacting with them, which is something that has the potential of being missed when enforcing blended care. Therefore, the challenge of personalization while blending the care is still deemed very valid.

3.4.4 Patient-Centered Care

In the recent past, there has been a shift in place from the paternalistic/disease-centered to patient-centered care models in cardiac rehabilitation. Paternalistic care focused on objective data as the result of multiple tests and scores in CR to adapt care for the patients, meaning that the healthcare professionals were the ones scoring patients. Whereas, in patient-centered models, care is adjusted based on both the objective data as well as self-reported subjective data from the patients. Presently, both types of data are used in the CR care path. However, the objective ones are used mainly at the start of the program for personalization, and the subjective ones are used for adaptation during the program.

The main reasons for such a transition are as follows:

(1) Developing trust in the body

Centralizing objective data in the care had led patients to become not only insecure and uncertain because they felt the pressure to reach a particular score to be accepted in the care, but also left them feeling incompetent after rehabilitation. This is in contrast to using more subjective data so that patients learn to trust their own bodies and feelings instead of relying solely on medical (objective) data.

> I used to work in another rehabilitation center, where the patient used a band with a sensor for their heart rate during exercise. There we color-coded the heart zones and told the patient to work hard until they reach a certain color on the band. But after a while, they got so medicalized in a way that they had the feeling that they always needed to track their heart rate, and we noticed that they got a lot of fear if they did not reach the desired color.
>
> [Physician assistant]

> In the case of a patient who ends up with a fantastic VO2 max where we all say wow! We have saved this patient, while from our perspective the cardiac risk of the patient is lower and the patient has very good health improvements after rehabilitation. But if it means that they still cannot clean their car, or do their household. It is fantastic that the risk is lower but that is not why patients come to rehabilitation.
>
> [Physician assistant]

(2) Centralising the Patients

From the patient perspective, it is also much more helpful to deal with subjective data because they understand it better, and they are the ones scoring themselves, so they do not have to participate in a competitive atmosphere.

> We prefer self-referenced evaluation above other-referenced evaluation because this stimulates a goal-oriented mindset and a learning climate. Whereas an other-referenced evaluation could potentially result in a competitive mindset, which could be unhelpful in a rehabilitation setting.
>
> [Physiotherapist]

Of course, having more objective data in the care is preferred by the health professionals because they can relate to it better. However, as they have the interest of the patient's benefit at heart, they admit the advantages of the subjective data included in the care path regardless of the challenges it has brought.

> After introducing more subjectivity, in the beginning, I was a bit unsure because one person finds the exercise already super hard while from my perspective it is not training enough. But over time, I noticed that this is actually working better because at the end of the course the goal is that they can do whatever they want at the end in their daily life.
>
> [Physician Assistant]

> Some patients, while they are doing exercise and you ask them for the BORG score, and they say that I am at 13. Then you look at their heart rate and the physical data and realize that what they are saying does not really fit from a clinical view.
>
> [Physiotherapist]

(3) The untrustworthiness of objective data in CR

Related objective CR data such as the heart rate is deemed unreliable as an evaluation criterion to adapt the exercises for patients because of the imposed effect of the medicine. For example, a patient sitting on a chair could have a high heart rate, which makes a monitoring device that checks the patient objectively understand that they are training and exerting themselves, while that is not true.

> We ask patients to report how hard and heavy they find the exercise because we cannot tell this only based on their heart rate because of the conditions of the patients and the sort of medication they are taking. Besides, we add this also because it is in line with the aims of rehabilitation. That people learn to trust their body and what they feel and not trust a measurement or something. They should learn how high they sit in their energy exertion.
>
> [Physiotherapist]

All in all, the healthcare professionals were happy about the inclusion of subjectivity and supported the idea of intensifying that in the care because of the aforementioned reasons. Not only does it help them deal with less scared and uncertain patients, but it also helps patients to learn about their bodies.

3.4.5 Current Pain Points

Health professionals expressed some concerns about the personalization of the current care and the complications as the result of blended care, which are as follows:

The CR (blended) care is currently considered not personalized enough:
According to the physiotherapists, there is a one-size-fits-all approach to the exercises currently given to the patients in which they do not decide much.

> We have 3 pre-made programs of exercises on Physitrack for low, moderate to high intensity, but we usually give out the second program to all patients to cover the big range of patients, and patients do not get a say in it.
>
> [Physiotherapist]

Due to this generic approach to prescribing care plans, the health outcomes of the patients can be compromised because they would not be training enough (the range of 11-15 on the Borg score) if the exercises are too easy or too hard for them.

> I see these exercises for patients, and they are like nothing from a medical point of view. I do not think they will get the patients to train enough, only to get them moving a bit, I guess.
>
> [Physiotherapist]

Personalization is time-consuming:
Although the physiotherapists are super inclined to introduce more personalization for the patients, they are afraid that it would take more time from them.

> I think if we could change their exercises throughout the program based on what they like, they would end up doing more of them. That would take so much time of course, but maybe we can do it at least in the intake.
>
> [Physiotherapist]

There is little idea about what happens at home:
The physiotherapists have no clue what happens at home, and whether patients follow the care plan and advice they had received. Therefore, patients are again suddenly on their own, only doing some exercises at home while officially in the CR program.

> At the start, we give it to them and say good luck with it. We have no idea whether they do it or not. Sometimes we give them a call to see how things are going, but that is it.
>
> [Physiotherapist]

Patients want feedback on their performance at home
The fact that physiotherapists have no insights coming from the home context also concerns the patients, which could be because of their desire to be supervised and keeping the health professionals in the loop of how they are doing to feel safer.

> Yesterday, I had a call with this patient, and he asked me whether we see how they are doing at home. I told them no, it is for yourself you have to do it. But I guess then they have less motivation.
>
> [Physiotherapist]

3.5 Takeaways

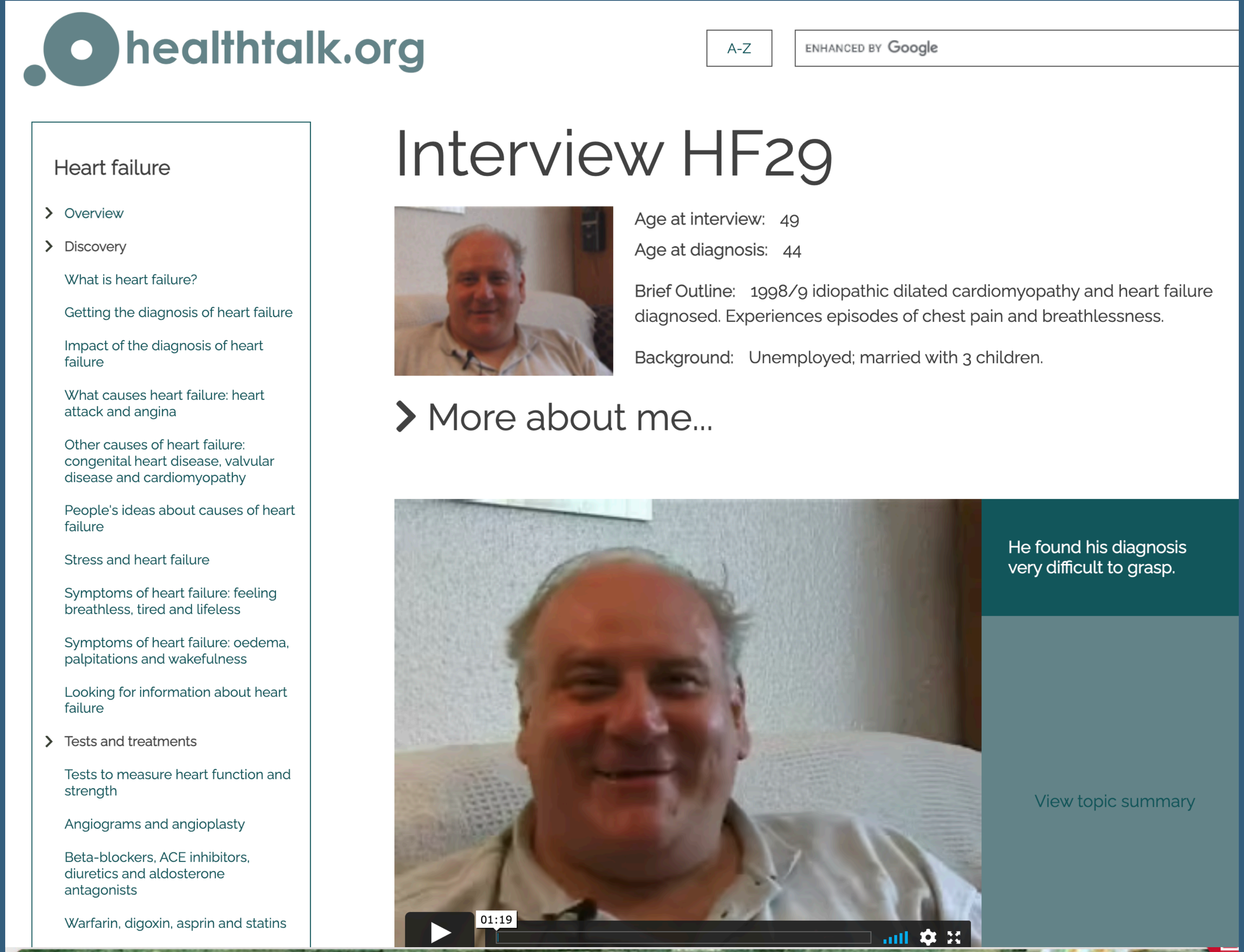
The CR ecosystem was unraveled so that it can be used for the integration of the future concept and proposing subsequent changes concerning the CR workflow in the care path.

The vision of blended care with more details regarding stakeholders and workflow was created in collaboration with the lead cardiologist of Basalt in which patients have to come to the center less frequently as they undergo the program with scheduled appointments with physiotherapist.

The current personalization level of the CR care path was identified to be low already (making goals and reporting RPE), and it was argued that leveraging CR subjective data could potentially contribute to personalization because it centralises the patients.

The pain points and concerns of the health professionals regarding personalization and blending the care at home and center were elicited with the most important ones being the time consumption of personalisation, demand of patients for feedback while heath professionals have no insights into that.

The conversations with the health professionals mainly consisted of the exercise part of the CR care path as it projects how they see rehabilitation. However, it did not help with understanding what needs to be personalised in the CR care path for patients. Therefore, the next chapter focuses only on the patients to see what the personalization level in CR could be using the subjective data.



Heart failure

- Overview
- Discovery
  - What is heart failure?
  - Getting the diagnosis of heart failure
  - Impact of the diagnosis of heart failure
  - What causes heart failure: heart attack and angina
  - Other causes of heart failure: congenital heart disease, valvular disease and cardiomyopathy
  - People's ideas about causes of heart failure
  - Stress and heart failure
  - Symptoms of heart failure: feeling breathless, tired and lifeless
  - Symptoms of heart failure: oedema, palpitations and wakefulness
  - Looking for information about heart failure
- Tests and treatments
  - Tests to measure heart function and strength
  - Angiograms and angioplasty
  - Beta-blockers, ACE inhibitors, diuretics and aldosterone antagonists
  - Warfarin, digoxin, asprin and statins

Interview HF29

Age at interview: 49

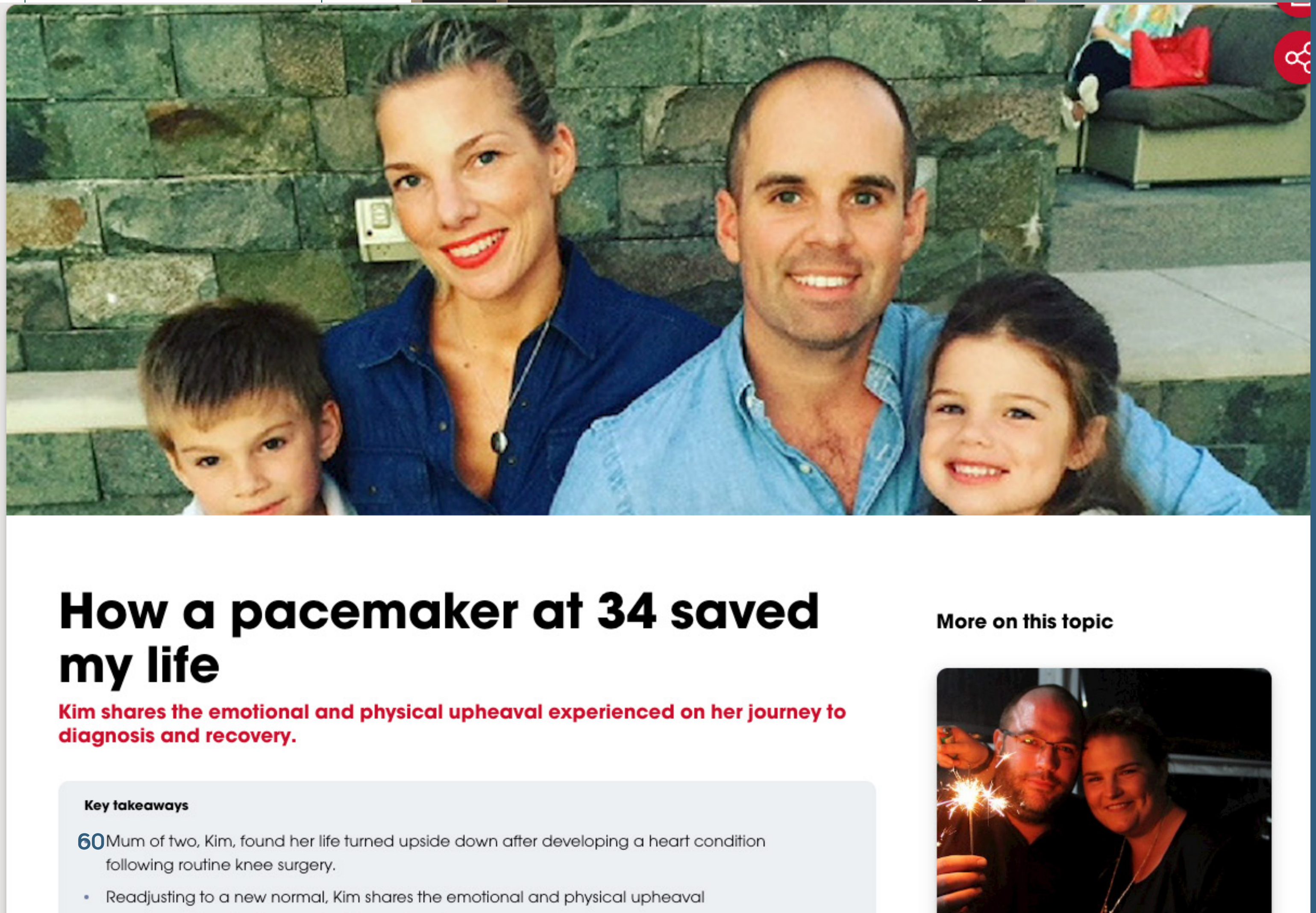
Age at diagnosis: 44

Brief Outline: 1998/9 idiopathic dilated cardiomyopathy and heart failure diagnosed. Experiences episodes of chest pain and breathlessness.

Background: Unemployed; married with 3 children.

> More about me...

He found his diagnosis very difficult to grasp.



How a pacemaker at 34 saved my life

Kim shares the emotional and physical upheaval experienced on her journey to diagnosis and recovery.

Key takeaways

- Mum of two, Kim, found her life turned upside down after developing a heart condition following routine knee surgery.
- Readjusting to a new normal, Kim shares the emotional and physical upheaval

Chapter 4

USER RESEARCH

This chapter aims to present all the research conducted to understand the patients to determine the level of personalization needed in the care which is divided into two parts. The first part presents the CR patient experience and the contextual factors influencing their transition from phase 2 to phase 3 of CR (moving from CR center care to home care while learning to manage their condition) which are the results of the text mining analysis of online patient stories. The discussion and conclusion of this analysis were used as the input for the second part of the user research in which sessions were conducted with stakeholders to explore the level of personalization evident in the care using the patients' CR subjective data. Finally, the chapter concludes by bringing all the results of the user research together to shape profiles of patients used for personalization and adaptation.

4.0 Introduction

The study thus far has unearthed several factors relating to health professionals and the system to shed light on the project's viability and feasibility.

In order to better understand patients and the appropriate personalization window in the care, this chapter is devoted to user research to address the desirability as well as other aspects.

Thus, this user research started with the purpose of understanding the experience of cardiac patients during CR using the patient stories and identifying the personalization degree desired by the stakeholders via sessions with stakeholders.

4.1 Patient Stories

To start the analysis, I collected a dataset of online patient stories and analyzed them using text mining techniques (see Appendix B). The first result of the analysis was zoomed-out perspective of the recovery journey of cardiac patients in which CR makes just a portion of it.

While examining the experience of patients, I identified three main phases in the recovery of cardiac patients being the following:

> **1- Towards the New Normal.**
> **2- Transition to the New Normal.**
> **3- Experiencing the New Normal.**

The names were inspired by the quotes of patients in which they implied that their recovery process was a journey to get to know their new self in the new normal. In this recovery overview, CR was considered in the middle, where it helped patients to transition to their new normal to some extent. The recovery period can be found in Appendix C with more details.

After empathising with the overal recovery experience of patients, I zoomed-into the experience of CR itself, which showed the CR specifc experience of patients as well as the contextual factors influencing their recovery and the aforementioned transition in the CR center and home context.

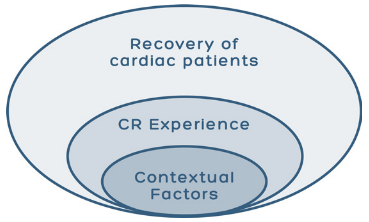


Figure 4.1: User research results from patient stories

4.1.1 CR Patient Experience

The CR journey consisting of the experience of patients in the second phase of CR from the start to the completion point at the rehabilitation center contains several key moments shown in figure 4.2. These moments correspond to the CR workflow devised in the previous chapter, which shed light on the experience of patients during the care.

The CR care pathway occurs when patients are transitioning to their New Normal, in which they start to learn about their body and condition and how to manage them. In order for them to continue living their lives, CR plays a significant role in assisting them in realizing their capacities and limitations.

However, they find their transition at the end of CR quite hard, feeling clueless and unsure about what they can or cannot do. Moreover, according to patients, the overall perceived personalization level of the care is considered rather low, except when they make goals to reach throughout rehabilitation.

Therefore, CR is considered more than only doing exercises for patients in contrast with how health professionals mainly address it (CR being more about the exercises), as patients see it as a few weeks of learning about their body and how to manage their condition.

The complete CR experience journey can be found in Appendix D.

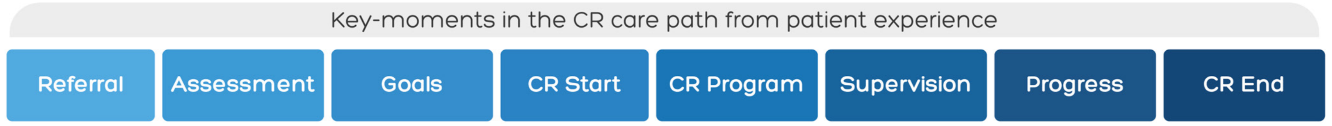


Figure 4.2: CR key-moments from the patient experience

4.1.2 Contextual Factors

The context for the patients starting in the CR care pathway is not only the center they receive the care, but it is also their home context and environment during the 6-8 weeks of CR.

The notion of blended care, in which some of the patient’s care is delivered home, places a high value on the home context. In this case, the contextual factors at home become of utmost importance, especially because of the fact that the health professionals are unfamiliar with what occur there. Thus, these factors can compromise the recovery of the patients envisioned in CR.

However, context is in itself very nuanced and difficult to capture. Ovretveit (2011) defines context as “all factors that are not part of a health quality improvement intervention itself.” According to ASHA (2022), these (contextual) factors include, but are not limited to:

> “**Environmental Factors**–factors not within the person’s control, such as family, work, government agencies, laws, and cultural beliefs.
>
> **Personal Factors**–include race, gender, age, educational level, coping styles, etc.”

One way to look at these factors is to see them as facilitators and barriers not only to the received care but also to the implementation of the future solution. Another viewpoint is to consider them as some of the factors based on which the intelligent solutions learn and adapt. The second perspective is adopted in this project. These are the factors that might potentially hinder the transition of patient to their normal daily life in CR phase three that need to be ideally captured in the home context.

As stated earlier, the factors influencing the care and transition of patients in both contexts of home and center were elicited from the experiences of patients in the online stories.

Appendix E presents explanation about the factors pertinent to the project scope visible in figure 4.3.

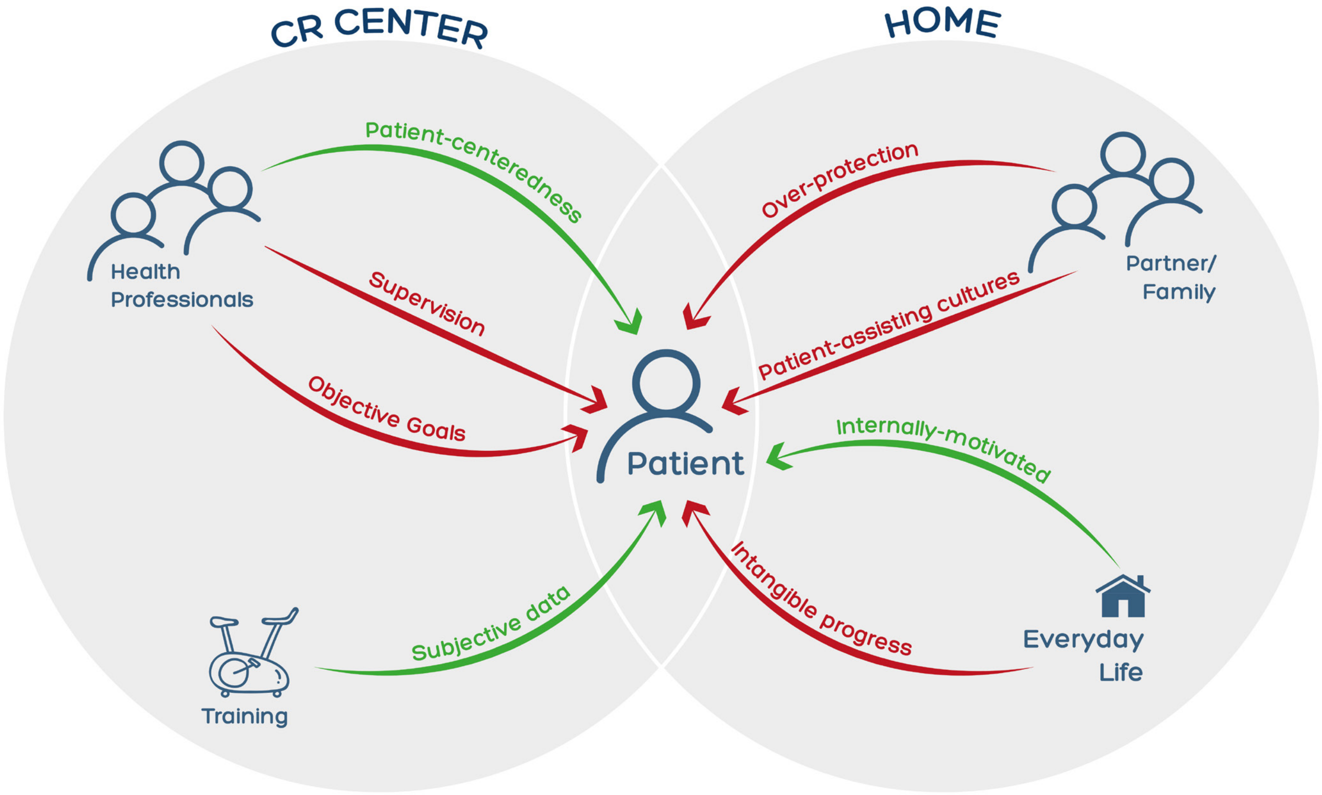


Figure 4.3: Project-scope Relevant Contexual Factors

4.1.3 Discussion

The first part of the user study was carried out by analyzing online patient stories, which resulted in insights into the CR experience of patients and the contextual factors in place in the center and home context of the patients, which is crucial to consider when implementing blended care while personalizing the care.

The experience of patients showed that the current status of traditional CR is perceived already not personalized by the patients. This means that it might become even less personalized when they have to do most of it at home when blending the care.

Moreover, according to patients, CR is seen as a part of the bigger picture of recovery and means more to patients than solely some exercises as opposed to how health professionals generally see CR.

The difference in perceiving CR between the two main stakeholders of health professionals and patients is evident. From the medical point of view, patients need to "train enough" (range of 11-15) on the borg in order to have health outcomes at the end of rehabilitation and that is what they should work towards. However, patients see CR as means to reaching their personal and subjective goals in rehabilitation. This different perspective on rehabilitation might cause some friction between the stakeholders resulting in the CR not being personalized from the patients' viewpoint.

Identification of the influencing factors in the home and center context revealed several aspects that affect patients' recovery. One of the factors was that patients find the CR data hard to relate, especially to the home context. This might be one of the reasons for the shift from the paternalistic to patient-centered model in CR introduced earlier, in which more subjective data is used with patients for personalization.

As a measure to combine the results obtained from the patient stories, I set out to explore whether (subjective)data currently in place in CR can be utilized and leveraged to increase personalization for patients while not increasing the workload of the CR health professional and the system in the blended care.

Therefore, I conducted sessions with the stakeholders specifically to explore whether using the CR data can bring any value to the stakeholders by increasing the personalization level.

4.2 Sessions with Stakeholders

After having a general knowledge and understanding of the pain points and the context in place from the patient stories, I approached the patients and health professionals specifically to understand the new possibility introduced earlier, which is to explore whether CR subjective data can be leveraged to introduce more personalization for patients.

As mentioned earlier in chapter 3, the subjective data in CR are the PSG, which is used to make goals at the start of the CR care path, and the BORG, which is used to adapt the exercises to patients' limits throughout the care path. The reason for choosing these two data was the insights and benefits of this score already mentioned in the patient stories and the fact that it supports the concept of patient-centered care needed for personalization in blended care.

Thus, these two data were used as the conversation-starters with stakeholders in the sessions conducted with the physiotherapist and patient. The general procedure for these sessions contained facilitation of discussion using different scenarios concerning the data (visualization), which sparked new and unexpected notions.

The result of this activity is presented in the discussion.

4.2.1 Physiotherapist

From the context inquiries through CR healthcare professionals introduced in the previous chapter, I discovered that the physiotherapists were the ones in most direct and continuous contact with patients throughout the care path, while the cardiologist or the physician assistant are the ones having the overview of the care for the patients. Thus, for this session, I deliberately approached the physiotherapist since they have observed all types of patients, and they can have more close opinions and be more accurate.

The session with the physiotherapist consisted of showing different types of hypothetically logged-in data with regards to the aforementioned two scores and asking about the type of patients they have observed who demonstrate such behavior with the aim of understanding nuances and opportunities for personalization.

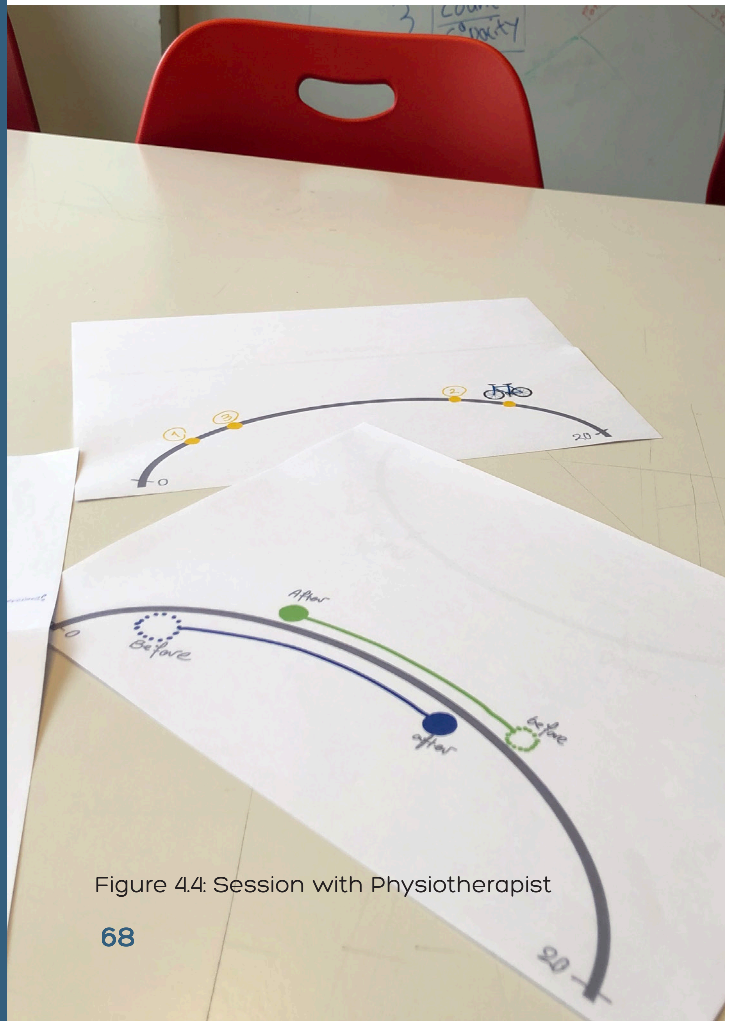


Figure 4.4: Session with Physiotherapist

4.2.2 Patient

The approach taken towards the physiotherapist's session was also taken with the patient's one. The interactive session consisted of the patient seeing multiple ways that the data could be used and giving meaning to it, intending to understand what is personal in this data for the patient.

The patient that participated in the session had already finished their rehabilitation a few months back, meaning that she had to be sensitized to recall her experiences with the data during CR. As a result, I had pre-made different scenarios in which different data was logged in based on the assumptions elicited from the previous research. This session, similar to the one with the physiotherapist, was aimed at understanding whether utilizing the CR subjective data could be of value for personalization.

Figure 4.5: Session with Patient

4.2.3 Discussion

After facilitating sessions with the stakeholders regarding the different scenarios that could possibly happen with this subjective data in CR, I discovered that these data are indicative of more behaviors, nuances, and traits than initially assumed.

A certain process of reporting the data by the patients helped the physiotherapist recognize a certain type of patient, which triggered how they should be treated. The patient also explained her experiences with stories fitting the presented scenario in which most of my assumptions were validated.

Although the sessions validated many of the assumptions, they created a new knowledge that I did not set out to uncover, and it was solely created by seeing the data.

I started this study with a (sub)goal (as an assumption) to see whether the scenarios of different logged-in data could distinguish the fearful patient as this trait was initially assumed as the personalization level and the main identified difference between patients. Nevertheless, it was revealed that patients have more profiles than only the insecure ones, and it would be naive not to take them into account. These differences can occur with what patients do in CR, which is reflected in their exertion and goal data, and some uncontrollable factors such as age, condition, etc.

These data points can potentially constitute the Understand loop of the intelligent solution so that the system can detect certain behaviors and traits of the patients to personalize the solution using the Adapt loop.

Therefore, the insights in this section are presented as "what you have" and "what you do" which are envisioned to be used in the Understand loop to detect nuances of patients, and "what you need" which are to be used in the Adapt loop of the intelligent solution for personalization.

Figure 4.6: Three categories of data points

What you have: (input)
'What you have' refers to the (more obvious) data points belonging to the demographic, condition, age, and gender of the patients, which is needed for the intelligent solution to Understand the patient.

What you do: (input)
This one on the first level refers to the data points needed to Understand the patients' behaviors, experiences, and context. Second, it is used by the system to understand whether the adaptation resulting from a previous Understand loop is adopted or even accurate to learn to make itself better.

What you need: (output)
The data point from the previous two items, "What you have and do," determines what a certain patient needs, which is contained in the Adapt loop. It indicates the adaptations of the intelligent solution with regards to the design and also the made decisions in response to the Understand loop.

Therefore, the intelligent solution could be considered as figure 4.7. The ecosystem (inside the loops shown in the figure) is the result of the previous chapter in which the current CR ecosystem was uncovered in the center.

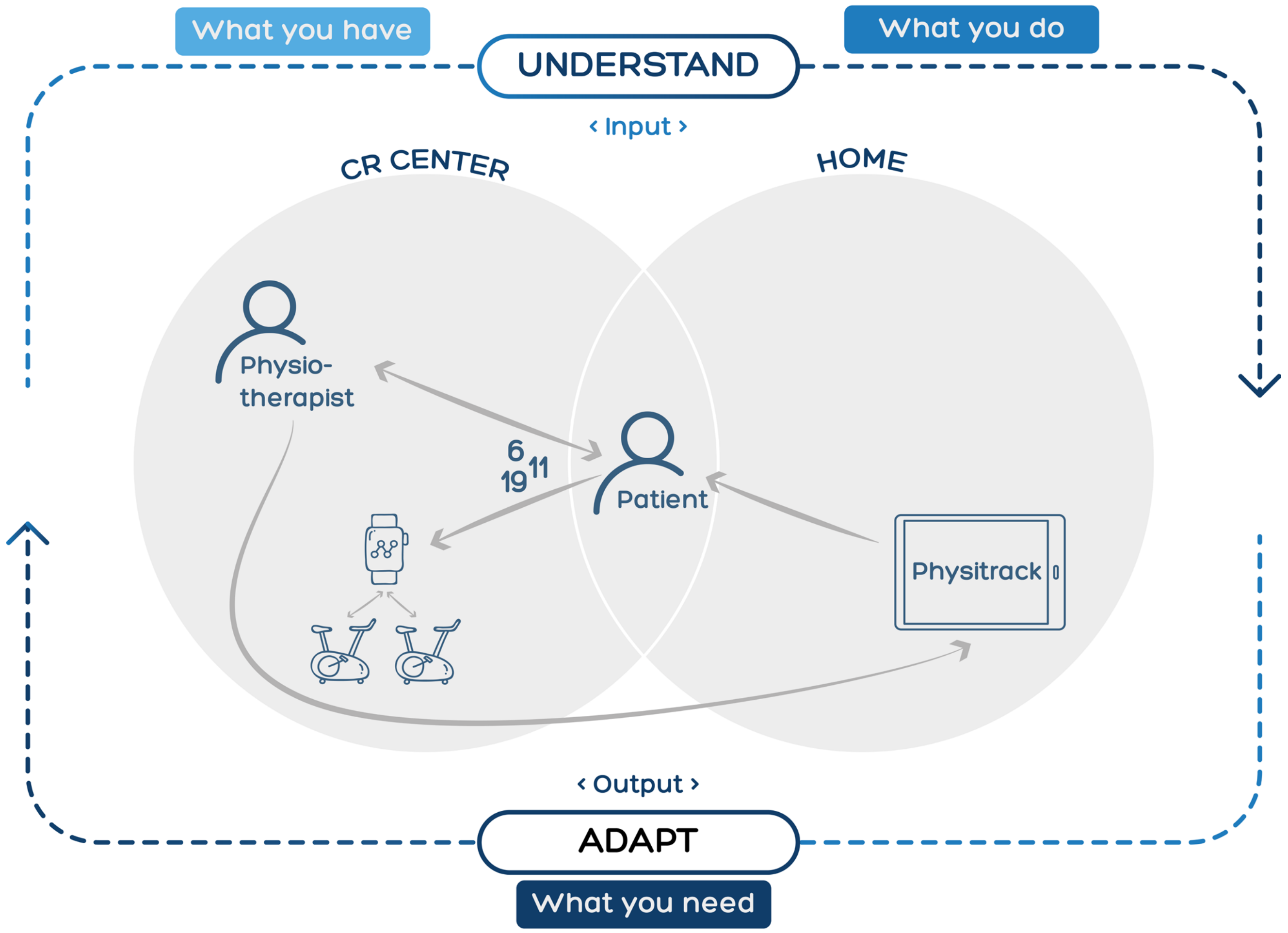


Figure 4.7: Intelligent solution with data points

The following two subsections present the results in terms of the three aforementioned categorised data:

Exertion Level

As previously mentioned, the BORG is a scale from six (minimum exertion) to twenty (maximum exertion) with which patients rate the heaviness of exercises and activities in CR. However, the result of the sessions revealed that more meaning could be derived from this scale, and it has more value than solely assigning a number to an activity.

> “When we see a patient reporting a number on the Borg during exercise, and they keep increasing it rapidly, for example one minute it is 9, the next 12, and then 15. Then we know the patient is scared because they are reporting and increasing the number frequently.
>
> [Physiotherapist]”

> “Some patients do not exert themselves above a certain number, then we know that they are the scared type. On the other hand, you have to put a break on some patients because they are fearless and want to do as much as possible like +17 ,but then it might become very dangerous for certain cardiac conditions, and they might end up being tired all the time.
>
> [Physiotherapist]”

If we divide the Borg scores into three regions of under-training, enough-training, and overtraining, the zone that the patients usually train there says a lot about them. For example insecure/scared type of patient tends to under-train, and the fearless kind of patient tends to overtrain, and the person enough training is already doing a very good job.

The differences between the behavior of such patients require them to need something different from the rehabilitation, which can the personalisation level missing currently.

The overview of the insights with regards to the scale are shown in figure 4.8.

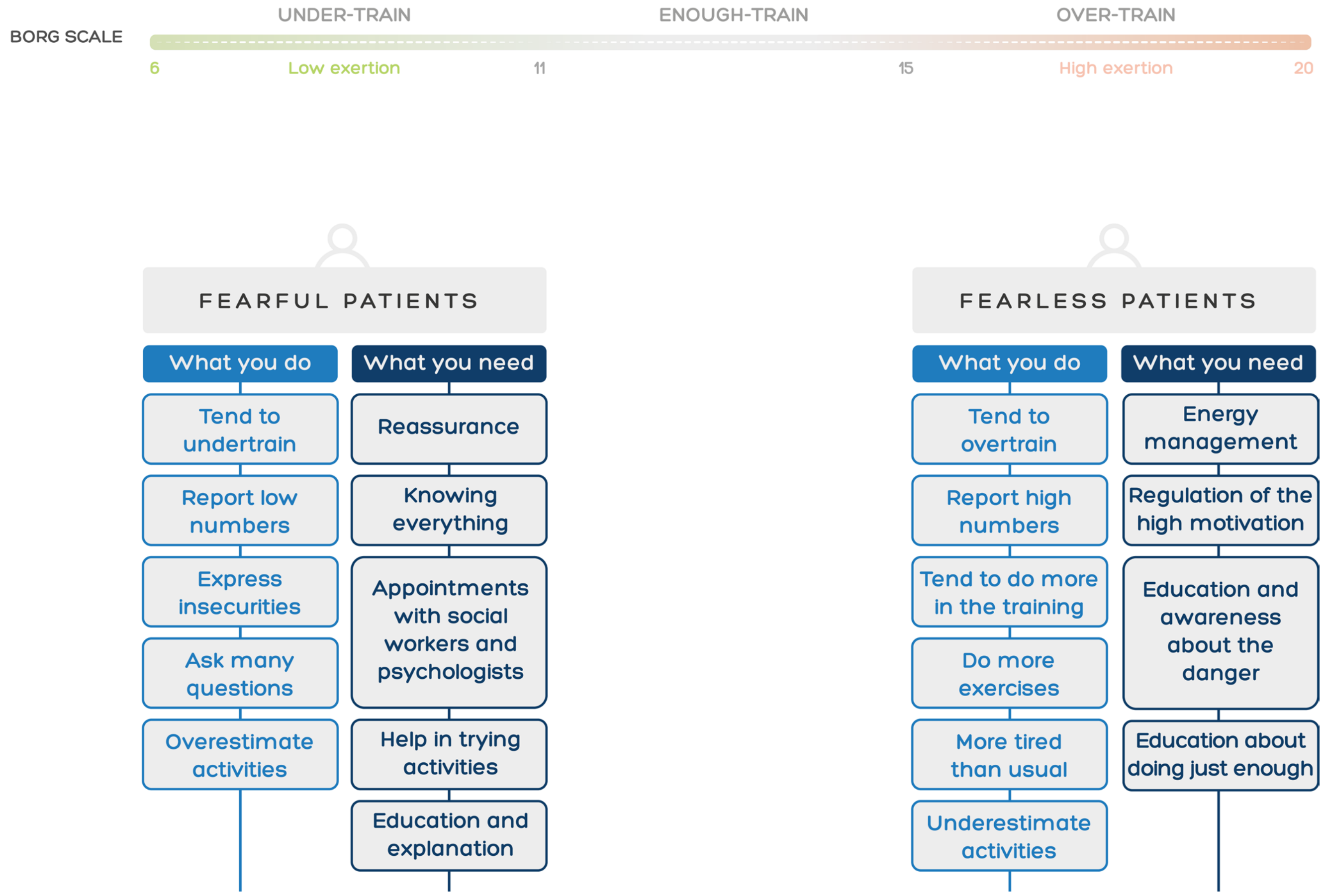


Figure 4.8: Insights regarding the Borg scale

Goal Making

The physiotherapist, who deals with patients when they need to make some physical goals at the start of the rehabilitation, shared stories of different patients in this situation. The aggregation of the stories revealed that patients exhibit different behaviors toward making rehabilitation goals depending on their motivation level and referral method to CR.

As mentioned in chapter 2, the referral to CR is currently a significant problem because of the shortage of CR health professionals and the capacity of the system, meaning that very few people are referred to CR in the first place. However, the ones who do get referred, have different methods of referral which could be initiated by the doctor or the patients themselves.

For example, a patient could be the one asking their doctor to refer them to CR in which case they have the highest motivation to undergo CR. On the other hand, there are some patients as well who get referred to CR by their doctor while they do not see the relevance and do not think that they need it. Thus, they feel much more difficulty coming up with goals in the first place, and as a result, feel less motivated to undergo CR.

The range of the patient’s motivation concerning the data points already mentioned can be seen in figure 4.9.

> “I sometimes see patients who get referred by their cardiologist to CR, and they cannot really see why they are there. We have a lot of difficulties with such patients because they cannot come up with a goal themselves, and they keep coming to CR less and less because they do not feel internally motivated.
>
> [Physiotherapist]”

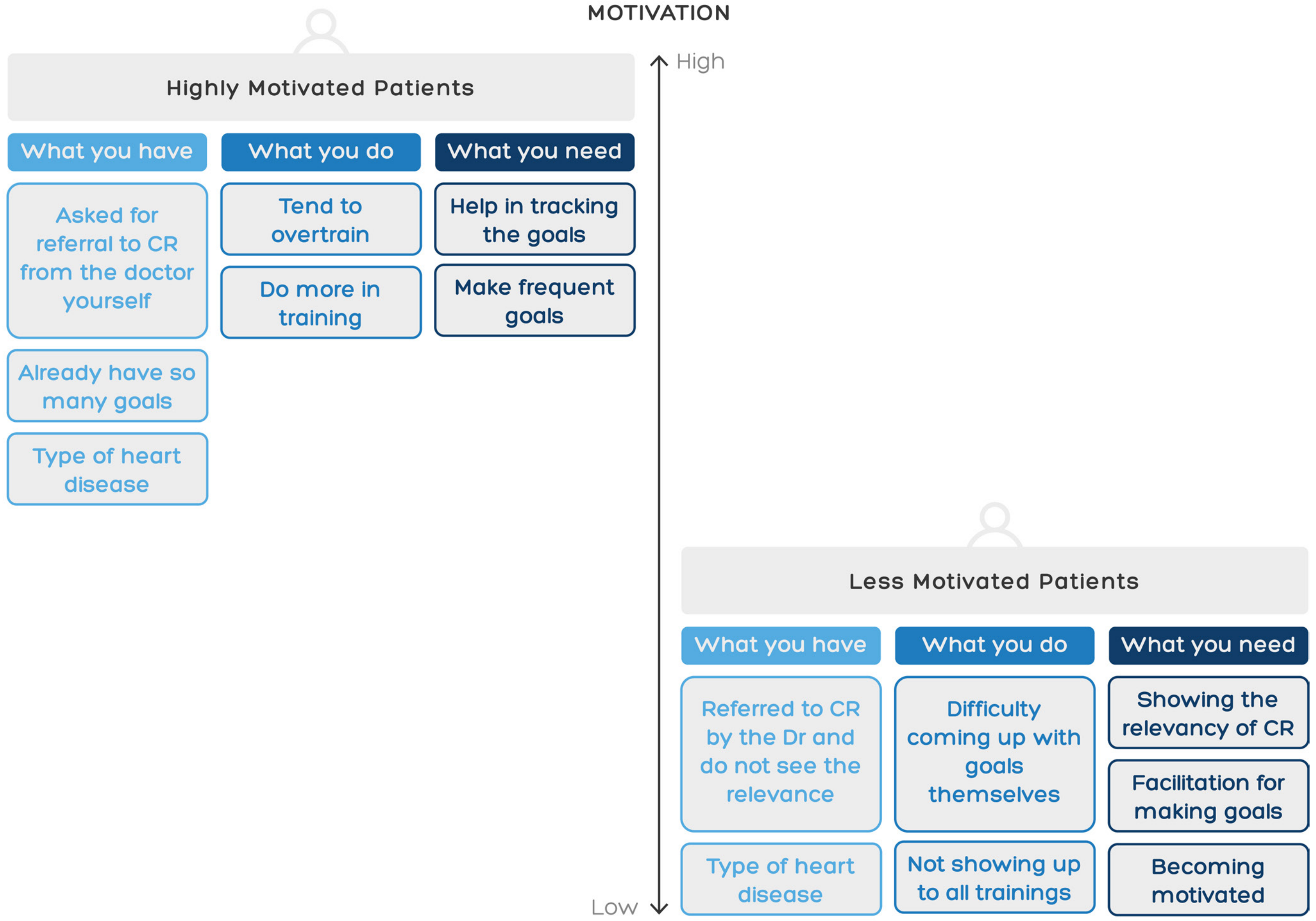


Figure 4.9: Insights regarding the goal making

4.3 Patient Profiles

In order to combine the two earlier-presented figures, I devised profiles of patients (figure 4.10-11) which were elicited from the data gathered from the user study in this project, reflecting the different sorts of patients starting CR.

These need-based profiles are aimed to cluster representative profiles based on their needs and behaviors to detect archetypes with two main axes for the goal/motivation, and the exertion level.

Usually, profiles are used to tailor the design solution as a measure to personalize the design. While that is still true, here I did not mean to label or stigmatize patients by giving them a type and making a one-time adaptation based on the profiles. Due to the long period and the exploratory nature of CR, patients might navigate between profiles because they are still experimenting to identify their capabilities and limitations, meaning that the solution should detect these changes and adapt to them. This is best explained by the patient's case:

Case of the patient:
The interviewed patient started rehabilitation with profile (2) consisting of high motivation and fear, indicating that she overestimated many activities and underestimated her capabilities. In the first weeks of rehabilitation, the training went better and easier than expected and she did more exercises because she liked them. Thus, she felt really confident that she is now capable of doing many things. This resulted in her doing more than usual which left her tired, out of energy, and confused about why that was happening. Here she had transitioned to profile(1), in which she was still with high motivation, but her insecurities were gone, so she kept doing things and feeling tired.

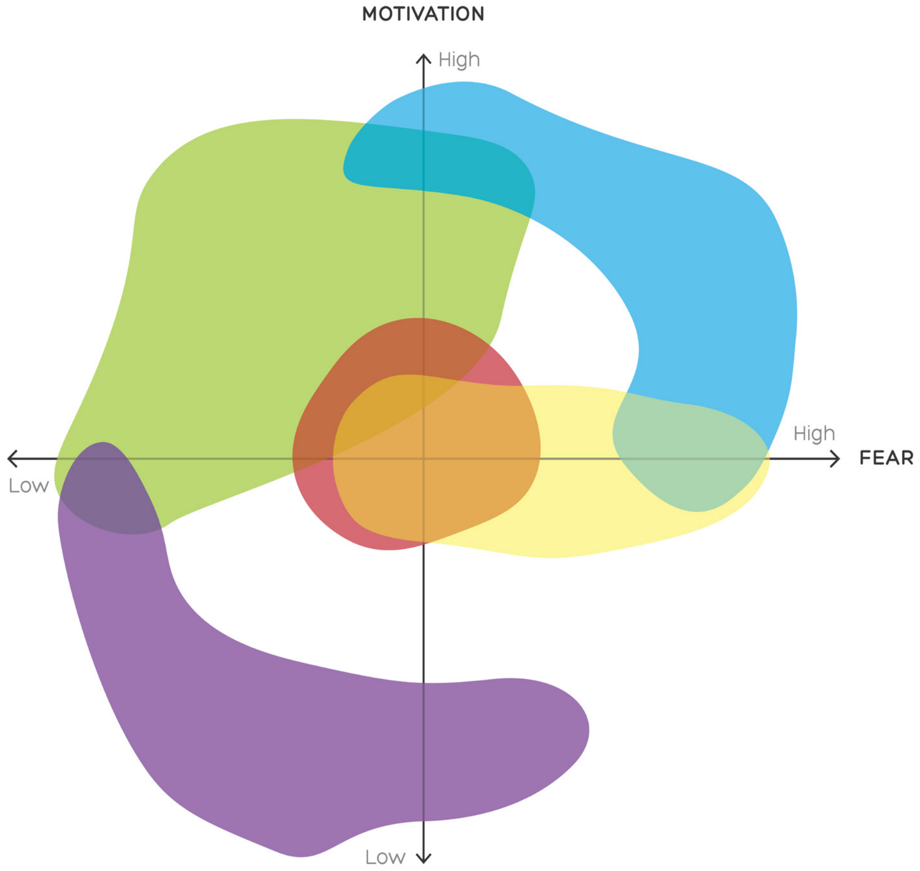
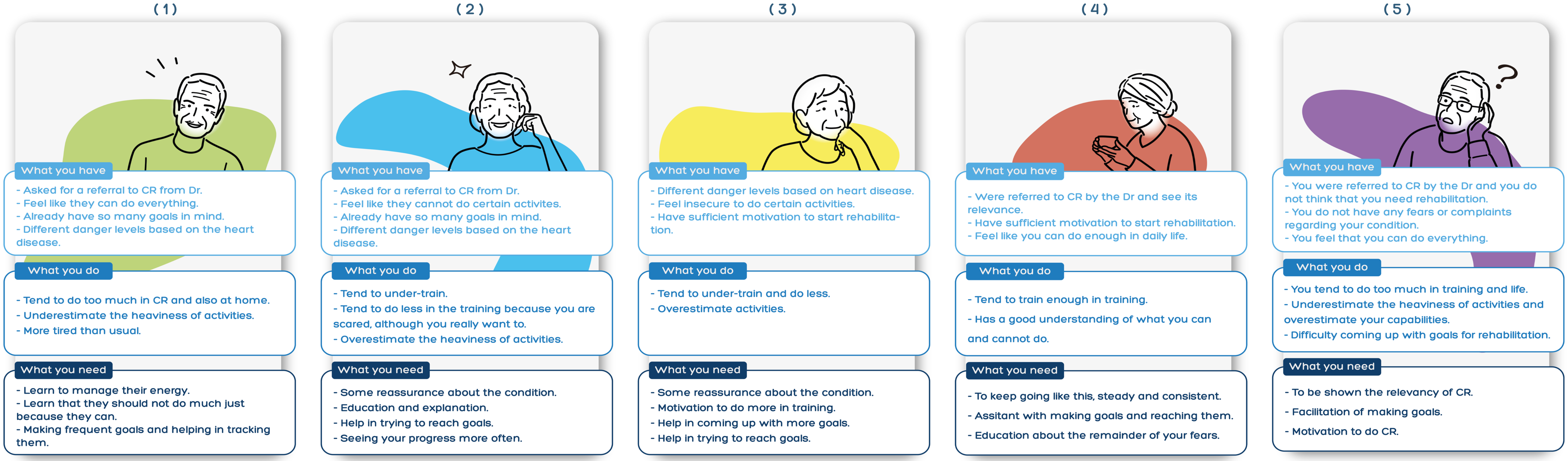


Figure 4.10: Patient profiles on the matrix



(1)

What you have

- Asked for a referral to CR from Dr.
- Feel like they can do everything.
- Already have so many goals in mind.
- Different danger levels based on the heart disease.

What you do

- Tend to do too much in CR and also at home.
- Underestimate the heaviness of activities.
- More tired than usual.

What you need

- Learn to manage their energy.
- Learn that they should not do much just because they can.
- Making frequent goals and helping in tracking them.

(2)

What you have

- Asked for a referral to CR from Dr.
- Feel like they cannot do certain activites.
- Already have so many goals in mind.
- Different danger levels based on the heart disease.

What you do

- Tend to under-train.
- Tend to do less in the training because you are scared, although you really want to.
- Overestimate the heaviness of activities.

What you need

- Some reassurance about the condition.
- Education and explanation.
- Help in trying to reach goals.
- Seeing your progress more often.

(3)

What you have

- Different danger levels based on heart disease.
- Feel insecure to do certain activities.
- Have sufficient motivation to start rehabilitation.

What you do

- Tend to under-train and do less.
- Overestimate activities.

What you need

- Some reassurance about the condition.
- Motivation to do more in training.
- Help in coming up with more goals.
- Help in trying to reach goals.

(4)

What you have

- Were referred to CR by the Dr and see its relevance.
- Have sufficient motivation to start rehabilitation.
- Feel like you can do enough in daily life.

What you do

- Tend to train enough in training.
- Has a good understanding of what you can and cannot do.

What you need

- To keep going like this, steady and consistent.
- Assitant with making goals and reaching them.
- Education about the remainder of your fears.

(5)

What you have

- You were referred to CR by the Dr and you do not think that you need rehabilitation.
- You do not have any fears or complaints regarding your condition.
- You feel that you can do everything.

What you do

- You tend to do too much in training and life.
- Underestimate the heaviness of activities and overestimate your capabilities.
- Difficulty coming up with goals for rehabilitation.

What you need

- To be shown the relevancy of CR.
- Facilitation of making goals.
- Motivation to do CR.

Figure 4.11: Patient profiles

Chapter 5

DEFINE

This chapter aims to bring all the research conducted thus far together in order to answer the research questions initially formulated for the project. Therefore, it starts with a quick recap of the stated problem and the research questions, after which it provides answers to all the questions, while the pertinent insights from the previous chapters are also presented in summary to get the overview. Finally, the chapter finishes by stating the vision and design goal set for the project.

5.0 Introduction

This project started with the initial problem framed as how to support the transition of blended care while increasing the personalisation level by exploring the role of data in order to help patients with having a smoother transition to the home care, allowing more patient to enter the CR care path while having good health outcomes. In this regard it was envisioned to utilise intelligent solutions to realise the personalisation of the design for the patients.

According to this problem framing, the research questions were formulated which are as follows:

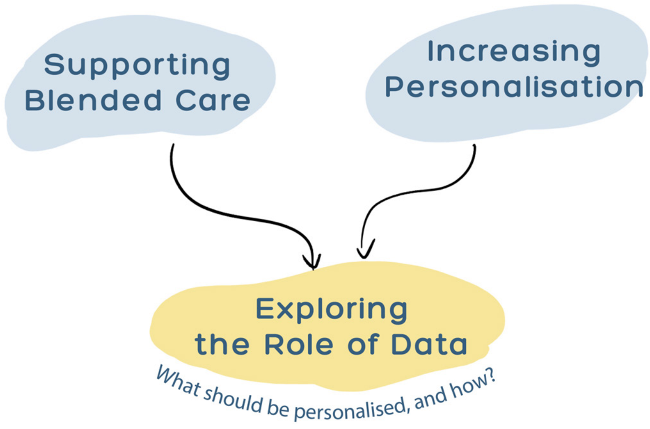


Figure 5.1: Initial Problem Statement

Supporting the Care:
(1) Which parts of the CR care in the CR workflow should the intelligent solution support?
(2) Since CR is delivered in a multi-disciplinary team, which health professional stakeholder(s) should be involved in the solution?
(3) What data from the patient should be communicated to the health professional to support blending the identified care part?

Personalisation:
(4) What is the desired and relevant personalisation level in CR care?
(5) What should the intelligent solution learn from the patient to adapt?
(6) What should be adapted based on the identified nuances?

5.1 Answering RQs

(1) Which parts of the CR care in the CR workflow should the intelligent solution support?

In order to answer this question, I discovered three things about the care, being the vision of Basalt for blended care, the current workflow in the center, and the CR ecosystem.

Firstly, I unraveled the vision of Basalt for blended care with the lead cardiologist (figure 5.2), in which patients will have to come to the center less frequently as they go through the program, with regularly scheduled sessions with the physiotherapist to have check-in moments with the aim of making the transition to home care smoother.

Secondly, I mapped the current CR workflow and care (chapter 3, figure 3.16) to understand which part should be supported mainly by the intelligent solution to help the transition to blended care.

Thirdly, I uncovered the CR ecosystem at the center and home in order to facilitate the integration of the future solution to ensure its uptake by the system.

All in all, the future solution is envisioned to support blended care at the center and at home, which according to the scope of the project, is about the exercises given to patients to do at home while involving the physiotherapist, which is the minimum support that the solution can offer. (Figure 5.5 shows the overview of the focus of the project on the workflow with the chosen data in CR to focus on)

Aside from supporting the envisioned workflow for blended care, the future solution should also support the differences of the patients in CR and adapt itself to them to increase personalization. In this regard, I argued that the intelligent solution should detect the data points relevant to the profile of the patients (figure 5.3) by utilizing its Understand loops to capture “what they have, & do ” to personalize itself using the Adapt loops (figure 5.4).

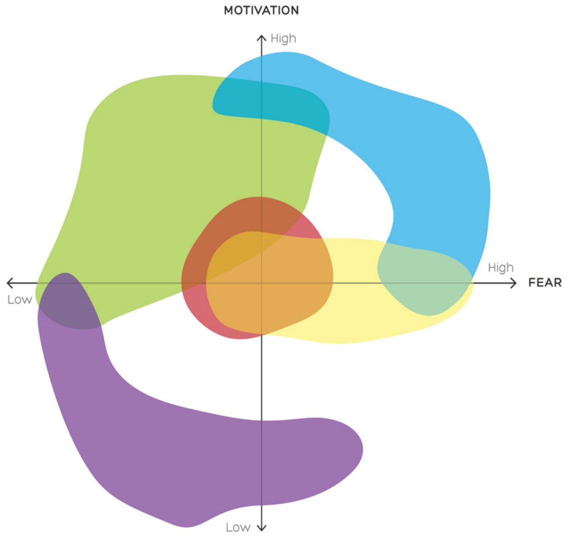


Figure 5.3: Patient profiles on the matrix

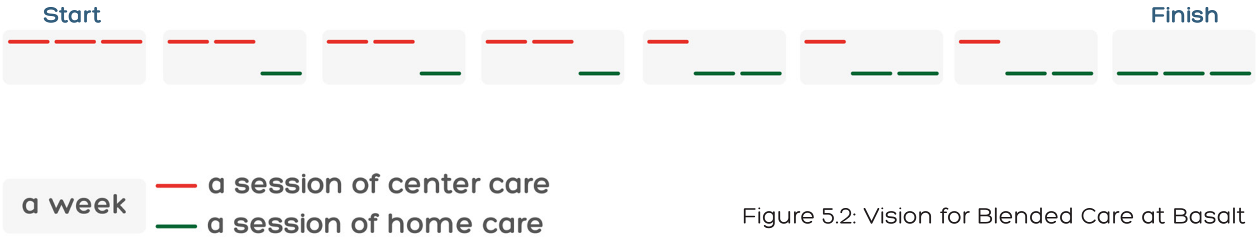
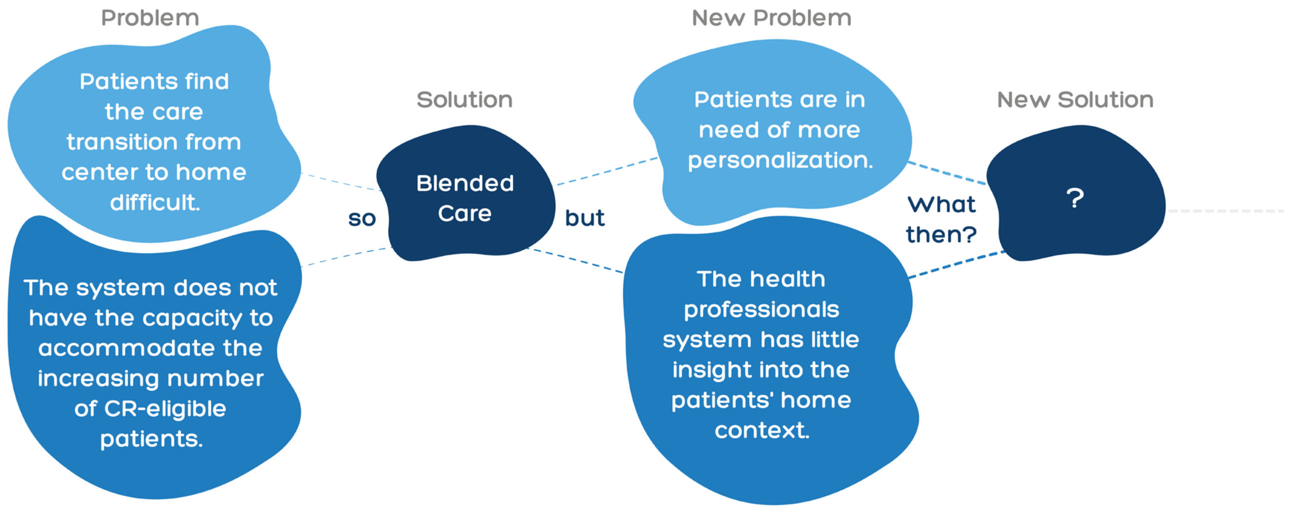


Figure 5.2: Vision for Blended Care at Basalt



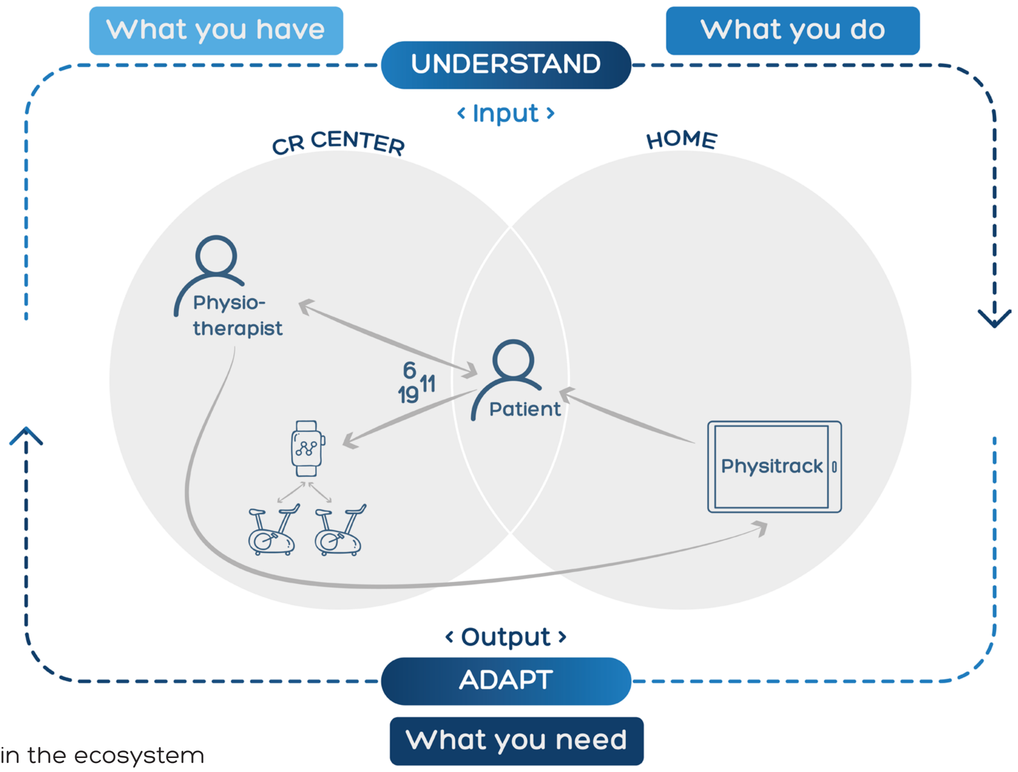


Figure 5.4 : Intelligent solution integrated in the ecosystem

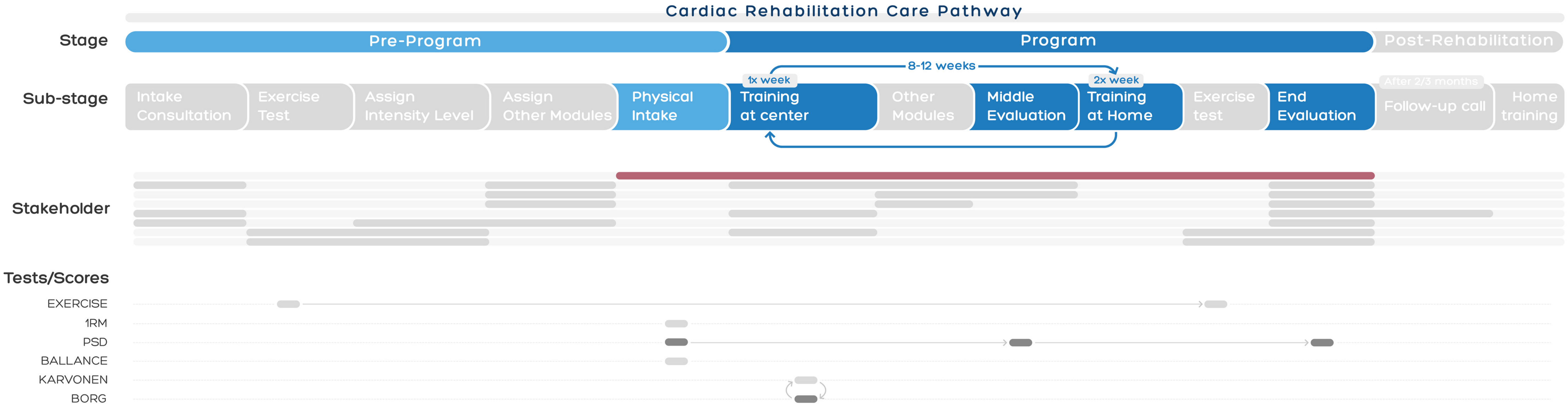


Figure 5.5 : Scoping down on the CR workflow and data (highlights)

(2) Since CR is delivered in a multi-disciplinary team, which health professional stakeholder(s) should be involved in the solution?

Defining the scope on the CR workflow helped with identifying the relevant stakeholders involved in the selected care part. As the solution is envisioned to support the exercises at home as part of the care delivered there, the physiotherapist who is in charge of this care part should be involved in the solution to support the transition to blended care. Therefore, as seen in figure 5.5, the physiotherapist's role has been highlighted as the one involved in the design.

(3) What data from the patient should be communicated to the health professional to support blending the identified care part?

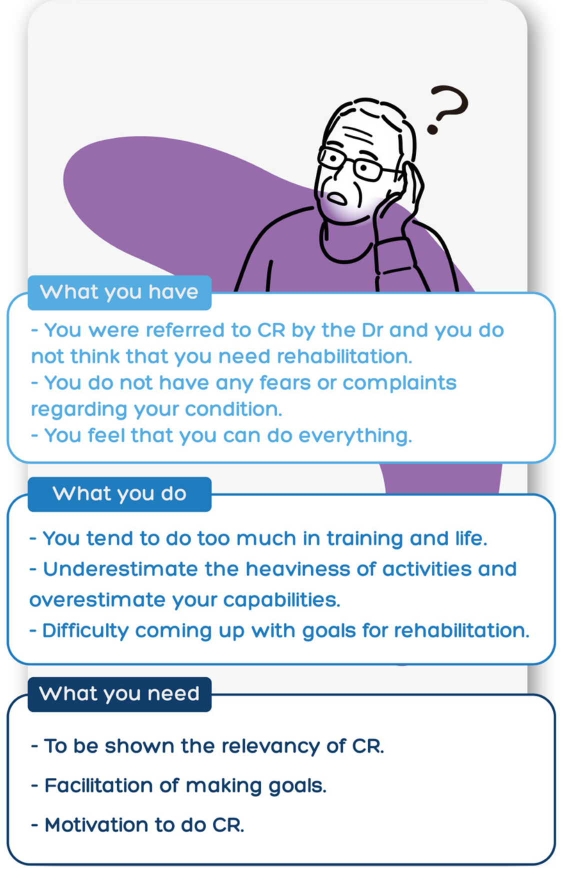
Presently, the physiotherapists have no clue what happens at home and if patients follow the care plan and advice they have received. This indicates that no insights into the relevant home contextual factors are available. Therefore, it is desired that the physiotherapists would be informed of the irregularity and diagnosis of the performance data (home and center) shown in the Borg scores of the patients' performance during the planned sessions to support blending the care as well as personalization.

(4) What is the desired and relevant personalisation level in CR care?

By exploring the CR subjective data with the stakeholders, I sought to determine the appropriate level of personalization, which produced various patient profiles. The profiles classify the patients based on their motivation level to start CR at the beginning and their insecurity level during the care path, as these two factors were the major differences that came out of the user research.

(5) What should the intelligent solution learn from the patient to adapt?

The patient profiles consist of three categories of data points: 'What you have', 'What you do', and 'What you need' (example in figure 5.6). This indicates that the intelligent solution should learn from the patients by understanding the first two datapoint categories.



What you have

- You were referred to CR by the Dr and you do not think that you need rehabilitation.
- You do not have any fears or complaints regarding your condition.
- You feel that you can do everything.

What you do

- You tend to do too much in training and life.
- Underestimate the heaviness of activities and overestimate your capabilities.
- Difficulty coming up with goals for rehabilitation.

What you need

- To be shown the relevancy of CR.
- Facilitation of making goals.
- Motivation to do CR.

Figure 5.6 : Example of a detailed patient profile

(6) What should be adapted based on the identified nuances?

This question is not completely answered as the efforts thus far were towards understanding the personalization level. Therefore, this question will be answered in the rest of the project, where adaptation will be explored in ideation.

5.2 Designer Vision

Based on the aforementioned evidence which aimed to inform the initially formulated problem, I set my own designerly vision for the rest of the project:

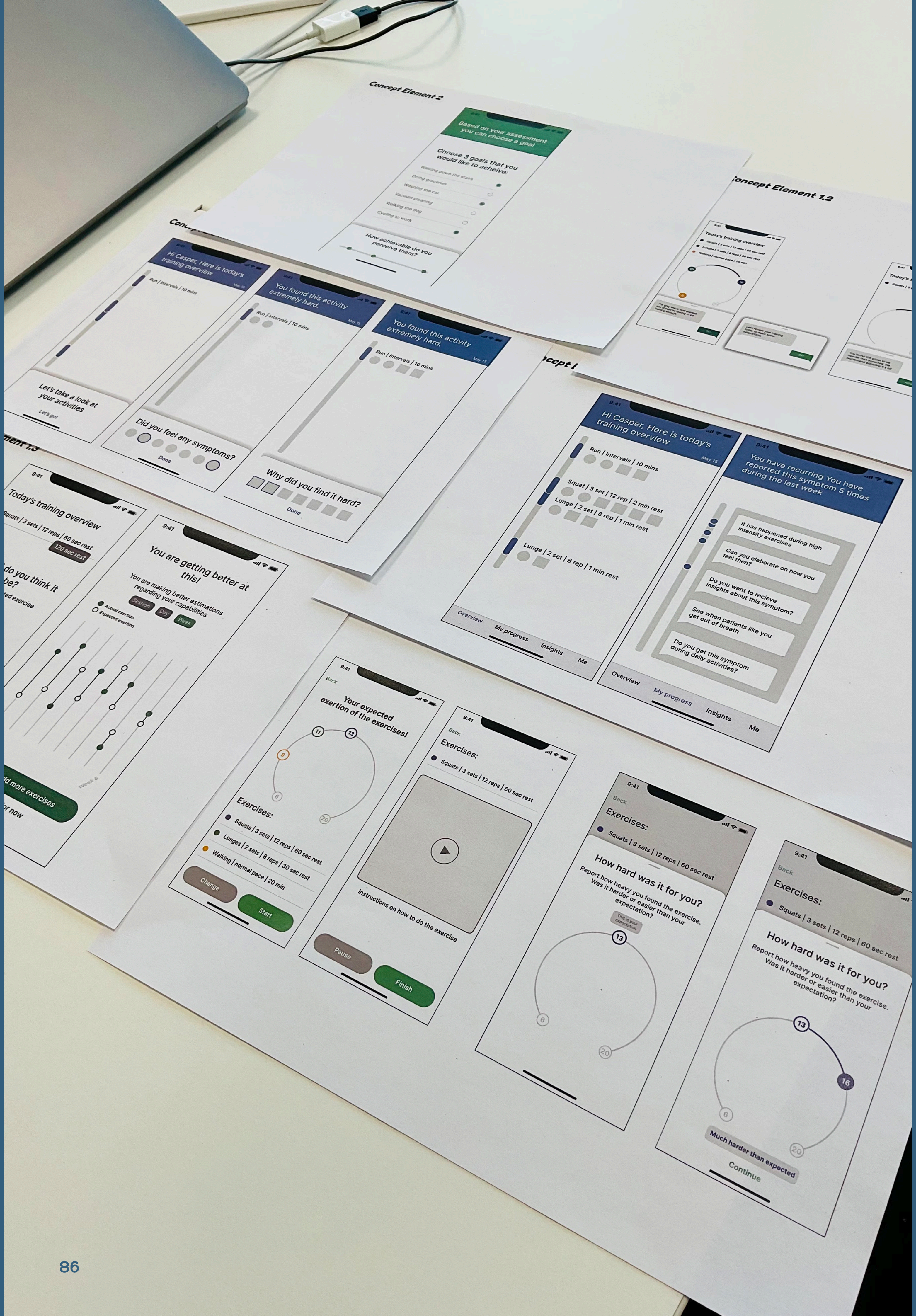
The intelligent solution should support the patients in blending the CR care at home and center in a personalized manner so that they can learn about their bodies by becoming more active and responsible in their care, enabling them to have a smoother transition to home care once the CR is complete.

5.3 Design Goal

Herewith is my design goal envisioned for the stakeholders:

The goal for the patients is to perceive the CR care as homogenous at the center and at home while it is personalized and relevant for them to engage in their care while learn about their bodies, while part of this personalisation and the homogeneity of the care is enabling the physiotherapists to have some insights into the care delivered at home.

The health system will then be able to accommodate more CR-eligible patients while maintaining thehealth outcomes & personalized nature of care along the CR care pathway by providing some of the care at home.



Chapter 6

IDEATION

This chapter aims to present firstly the general approach towards the ideation in this project, and secondly the concept aggregated from the previous iterations is presented.

6.0 Introduction

Due to the chosen methodology, being research through design, I started ideating very early in this project from the first iteration. Therefore, the ideation process did not occur linearly after the define stage, but through different iterations of exploring possibilities and receiving feedback, which helped with making certain design choices and rejecting some design and concept directions because of not providing value in terms of desirability, feasibility, or viability. Appendices F-J include details of ideas in iterations.

Before setting the design goal, the first three iterations produced many concepts. Then, after breaking each concept down into few elements that captured their core, I set out to get feedback on them. This helped with putting together the effective and appropriate elements shaping the final concept.

As a result of the accumulation of all the concepts and tests conducted up until this point, I decided to use everything that worked well, was preferred by the stakeholders, and also matched the design goal and problem earlier identified, to begin shaping the final concept.

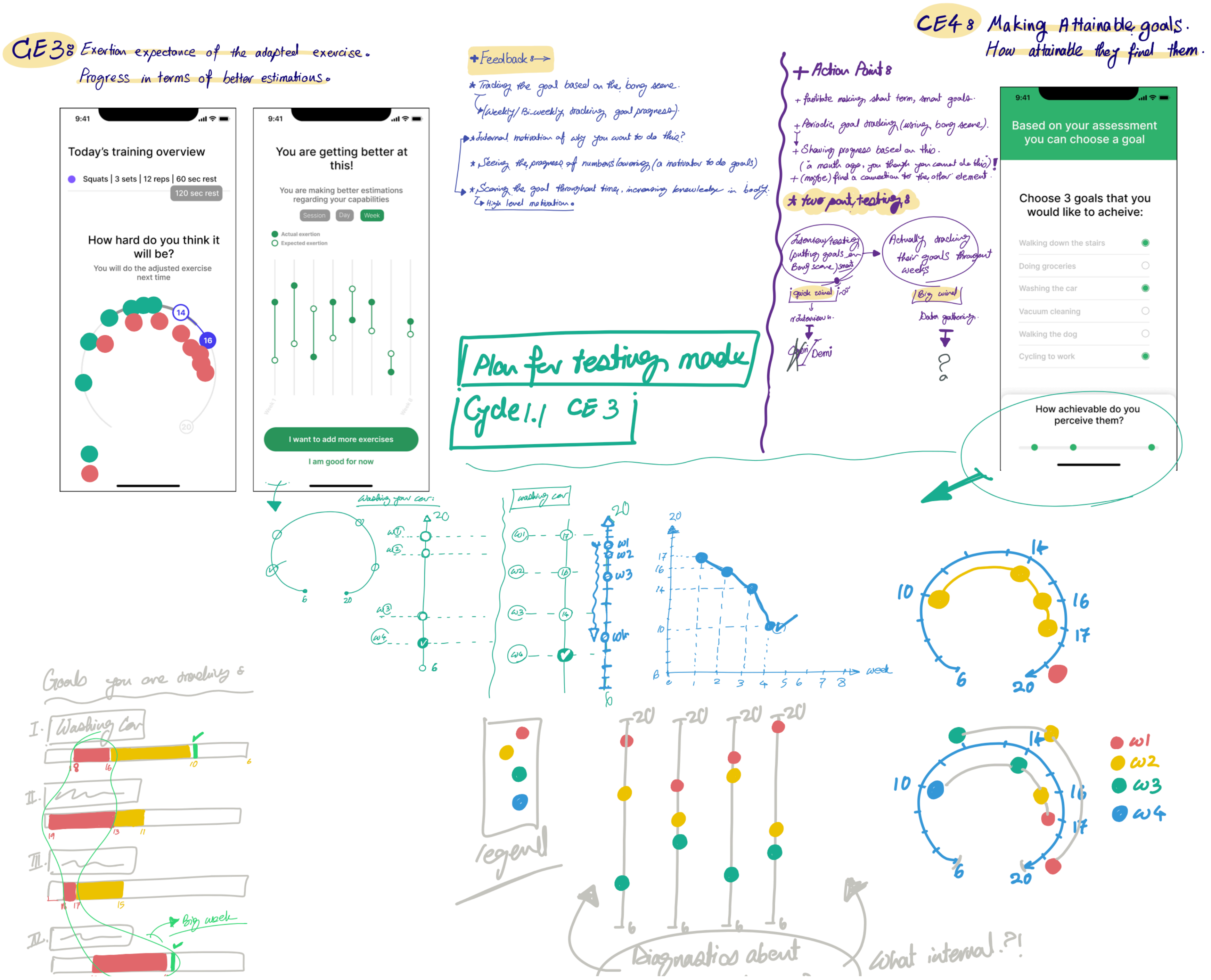


Figure 6.1: Impression of the ideation (iteration 5)

6.1 Concept

The concept chosen to continue with is an intelligent solution comprised of an app for the patient to use at home and a dashboard for physiotherapists supporting the home care part of CR. The concept has three main modules to realize the design goal formulated earlier for the project, in which integrated feedback loops allow the understating and adapting capabilities of the solution needed for personalization.

It is envisioned that patients start using the concept when starting in the care path to make goals and engage with their exertion data and reflect on it to better understand their body and take subsequent actions. The further patients go into the program, the more responsibility they will have to do the things that otherwise the health professionals would do for them at the center.

This concept supports blended care in a way that enables the patients to log their exertion data at home so that the physiotherapist is aware of their performance and allows integration of the data coming from the center and home to do deeper reflections.

The following sections provide the essence of the concept, the concept modules, the integrated intelligence, and finally, a user storyboard providing an overview of the concept as a service.

6.1.1 Concept Essence

Supporting blended care by enabling the patients to do the same procedure as the center at home (doing exercises and reporting exertion) while informing the physiotherapist about the performance so that the patients feel that the home care part is still part of their rehabilitation.

Activating patients and giving them more responsibility by allowing them to reflect on their experience of rehabilitation training and the actions needed to make their condition better.

Personalising the concept by understanding their profile using the Understand loops of the modules to adapt according to their needs.

Facilitating making personalized goals fitting their profile.

6.1.2 Concept Modules

The concept has three main modules realizing the envisioned effect on the stakeholders, each presenting a certain functionality of the concept, where each of which has its own Understand and Adapt loop to learn from the patient.

(1) Goal setting:

This module takes place in the pre-program phase of CR where patients make goals for their rehabilitation, and evaluate them during the care path as well as in the sessions with the physiotherapist. This module tends to position the patient on the vertical axis of the patient profile at the start of CR by understanding the CR referral method which presumably conveys much about the patients' goals and motivation.

(2) After rehabilitation check-in:

This module is intended to be used after the CR training sessions either in the center or home rehabilitation. This module understands the logged-in Borg scores at home and center and tries to either give meaning to it or facilitate the patient to make sense of it. The input for this module is whether the accumulation of the scores states that the patient is undertraining, enough training, or over-training to position them on the horizontal axis of the patient profile, which is assumed to occur during the rehabilitation care path as the result of the reflection on the Borg scores.

(3) Everyday life:

This module is meant to help patients transition to home care and build trust in their bodies by seeing their progress or the personalized content and insights. This module is meant to use the output of the first two modules (their position on the motivation and the insecurity level) to make personalized content.

Figure 6.3 shows the modules with their feedback loops in the service alongside the CR care path.

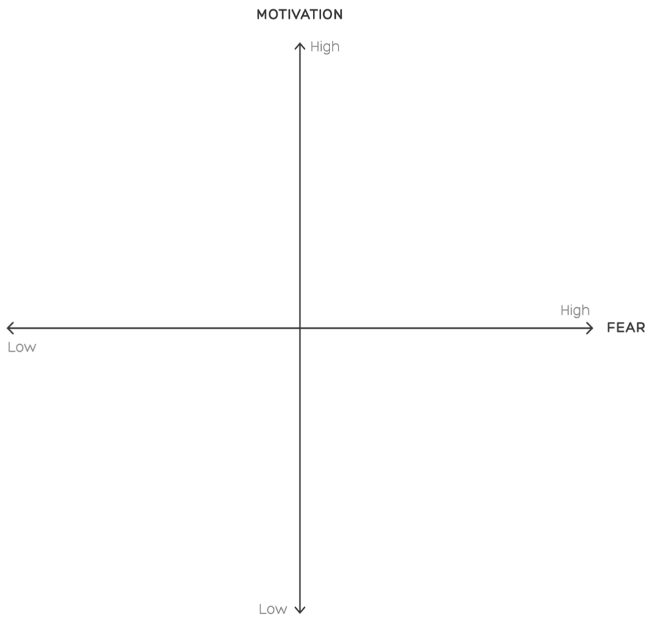


Figure 6.2: Patient profiles on the matrix

6.1.3 Concept Intelligence

One of the effects of this concept, being care personalization for the patients, is envisioned to be shaped and modified according to the patient profiles, which is achieved by the Understand loop in each module.

The idea is that patients starting in the service do not have a certain profile at first, but it gets shaped based on their ranks in the first two modules (their motivation levels and goals, and their insecurity level), which will shape the profile throughout the program. The former positions patients on the vertical and the latter on the horizontal axis of the profile matrix (figure 6.4).

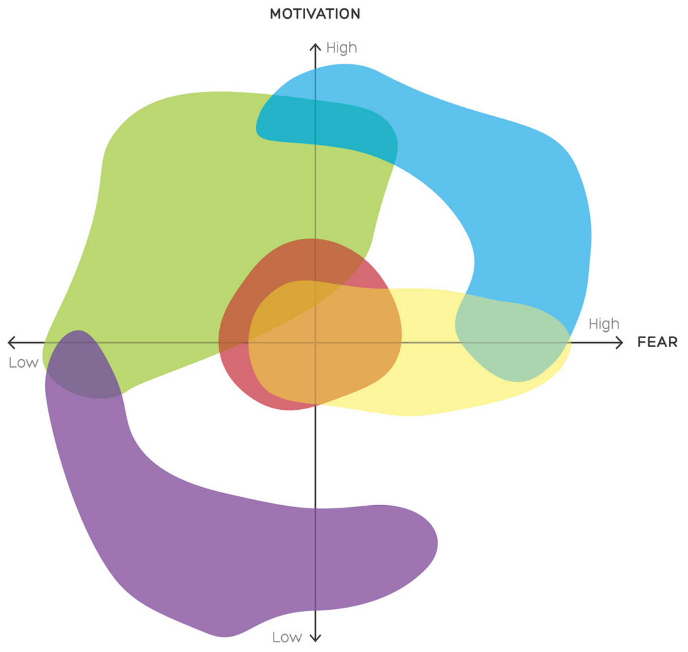


Figure 6.4: Patient profiles on the matrix

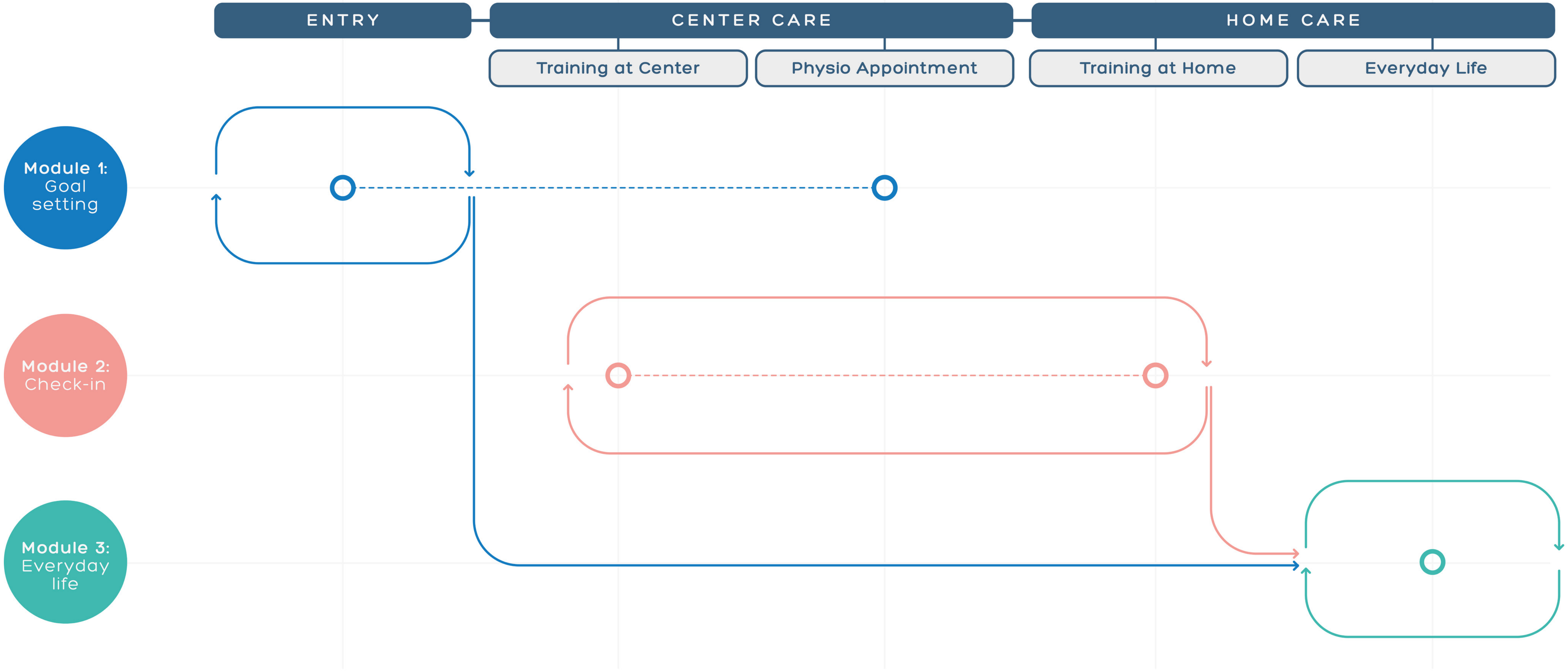


Figure 6.3: Concept Modules in the service

6.1.4 User Storyboard

Figure 6.6 (on the next page) shows one scenario using the concept in which the patients start CR by undergoing the pre-program stage (intake, etc.).

Before going to the center, they already use the app to make some goals, then they will discuss this during the physical intake with the physiotherapist

After this stage, they are ready to start CR training rehabilitation. Therefore, they go through the cycle of doing an exercise, giving a Borg score to it, and logging it in on the bracelet.

When they come home, they receive a notification from the app that they can see their recent performance, and it would be helpful to do a 5-minute check-in in which they are asked about their experience as well as the reason for the reported number to diagnose their data.

The next training session is scheduled to be at home; therefore they open the Physitrack app to exercise, after which they report Borg scores on their app and are asked to do a check-in again to see how they did today.

Based on the data coming from the diagnosis of the check-in module some actions are proposed or facilitated for the patients in the Everyday Life module to help them diagnose their performance and take relevant actions based on their goals.

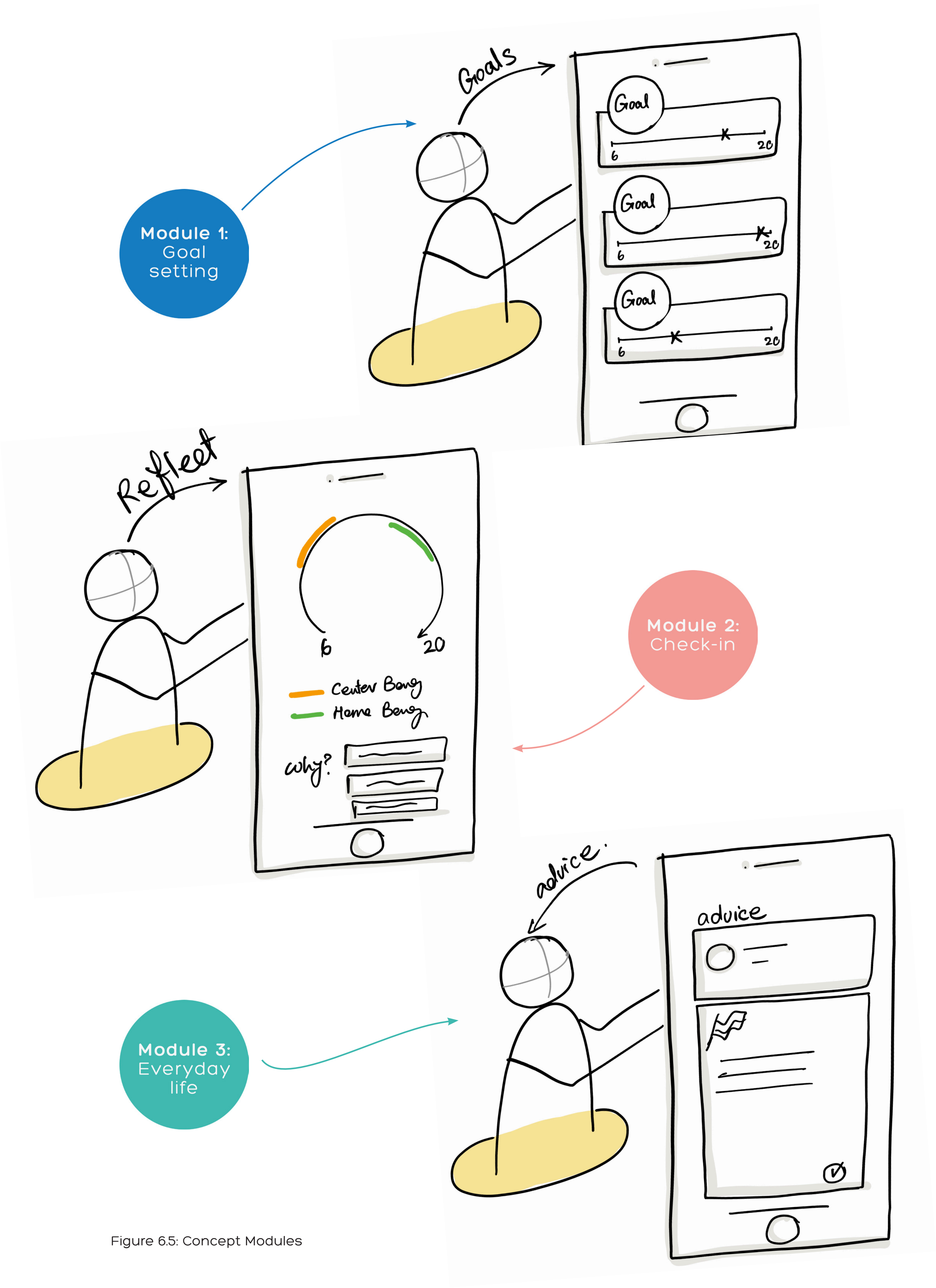


Figure 6.5: Concept Modules

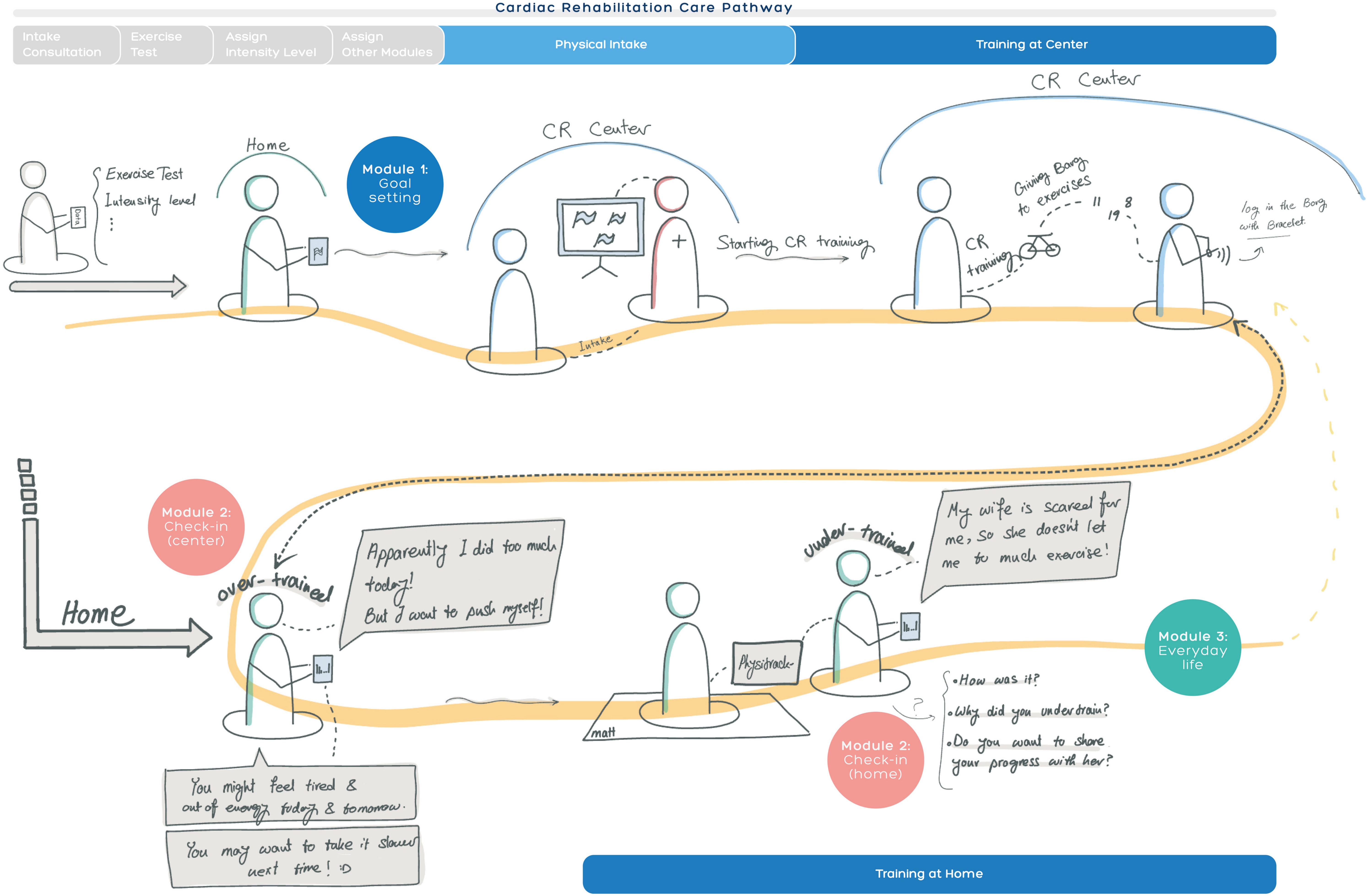
6.2 Takeaways

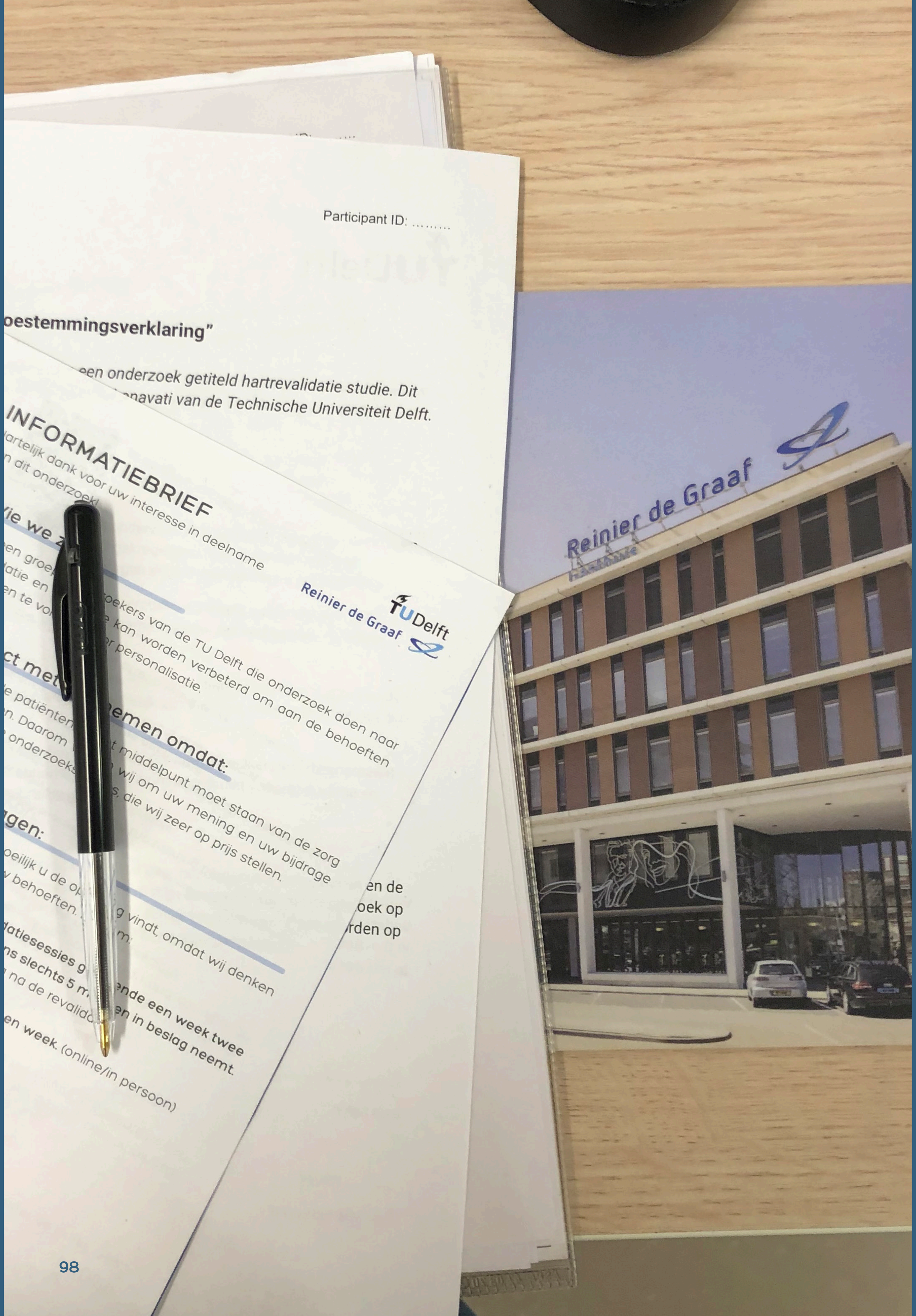
This chapter presented the approach taken towards ideation which resulted in a somewhat final concept which was the assemblage of different concept parts of earlier ideas that had received positive feedback and had the potential to create value by addressing the design goal.

The concept was elaborated in terms of its envisioned effect, the modules realizing those effects, a user storyboard, and finally, it was argued that the intelligence of the solution would be realized by the feedback loops integrated into the modules to provide care personalization according to the patient profiles.

The concept at this stage was deliberately not made very concrete, but it showed a general idea of the effect it is envisioning. This was due to an extensive development and evaluation iteration planned with the users following RtD principles to make the final decisions regarding the design choices in collaboration with patients over a course of two weeks.

Figure 6.6: Concept use scenario





Chapter 7

DEVELOPMENT & EVALUATION

This chapter aims to illustrate the testing and development of the concept introduced in the previous chapter which occurred over the course of two weeks. To make the information sensible as it was a tense and insight-dense iteration, I decided to present the chapter chronologically as the activities occurred. Therefore, firstly the aim and method of the testing in the first week is presented followed by the insights and the consequent design changes. Then the chapter continues with presenting information regarding the second week of testing and the final conclusion.

7.0 Introduction

Research through design necessitates involving the stakeholders in the development of the concept to validate or reject assumptions regarding the design that might otherwise not be discovered before the complete development and implementation of the concept. This is in contrast with designing a concrete concept and doing an evaluation at the end of the design process.

This method of working is also one of the core elements of the data-enabled design methodology in which users interact with the product remotely, enabling the researchers to learn about the users from a distance to have a desirable solution at the end.

Therefore, the focus of this iteration is the desirability of the users and I brought the concept introduced in the previous chapter to the users and started studying and developing it during a two week-period assigned to this activity while doing iterative testing with the patients at the hospital (figure 7.1). A total number of 10 patients participated in the study which were recruited after their Exercises Test at the Reiner de Graaf hospital, meaning that they had not yet started their CR at Basalt.

The first week started with testing the concept introduced in the previous chapter. It focused on the testing Understand loops of the concept and exploring what could be adapted as the result of the personalisation. After making conclusions in this regard and implementing the necessary design changes, the second week started with testing the Adapt loops and the effect of the design changes.

7.1 Participants

Ten patients, ranging in age from 55 to 75, took part in the study over the course of two weeks, two of whom were male and eight were female. They had not yet started rehabilitation at the point of recruitment, but already had their intake session at Basalt and were at the hospital to do the Exercise Test to start rehabilitation shortly.

The recruitment moment of the patients brought challenges to testing the modules earlier introduced. Although it was beneficial to test the first module, it was a disadvantage for the second one.

It brought value to testing the first module, which is about making goals because patients were exactly at the point in the care path in which they had to make goals for CR. On the other hand, it brought a disadvantage to testing the other module, which is focused on the Borg scores of patients and what meaning it could bring. The reason is that at that point patients had not yet been familiarised with the Borg score.

I had to explain the score to them Of course, but that could never be as good as the health professionals explaining it and patients trying and reporting it a few times at the center themselves.

Figure 7.1: My workspace at the hospital for the two weeks of testing

7.2 Week one

The first week's iteration started with testing the overview of modules presented in figure 6.3 (previous chapter), which was focused on the Understand loops of the solution to see whether the data points can be captured to personalize the concept based on the patient profiles. Accordingly, this iteration was also aimed to validate the patient profiles.

The exploration aimed to answer the following questions:

> **1:** Are the devised patient profiles with the associated 'what you have, do, and need' data points valid with real patients? If yes, how much is their level of perceived personalization?
>
> **2:** Is any adjustment needed for the data points (for the understand loop) acquired from the patient in the entry phase for personalization?
>
> **3:** What could be adapted (as output) to what is understood (as input) to personalize the concept?
>
> **4:** What is the general opinion about the blended care concept?

7.2.1 Module 1: Goal Setting

This module is about making goals at the start and tracking them during CR. The initial level of understanding regarding this module is about how much motivation the patients have towards rehabilitation.

The assumption was that the referral method to CR as a captured data point from the patients already reveals much about this trait, positioning them on the vertical axis of the profile.

Aim

Therefore, in this test, I aimed to understand whether that datapoint even reveals anything about the profile of the patients (to adjust my assumption). And if yes, what sort of adaptation would be suitable for different patient profiles to make goals (figure 7.2).

Method

Accordingly, at the start of the session, I simply asked them a multiple-choice question to understand their referral method and gave them a tool (from the concept, figure 7.3) to make goals with, after which I observed and inquired about whether this was personalized for their needs.

In this activity, the goal-setting tool was generic for all the patients, and there were no adaptations in place in this regard.

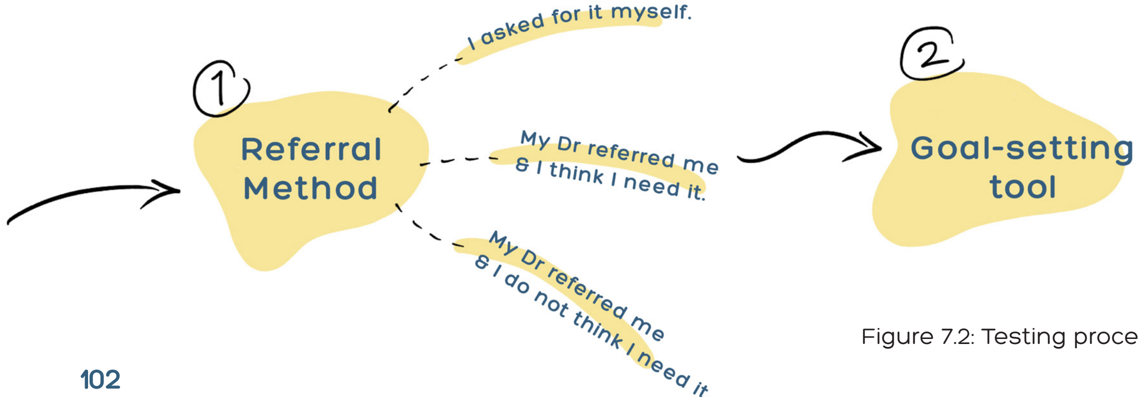
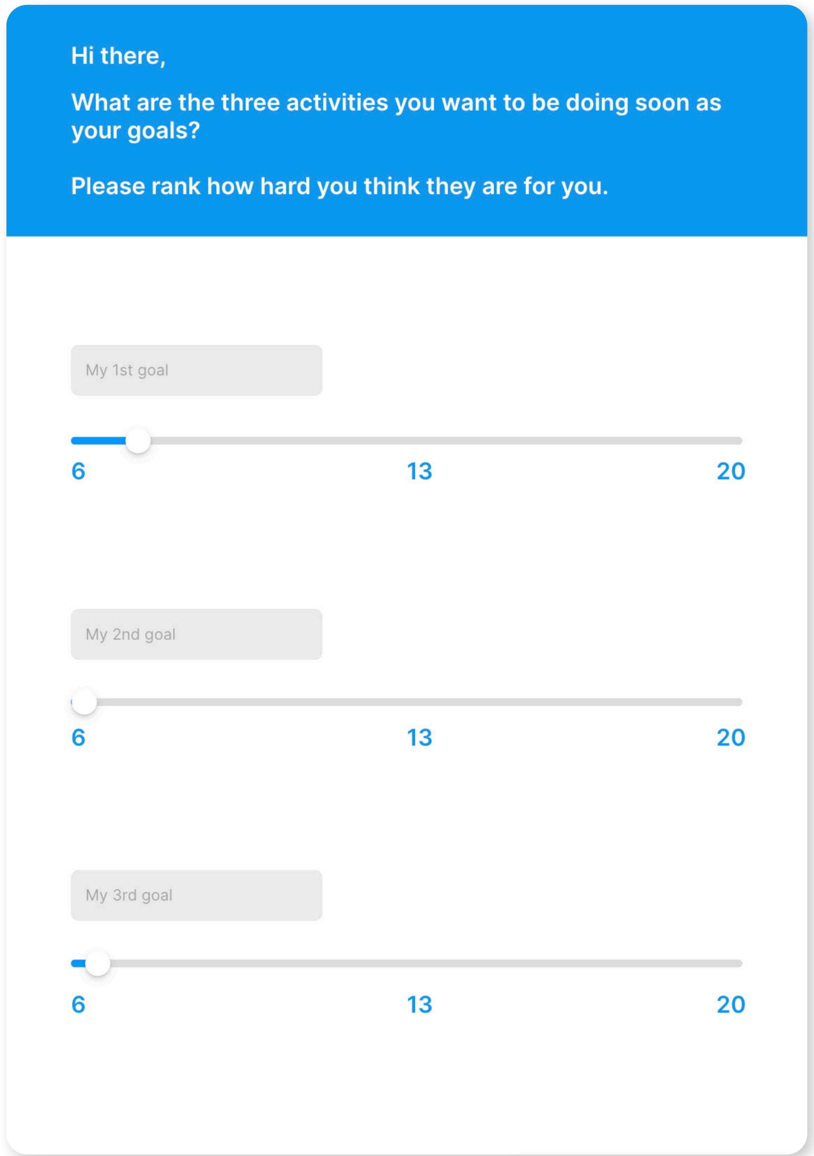


Figure 7.2: Testing procedure of module 1

Patients were asked to make goals for their rehabilitation using a tool shown in figure 7.3. The tool allowed the patients to set three activities that they want to be able to do after rehabilitation as their goals which are as SMART(specific, measurable, actionable, realistic, and timely) as possible. Then, they were asked to rank the goal using the Borg scale to rate how hard and heavy they think that activity is for them at that certain moment.

The design of this tool was inspired by the research insights in which patients were motivated and happy to see that their level of perceived exertion for an activity is decreasing with time. Thus, I designed this tool for them to make goals at the start, and keep track of them and see their progress during the course of CR.

The tool was used on the phone by the patients during the interviews in which they had to type the name of their goal activities, then use the slider for each goal to rate their expected perceived exertion.


Hi there,

What are the three activities you want to be doing soon as your goals?

Please rank how hard you think they are for you.

Figure 7.3: Goal-setting tool

Module 1:
Goal
setting

7.2.2 Module 2: Check-in

This module is about giving meaning to the Borg scores logged in by the patients at the center and home by allowing them to do a check-in after their rehabilitation to review their data. The initial level of understanding regarding this module is about how much patients tend and actually do exert themselves during rehabilitation. More specifically, the solution needs to understand whether patients are under, over, or enough-training according to their data.

The assumption was that the logged-in Borg scores as captured data points from the patient at the center and home could potentially to some extent reveal if patients are fearful, fearless, or just doing fine.

Aim

Therefore, in this test, I initially envisioned to understand if there is the assumed correlation between the logged-in numbers and the fear level of the patients, positioning them on the horizontal axis of the patient profiles. Due to the nature of this exploration and the objectives set for it, DED methods seemed sensible to use, which involve conducting the inquiry remotely.

Method

According to the concept, the transmission of the Borg data logged in at the center via the bracelet to the patient's app will be done automatically after their rehabilitation session. However, because there was no access to this data at that moment to do the test, I initially planned to ask this via a simple form submission (Appendix K) after the rehabilitation from the patients(figure 7.4).

Then I, as the AI, would do the processing and act as the classifier to understand the training zone of the patient and finally send back the adapted version of the rehabilitation check-in for the patient to interact with remotely (figure 7.5). The three adapted prototypes of the check-in module, which include asking relevant data points to make sense of the logged-in data, can be found in Appendix L.

The data collection tool set up in this test is the Data Foundry which is an infrastructure for prototyping and designing with data originally made in Eindhoven University of Technology. More details about connecting the digital tool for remote data collection can be found in Appendix M.

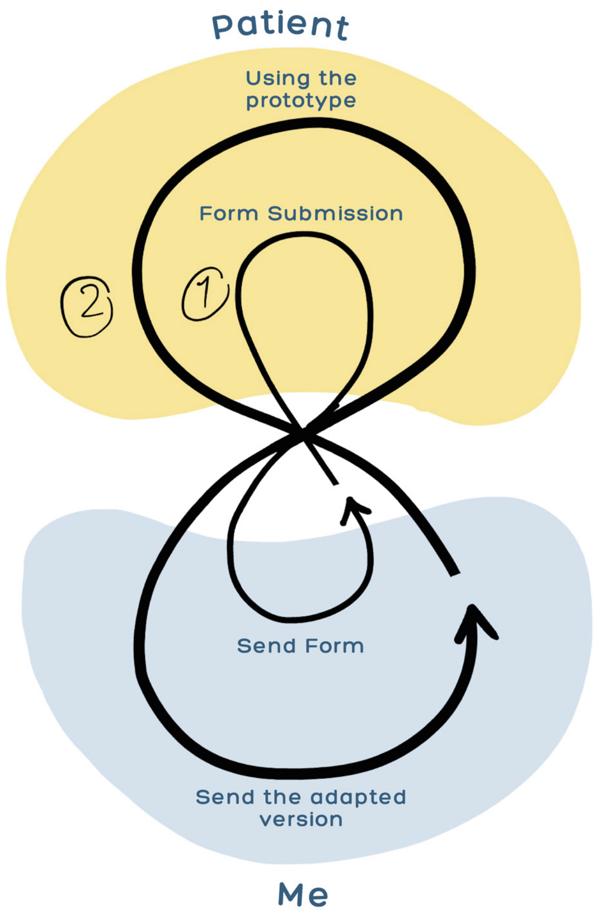
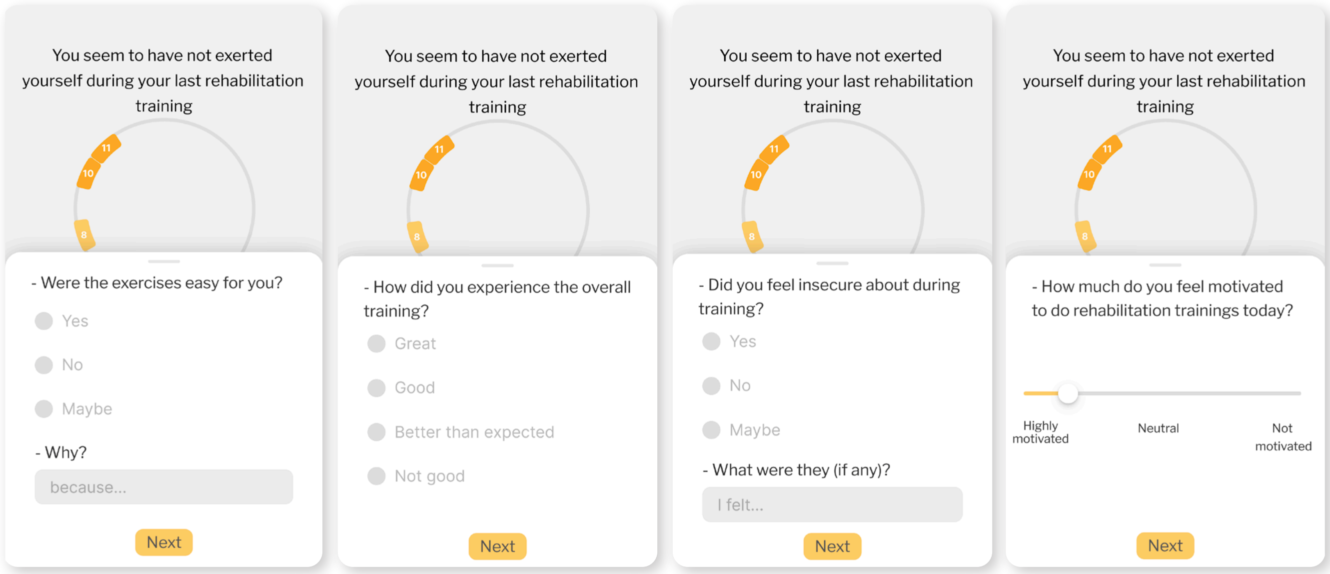


Figure 7.4: Initial testing procedure of module 2



You seem to have not exerted yourself during your last rehabilitation training

- Were the exercises easy for you?

○ Yes

○ No

○ Maybe

- Why?

because...

You seem to have not exerted yourself during your last rehabilitation training

- How did you experience the overall training?

○ Great

○ Good

○ Better than expected

○ Not good

You seem to have not exerted yourself during your last rehabilitation training

- Did you feel insecure about during training?

○ Yes

○ No

○ Maybe

- What were they (if any)?

I felt...

You seem to have not exerted yourself during your last rehabilitation training

- How much do you feel motivated to do rehabilitation trainings today?

Figure 7.5: Impression of the check-in module for under-training (more in Appendix L)

In the end, unfortunately, I was not able to conduct the test set-up with patients due to an unexpected issue that concerns the point of recruitment of the patients and the holiday season (July & August).

As mentioned earlier, the patients were recruited when they were still in the pre-program phase (doing the exercise test), meaning that they had not yet started rehabilitation. The assumption was that they would start CR almost immediately after the Exercise Test therefore,they could participate in the study.

However, due to the holiday season, almost all patients were doing the Exercise Test earlier than the start of their CR because they were going on holiday.

This prevented the test from being conducted as intended since patients would have begun CR at least two weeks after their scheduled interview with me, which would have taken longer than the project's allocated period. Therefore, in the first week, no element of this module was tested.

Module 2: Check-in

7.2.3 Discussion

In the first part of the study, I set out to explore the concept further and answer the formulated questions as the iteration goal. Therefore, the results of the study are presented here by answering the formulated questions to adjust the assumptions, followed by introducing the design changes to the concept.

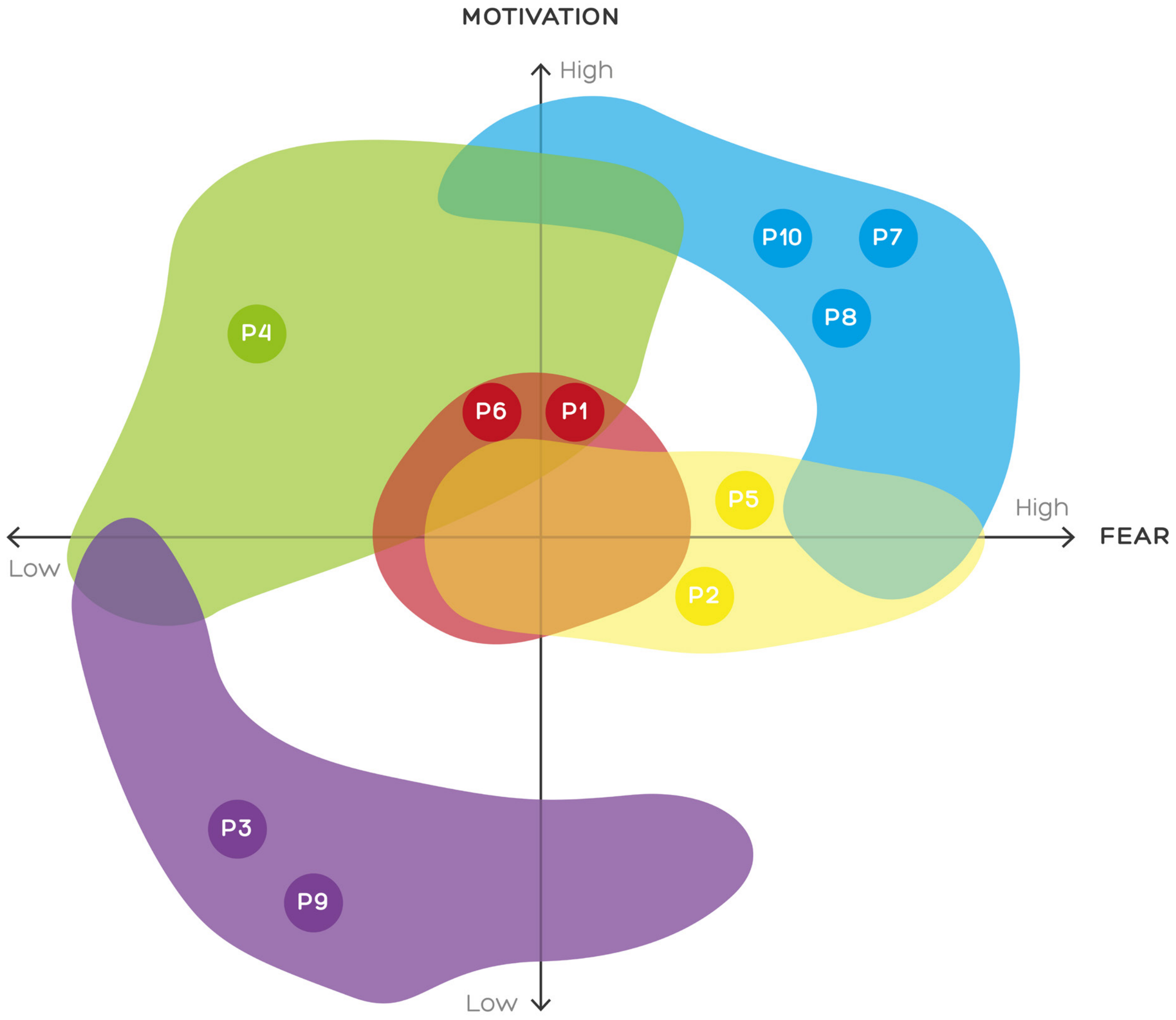


Figure 7.6: Profiles of patients participating in the study

1: Are the devised patient profiles with the associated what you have, do, and need data points valid with real patients? If yes, how much is their level of perceived personalization?

Fortunately, most of the assumptions regarding the patient profiles were accurate, and this level of personalization was indeed considered the most prominent distinction among patients. This was a positive outcome that allowed me to proceed with the concept because one of the main objectives of this study was to identify and understand the distinctions between the patients. Figure 7.6 shows the distribution of the ten patients participating in the study on the patient profiles. The judgment of assigning patients to profiles was done by me based on the interview results and the traits given to patients in each profile. However, this classification is envisioned to be done by the Understand loop of the intelligent solution capturing relevant data points.

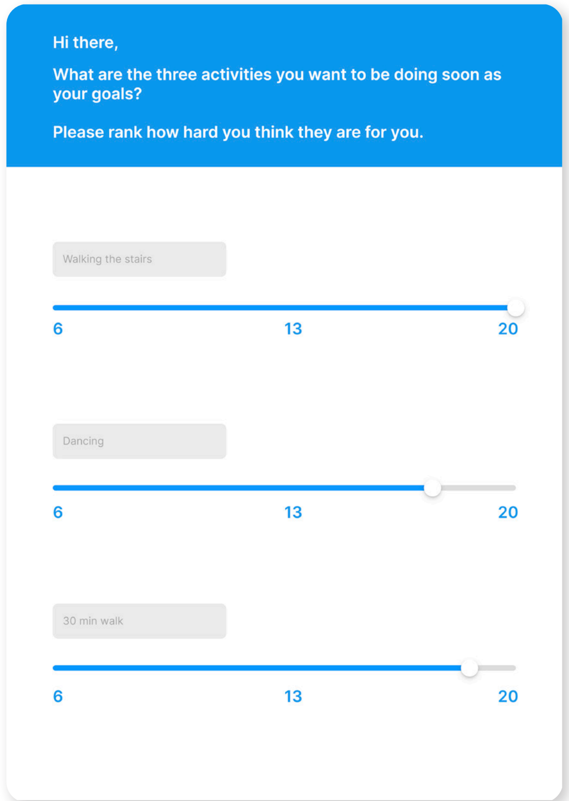
One interesting finding of this iteration regarding personalization is that the profiles are more separate and unique than previously assumed. This means that the patients from one profile had needs and interests in CR that the patients from other ones could not relate to.

This was evident when patients from different profiles started making goals with the tool. The design of the tool made more sense to the insecure patients having high levels of fear (regardless of their motivation). This was due to the patients' partial incapability, which prevented them from performing particular activities either because they found them difficult or out of fear. As a result, the tool, which involved setting goals for things patients wanted to be able to perform by undergoing CR, made sense to them since it met their needs.

On the other hand, patients from other profiles could not relate to this way of setting goals. For example, P4 already could do everything and did not have a certain activity that they were not able to do. Therefore, they did not see the relevancy of the tool. This means that the facilitation of goal-setting should be adapted for different profiles detected at the start of the care path.

This changes the concept in a sense that I had previously assumed that the profiles would take shape over the period of rehabilitation as the design learns from the patient. However, this test showed that the personalization level should be done at the start as strong as during CR.

The above-mentioned points made the personalization level perceived for patients quite low in the first week because my initial assumption with the concept was that all patients start at the same level and the changes can happen throughout time. However, it was revealed that the patient distinction at the start of the care path was already tangible.



Hi there,

What are the three activities you want to be doing soon as your goals?

Please rank how hard you think they are for you.

Walking the stairs

6 13 20

Dancing

6 13 20

30 min walk

6 13 20

Figure 7.7: Goals set

2: Is any adjustment needed for the data points (for the understand loop) acquired from the patient in the entry phase for personalization?

In the first module, the level of initial motivation was envisioned to be captured with the referral method reported by the patient. I came to understand that simply inquiring about the referral method already reveals a great deal about their motivation. For example, a fearless patient who was referred by the Dr did not think that he needed rehabilitation at all.

> **There is no activity that I cannot do, everything is alright. I do not have any limitations. Honestly, I do not think I even need rehabilitation.**
>
> P3

On the other hand, a patient whose interest in CR was to regain her daily energy and had asked for rehabilitation from his doctor and was super motivated to start rehabilitation.

> **After my vacation, I am starting rehabilitation, and I want to do as much as possible to have a better condition because although I am 63, I am a very busy woman and need to improve.**
>
> P4

Therefore, it was validated that the referral method highly correlates with helping to understand the motivation of the patient, which influences the goals they desire to make.

Other data points were envisioned to capture the insecurity level of the patients, such as whether patients got their condition as a shock. From the inquiries with the physiotherapist, it was noted that patients suffering from cardiac arrest (usually occurring suddenly) have a lot of insecurities because usually, their condition comes to them as a surprise leading to losing trust in their body. Based on this insight, I assumed that this datapoint could reveal the insecurity level of the patient (on the horizontal axis of the profile).

Consequently, I asked this question from the patients, however, I did not see any correlation between these two points. Therefore, the patient who got their condition as a surprise could eighter be fearful, fearless, or even neutral. As a result, I neglected this datapoint because it did not reveal anything (like the referral method did).

All in all, asking about the referral method and their complaints in the entry phase already put patients somewhere on the profile matrix with sufficient accuracy to implement the first adaptation to make goals.

Figure 7.8: Patients in the session

3: What could be adapted (as output) to what is understood (as input) to personalize the concept?

> In the study, patients appeared to be much more conscious of their needs and their goals had a greater impact than I initially thought which made it simpler to capture their differences.
>
> Moreover, patients seemed to have distinct CR interests (a general interest that drives them to do rehabilitation) while having different goals. Their CR interest has a lot to do with their complaints, and it is different than the SMART goals patients set at the start of rehabilitation. For example, one patient was interested to gain more energy in her day and wanted to accomplish this by CR, but their goal was to do her laundry in one go (instead of breaking it down into parts). Therefore, their CR interest changes the goals they want to make, meaning that first and foremost in the service, the goal-making module should be adapted based on the earlier introduced data points.
>
> In the proposed concept, the two modules were considered separate and had their own Understand and Adapt loop, which allowed the testing to run in parallel. However, from the learnings of the first week, it was revealed that the CR interest of patients changes the way they look at their Borg data. It seemed that they wanted to translate their data into their own CR interest to give it meaning, otherwise they did not find it relevant. As a result, the two modules cannot be considered separate anymore as the first one changes the second one in terms of content and the reflection on the data.

4: What is the general opinion about the blended care concept?

> The patients were unaware that they needed to exercise at home because they had not yet begun their rehabilitation at the time of recruitment. After my explanations about the concept, they readily accepted it and thought that this is how it should be. The reason for that could be that patients who have not started in CR are not aware how what the care path is like, and at this point they accepted it.

7.2.4 Design Changes

The insights presented in the previous sections inspired some design changes in the concept which are at this point somewhat abstract and on the system level, but will become more tan-gible in the second week.

Bringing personalization to the forefront:
As it was discovered that patients are reasonably distinct even at the very start of the care path, the adaptations should take place early on. Moreover, I realized that Understanding the patients at the start of the care path is easily detected because of their clear distinctions. Therefore, I designed an onboarding part in the concept which happens after patients are enrolled in the program and start with their app. It comprises a checklist of questions to reveal the aforementioned data points (which are comparable to the features of a dataset) to classify patients (their label profiles).

Adding more loops:
Based on the results of this test, the two modules cannot be seen as separate anymore. Therefore, it is needed to add more feedback loops so that the identified profile of the patient influences the adaptations of other modules (figure 7.9).

Adaptation of the goal-setting module:
I discovered that patients from different profiles had certain needs and wanted to make goals in a different manner.

For example, patients with low insecurity and high motivation level on the profile (green) have a complaint of being tired all the time because they are capable of doing everything and they actually do them. Therefore, because of their lack of energy, they divide the activities into many parts. Interestingly, the goal they wanted to make was to do activities in one go. On the other hand, patients with low motivation and low insecurity level (purple) wanted to make goals more related to exercises and wanted to break their records because they were fearless and unmotivated so the meaning and the role of the app was perceived different by them. However, regardless of the profile patients generally were happy to see that the Borg score for the activities was dropping as they felt progressing and getting stronger.

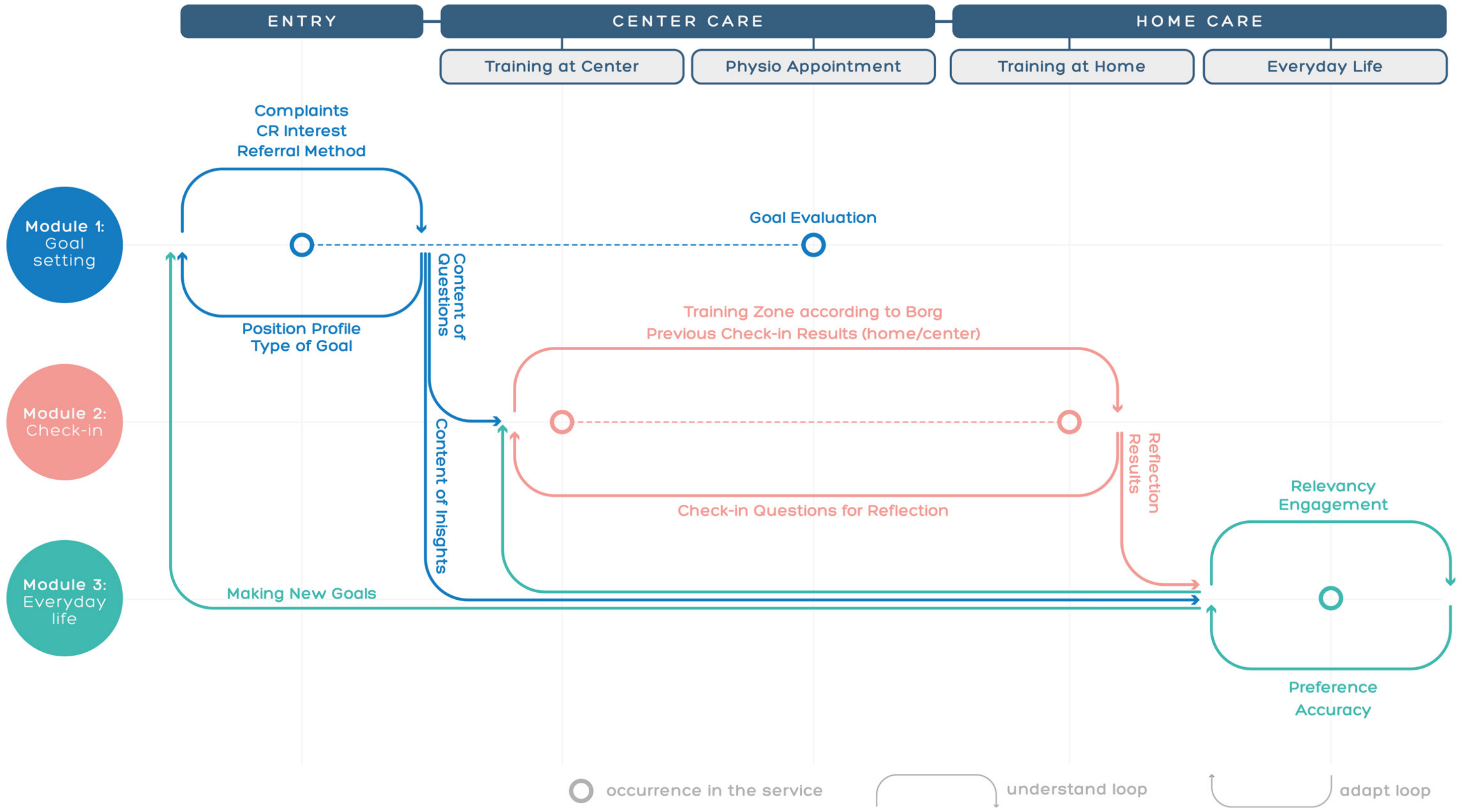


Figure 7.9 : Module feedback loops updated from figure 6.3

7.3 Week two

The second week of testing aimed to focus more on the adaptation part, while examining the effect of the design changes to check the perceived personalization level. The other focus of this iteration was on the understanding and visualization of the Borg data and perceiving the overall service instead of only parts of it. The second week was not as fruitful as the first week as two of the patients did not come to their appointments at the hospital, and there was one patient who did not speak English, so the test could not be done. Thus, there were fewer participants in the second week.

7.3.1 Method

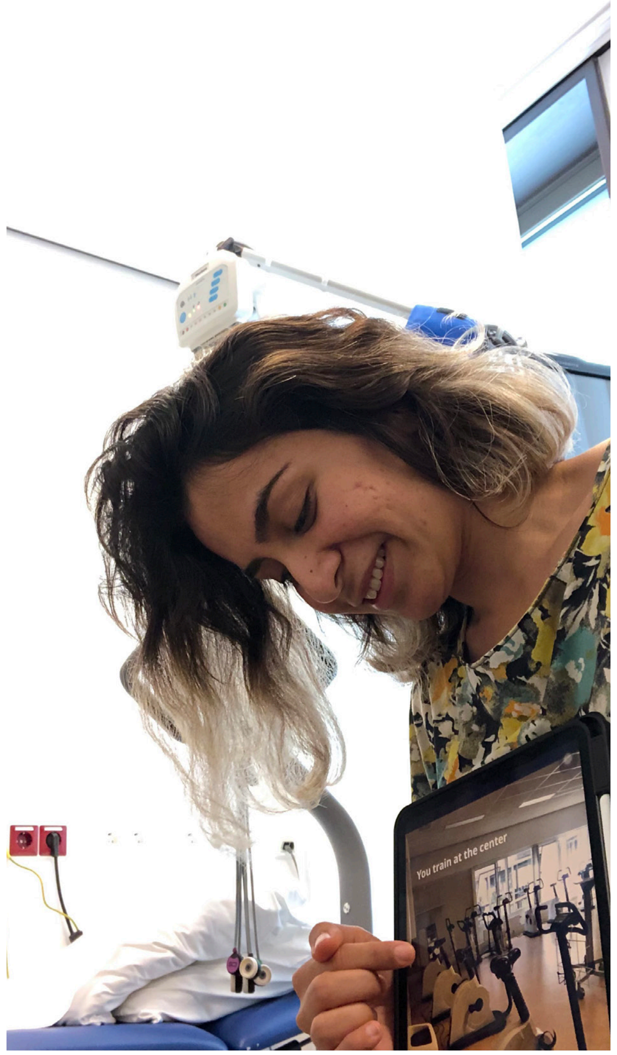
First of all, patients were given a scenario (figure 7.10) of being in the blended care path, which was explained by me (figure 7.11).

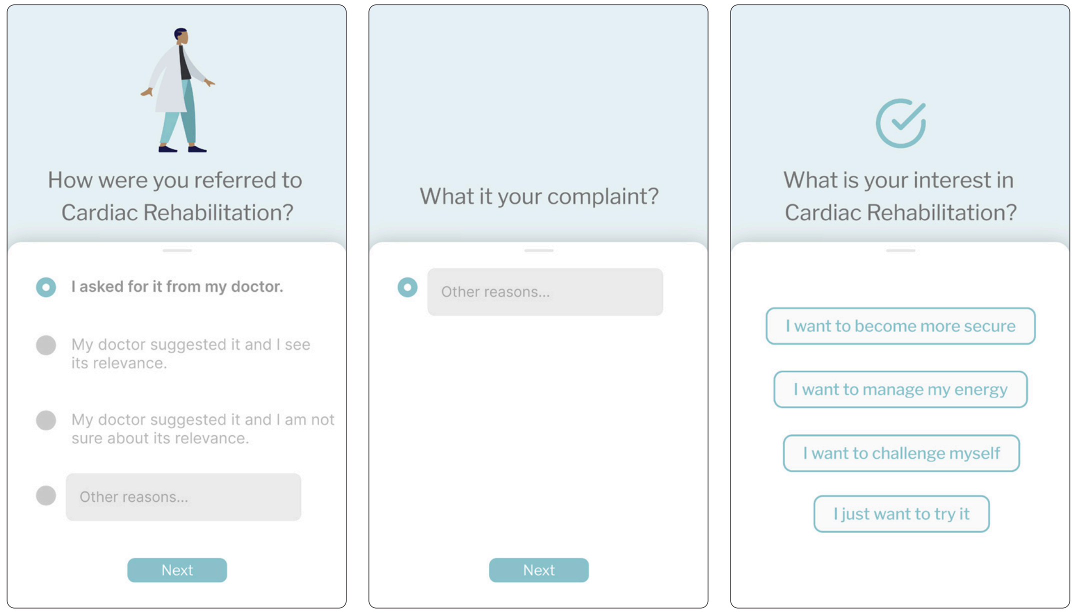
Then, they were given the onboarding prototype (figure 7.12), which aimed to understand the previously mentioned data points. The reason for testing the onboarding was that I wanted to not use my understanding of the patients based on talking and empathizing with them because I have been researching the experiences of cardiac patients, and I can easily distinguish their type. Therefore, I set out to see whether only doing the onboarding, which is simply answering a few questions without the inclusion of my own intelligence as a classifying party could be enough for the solution to Understand the patients.

After this part, I acted as the AI and gave them the adapted version of the goal-setting module (figure 7.14).

Finally, I would take them over the scenario in which they had rehabilitated at the center and see the visualized Borg scores on their app and ask their opinion (figure 7.15).

Figure 7.11: Me explaining the scenario





How were you referred to Cardiac Rehabilitation?

● I asked for it from my doctor.

○ My doctor suggested it and I see its relevance.

○ My doctor suggested it and I am not sure about its relevance.

○ Other reasons...

What it your complaint?

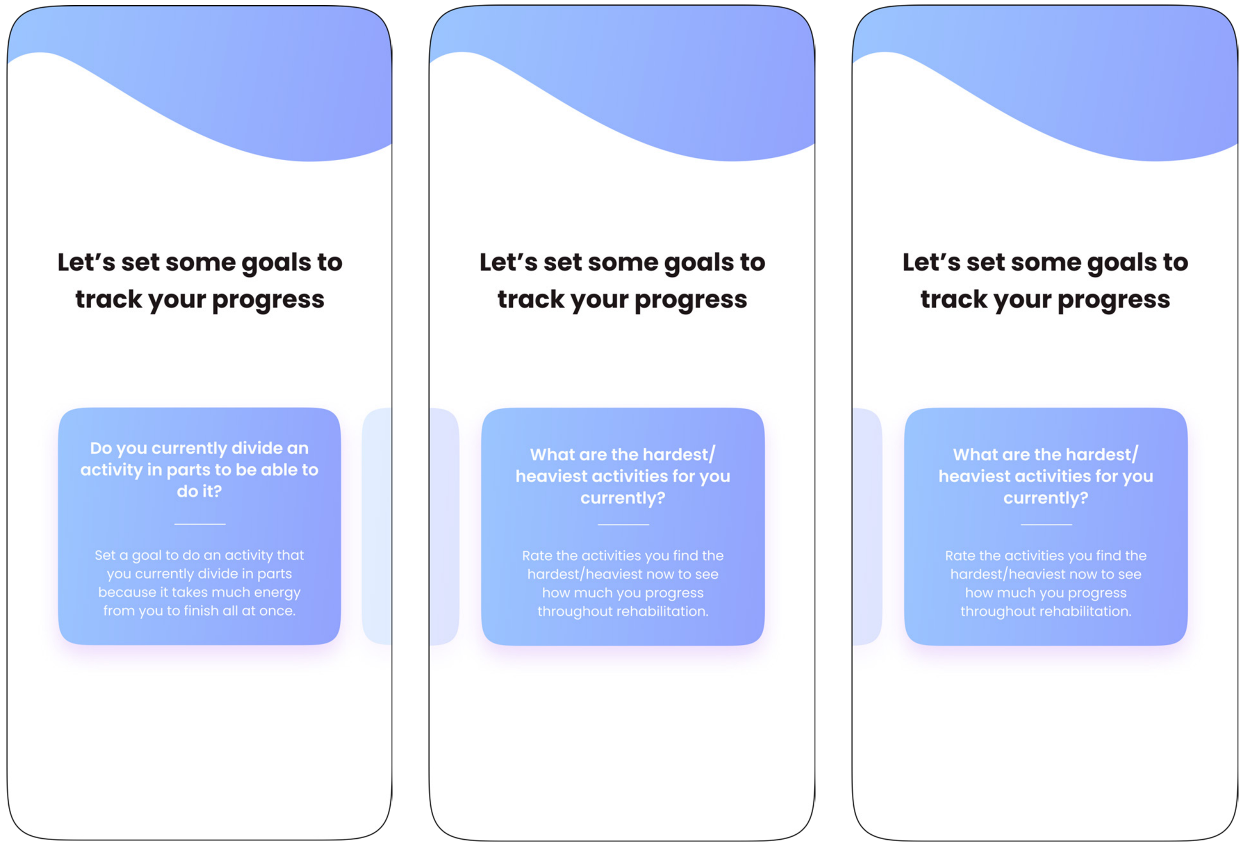
● Other reasons...

What is your interest in Cardiac Rehabilitation?

Figure 7.12: Onboarding prototype

Figure 7.10 : Scenario of blended care

Figure 7.13: Patient doing the onboarding



Let's set some goals to track your progress

Do you currently divide an activity in parts to be able to do it?

Set a goal to do an activity that you currently divide in parts because it takes much energy from you to finish all at once.

Let's set some goals to track your progress

What are the hardest/heaviest activities for you currently?

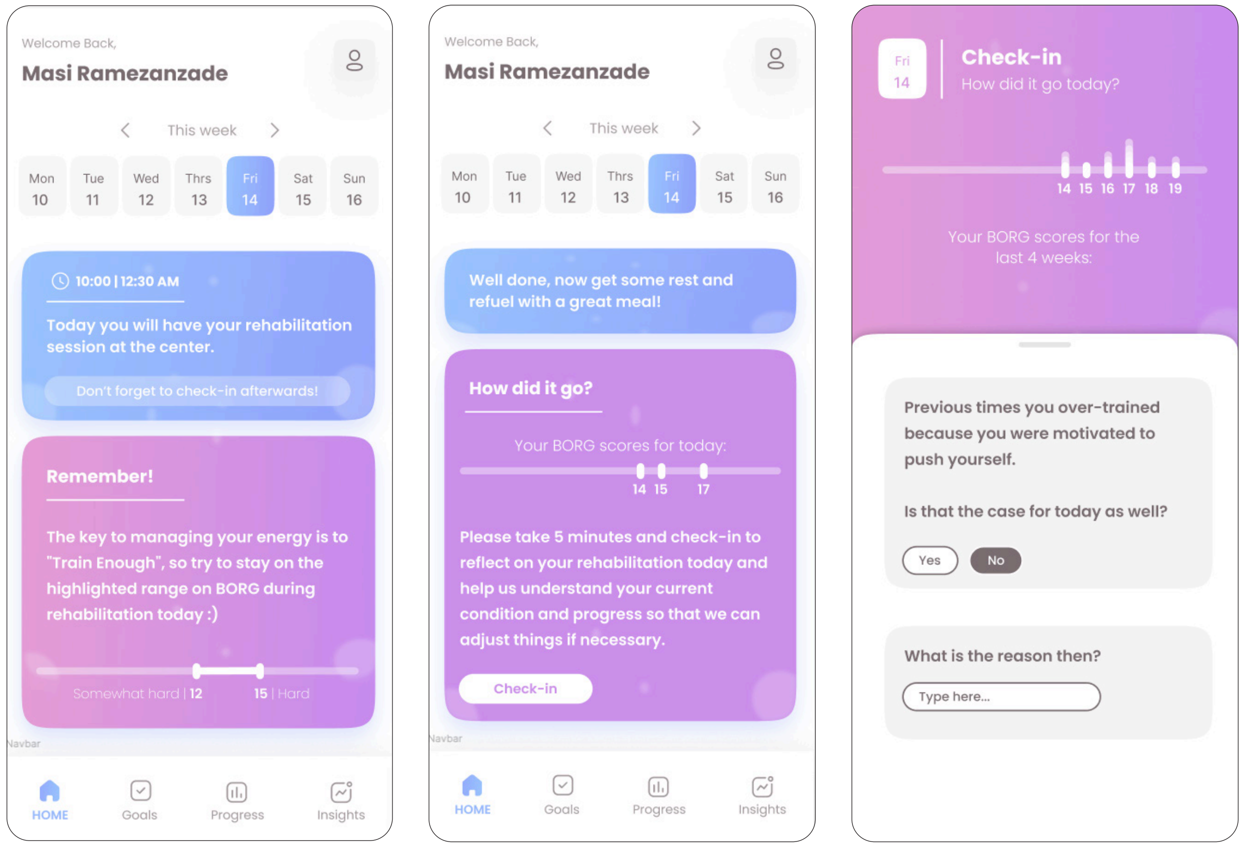
Rate the activities you find the hardest/heaviest now to see how much you progress throughout rehabilitation.

Let's set some goals to track your progress

What are the hardest/heaviest activities for you currently?

Rate the activities you find the hardest/heaviest now to see how much you progress throughout rehabilitation.

Figure 7.14 : Goal setting with the app



10:00 | 12:30 AM

Today you will have your rehabilitation session at the center.

Don't forget to check-in afterwards!

Remember!

The key to managing your energy is to "Train Enough", so try to stay on the highlighted range on BORG during rehabilitation today :)

Somewhat hard | 12 15 | Hard

What you see before going to the center to rehabilitate

Well done, now get some rest and refuel with a great meal!

How did it go?

Your BORG scores for today:

14 15 17

Please take 5 minutes and check-in to reflect on your rehabilitation today and help us understand your current condition and progress so that we can adjust things if necessary.

What you see after

Fri 14

Check-in

How did it go today?

14 15 16 17 18 19

Your BORG scores for the last 4 weeks:

Previous times you over-trained because you were motivated to push yourself.

Is that the case for today as well?

Yes [✓ No]

What is the reason then?

what you see when you check-in

Figure 7.15 : Seeing the Borg data and checking-in

7.3.2 Discussion

As mentioned earlier, due to fewer participants in the second week, I had fewer insights to work with. Therefore, I aimed to dedicate most of the test to familiarising patients with the entire service by taking them through a scenario of use.

Acceptance of the blended care:

All in all, patients accepted the idea of blended care as it was the only thing they knew about their CR care path. The fact that they yet had not started rehabilitation helped with this acceptance.

Easy understandability of the Borg data:

As patients were not familiar with the Borg score, I had to explain it to them using a visualization that I had made in this regard(figure X). To my surprise, patients immediately connected with this score and easily gave examples of home activities that they perceived to be exerting a certain number on the scale. This was the opposite of my assumption in which I imagined that it is hard for them to associate the heaviness of activity with a number. Therefore, I was already making a feature in the onboarding process of the app to teach patients elaborately about this scale before they start rehabilitation. However, I stopped doing that because of this new insight.

Onboarding:

The onboarding worked relatively well. However, due to the few numbers of patients I could not make a concrete conclusion that it works but I decided to keep it in the design.

Visualization of the Borg data:

The visualization was somewhat confusing to some patients, which could be because they were not familiar with it. But I decided to change it in a way that is more comprehensible.

7.3.3 Limitation

Point of recruitment:

As motioned at the start of this chapter, the point of recruitment hin-dered some testing process planned due to the holiday season and the fact that patients did not start rehabilitation immediately after the exercise Test. However, it was out of my control and this point of recruitment was the only option at hand.

Short duration of the study:

The study was overall short to make concrete conclusions about the feedback loops of the intelligent solution. However, it revealed some hinges of the design parts that could potentially work.

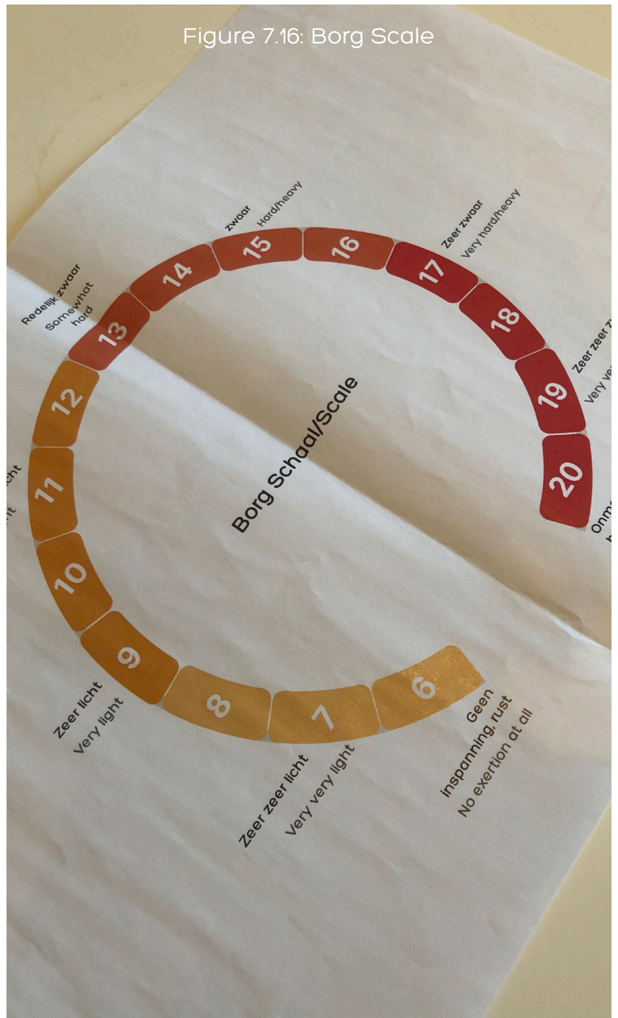


Figure 7.16: Borg Scale

7.4 Takeaways

This study used the concept introduced in chapter 6 and explored some parts of it more related to the patients.

As new insights were revealed the design also underwent changes which were mainly from the system point of view as it was one of the goals of this iteration.

The conclusions on the insight from this study informed the design, which is explained in the next chapter elaborately.

Chapter 8

FINAL DESIGN

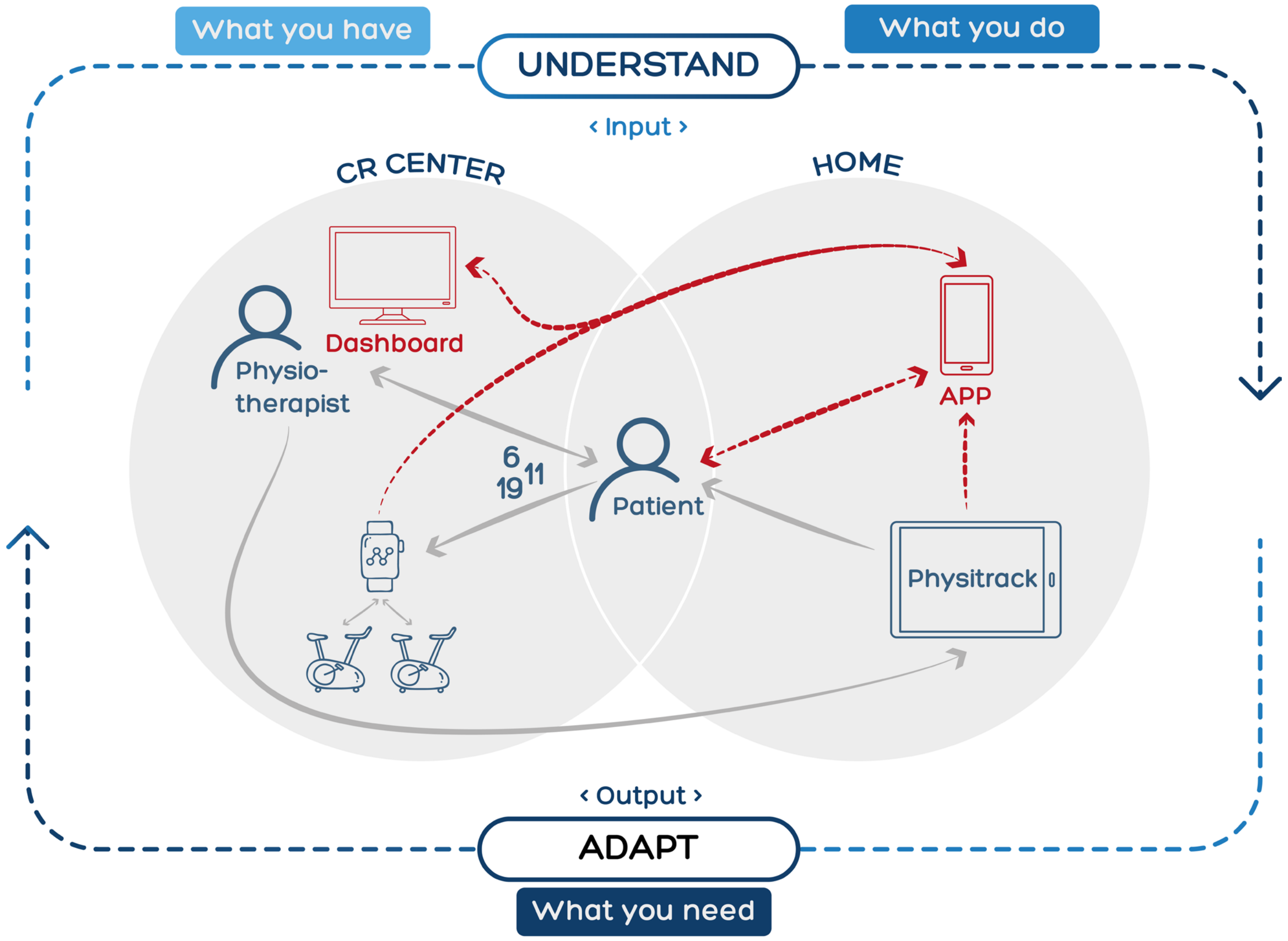
This chapter aims to present the final concept proposed for this project.

8.1 Concept Overview

The intelligent solution was built around the idea of homogenizing the home and center care to support blended care while increasing the personalization level by understanding patients' interest in CR and helping them engage in their rehabilitation exertion data(in both contexts) with reflection moments to learn about their body.

The final concept is an intelligent service presenting an app for the patient and a dashboard for the physiotherapist integrated into the current ecosystem of Basalt to support the notion of blended CR care in which some care parts are delivered at home while implementing personalization to help patients have a smoother transition to a home setting after rehabilitation.

It realizes this effect by having three different modules and utilizing the feedback loops incorporated in them, being Understand and Adapt loops that facilitate personalization in the care. The Understand loop learns about the patients based on 'what they have' at the start and 'what they do' during the care path and adapts itself to 'what they need' during different service phases following the CR care.



🟥 Addition to the ecosystem

Figure 8.1: Proposed ecosystem for the concept

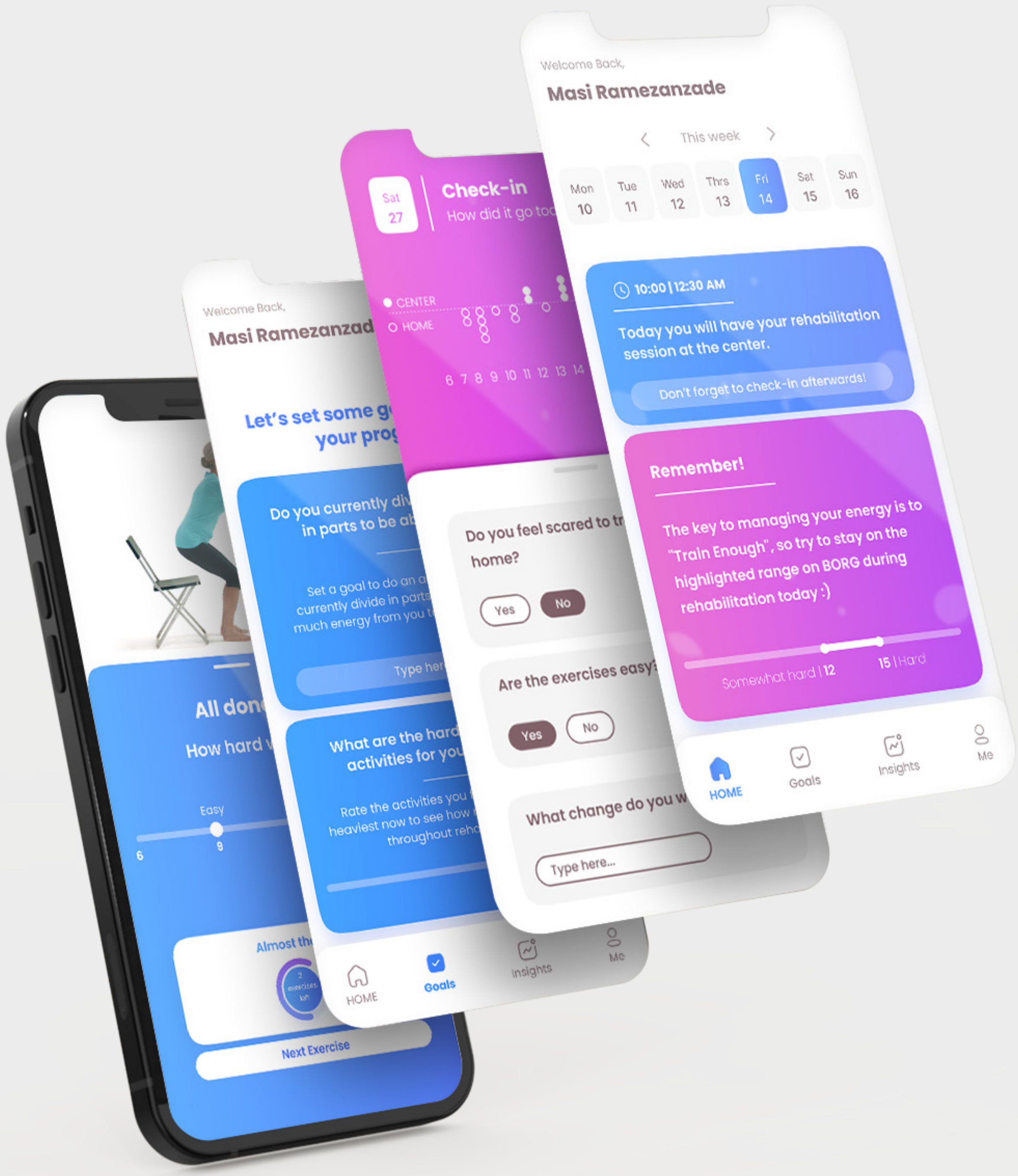


Figure 8.2 : App Overview

8.1.1 Application

The application for the patients supports them firstly to make goals for CR with the goal-setting module and secondly, to reflect on their exertion levels from home and center to help them develop self-knowledge about their body with regards to their goals and CR interests using the after-rehabilitation check-in module.

With these two modules, it tries to learn about the patients by their CR interest, logged-in exertion data, and their annotation to it in the check-in to adapt the correlations and predictions about the patient.

Moreover, it allows the physiotherapist to have insights into how patients follow the care at home by collecting the exertion data in the home care in which patients have to do training at home for some days.

8.1.2 Dashboard

The physiotherapist dashboard helps them with discussing the most relevant data from the patient, which gets detected by their app (by the correlations) and the CR interest of the patients. With this, it is envisioned to make use of the short consultation appointment and reassure the patient that their performance in home care is being tracked. (The envisioned dashboard has not been developed in this concept)

8.2 Concept Effect

The concept is envisioned to have certain effect on the stakeholders involved with the aim of reaching the formulated design goal: Care homogeneity (at center & home), Personalisation, Learning about the body while in CR, and Effective discussion.

Care homogeneity (at center & home):

I set out to homogenise the care delivered at home and center so that patients have the idea that what they do at home is still part of their rehabilitation care in order to support the blended care.

How?

in the days that patients have to rehabilitate at home, they can see the exercises assigned by the physiotherapist in Physitrack in their own app and can report their associated exertion levels after finishing them (figure 8.3).

Tackled Problem

In the present care, the procedure of rehabilitation differs when done in the center and at home. When exercising at home, patients do not track their exertion level, which compromises their health outcome (they might be under or over training instead of training enough), leaving physiotherapists and patient with no insight and reflection into their performance. Moreover, patients feel like that no one is aware of what they do when they have to rehabilitate at home.

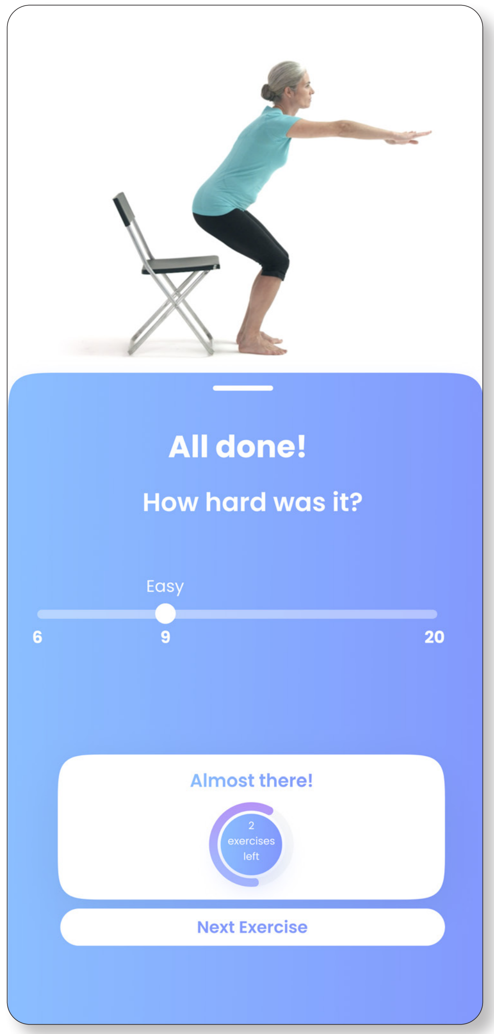
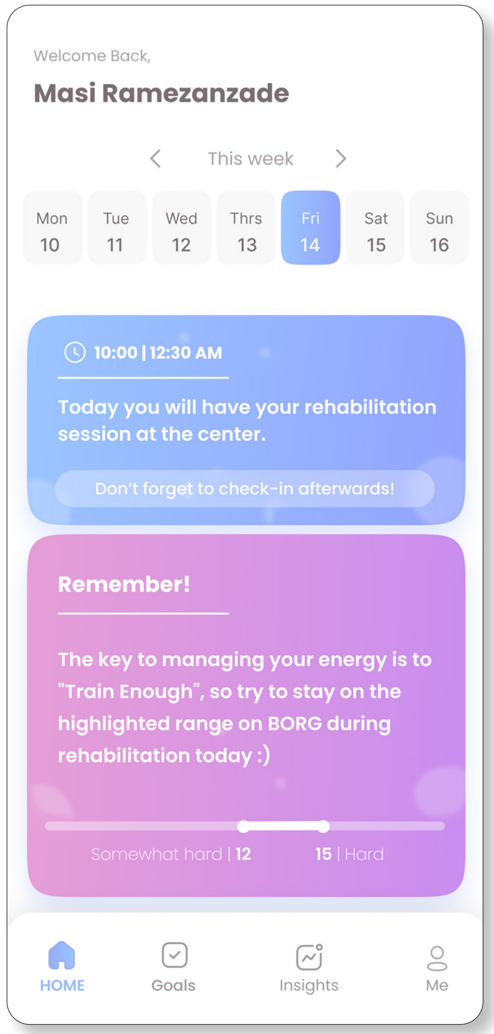


Figure 8.3: Home training with the app



Today you will have your rehabilitation session at the center.

Don't forget to check-in afterwards!

Remember!

The key to managing your energy is to "Train Enough", so try to stay on the highlighted range on BORG during rehabilitation today :)

Figure 8.4: App home page

How?

As a measure to unify the care and present it as a whole to patients, their home page of the app shows their schedules for the day where supportive features are also presented.

Tackled Problem

Since rehabilitation is a multi-disciplinary care where patients have to go through many phases with different stakeholders, it is hard for the patients to keep track of everything. This problem is assumed to become even worse in blended care where the schedule of patients changes weekly as they have to come to the center less frequently as they go through the care.)

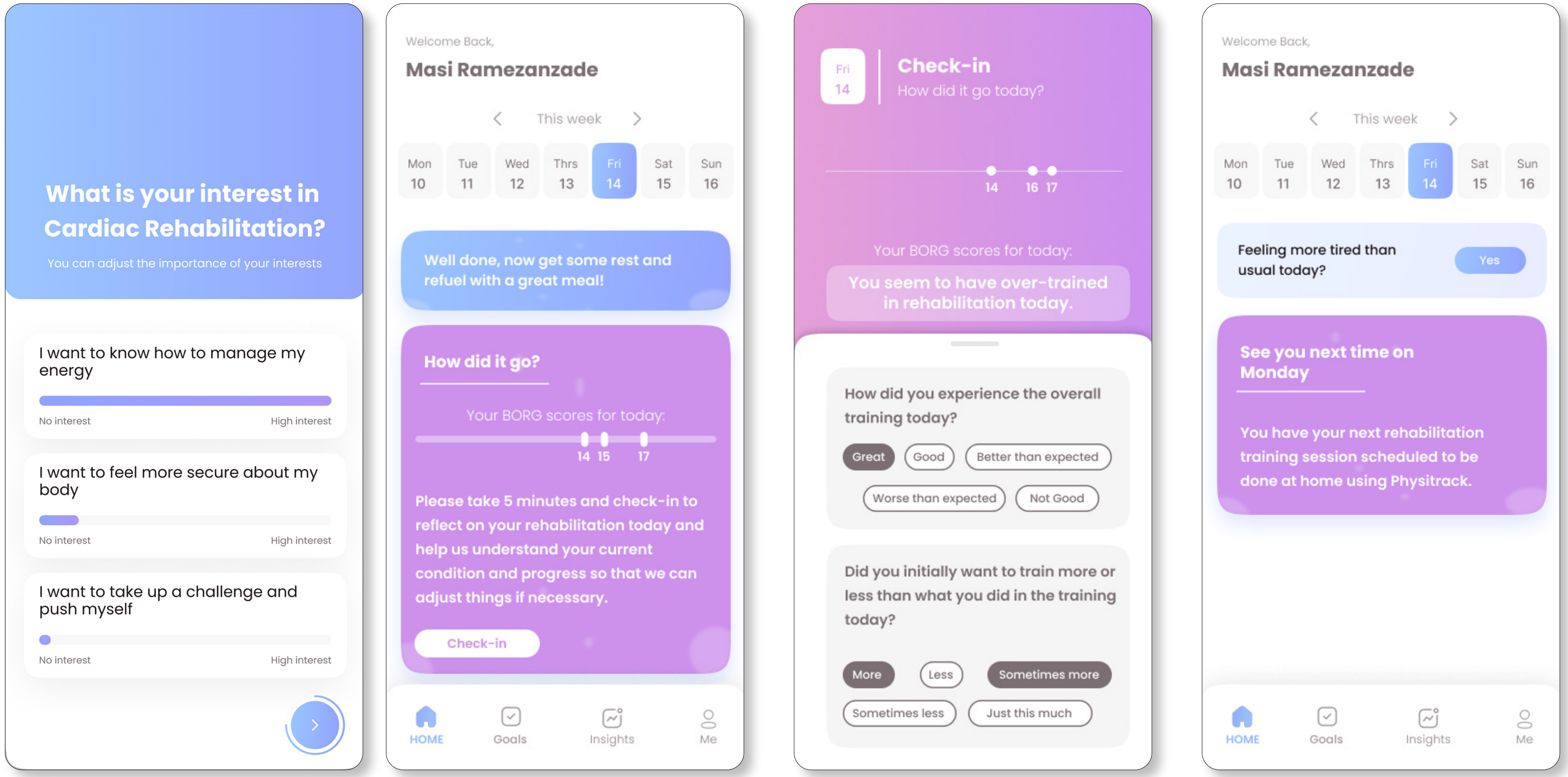
Personalisation:
I wanted the concept to become personalised based on the behaviours of patients according to the patient profiles introduced in the previous chapters, so that patients feel that their care is personalised to their needs although delivered at home by detecting their idiosyncrasies explained in the profiles.

How?

The personalization is envisioned to be done by the understanding loops of the modules to position the patient on the profile (matrix) concerning their motivation and insecurity level at the start of the care path ('what they have'). During the care path, 'what they do' regarding their exertion and self-reported data adjusts the profile of the patient and adapts the content of the app. The main home page adapts to the current state of the patients

Tackled Problem

The type of patients entering the CR care pathway is different, making them have distinct interests in CR (what they want to get out of it) and goals. Therefore, the level of personalization is currently deemed low in itself. This becomes worse when blending the CR care because health professionals see the patients less often, and the patients themselves are worried about the loss of contact resulting in their needs not being seen and addressed consequently.



What is your interest in Cardiac Rehabilitation?

You can adjust the importance of your interests

I want to know how to manage my energy

I want to feel more secure about my body

I want to take up a challenge and push myself

Welcome Back,
Masi Ramezanzade

Well done, now get some rest and refuel with a great meal!

How did it go?

Your BORG scores for today:

Please take 5 minutes and check-in to reflect on your rehabilitation today and help us understand your current condition and progress so that we can adjust things if necessary.

Check-in
How did it go today?

Your BORG scores for today:

You seem to have over-trained in rehabilitation today.

How did you experience the overall training today?

Did you initially want to train more or less than what you did in the training today?

Welcome Back,
Masi Ramezanzade

Feeling more tired than usual today?

See you next time on Monday

You have your next rehabilitation training session scheduled to be done at home using Physitrack.

Figure 8.5: App personalisation

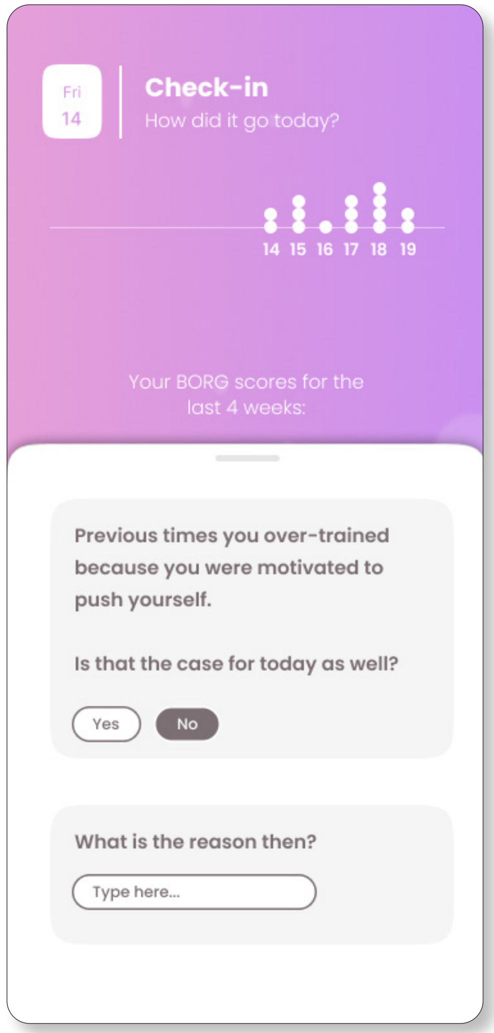
Learning about the body while in CR:
I wanted the patients to get to know their body and create self-knowledge by engagement and reviewing their exertion reported data at the center and home.

How?

The development of self-knowledge is envisioned to be done by facilitation of reflection on the goal and exertion data which allows the patients to take necessary actions. As mentioned earlier, the Borg data projecting the levels of the exertion of patients reveals much information about them once it is annotated with the right diagnosis information reported by the patient. This is designed to be done with check-in moments after rehabilitation sessions in which patients review their performance in the rehabilitation.

Tackled Problem

This problem originated from the fact that patients found the transition to the home setting after the finishing point of rehabilitation very sharp, leaving them with little clue and much insecurity about their bodies. Therefore I envisioned smoothening the transition at the end of CR by facilitating reflection on their performance during CR to learn about their body and start trusting it.



Previous times you over-trained because you were motivated to push yourself.

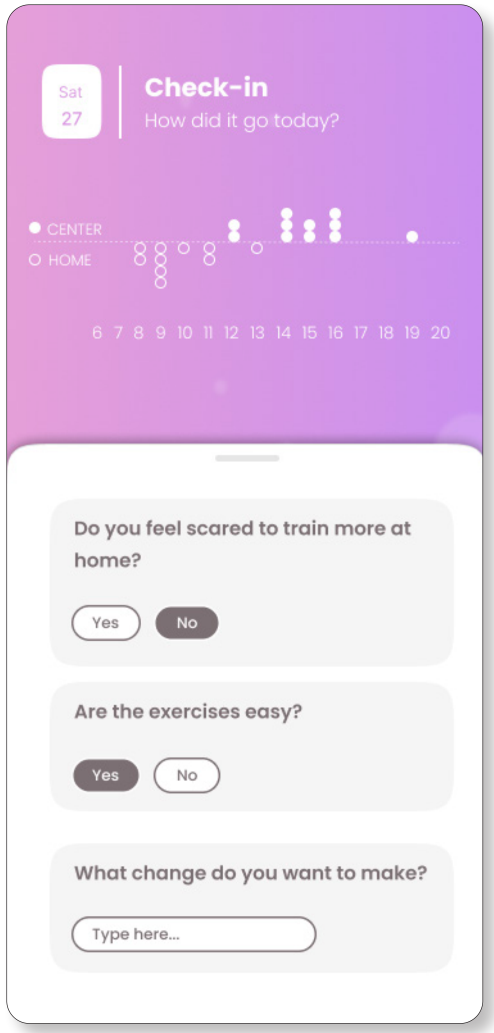
Is that the case for today as well?

Yes [✓ No]

What is the reason then?

Type here...

Figure 8.6: Check in with the app (short term)



Do you feel scared to train more at home?

Yes [✓ No]

Are the exercises easy?

[✓ Yes] No

What change do you want to make?

Type here...

Figure 8.7: Check in with the app (long term)

Effective discussion:
I envisioned making the most of the physiotherapist's planned consultation time by suggesting discussion topics that were pertinent to the patient's data rather than having a general conversation (how it is now).

How?

The intelligent system is envisioned to understand and learn about the behavior of the patient (using the input data) as well as their CR interests and goals. Therefore, it can detect the common behavior and irregularities in the performance data together with the patient's reflection on it. Accordingly, the system could suggest the progress, irregularities, and the correlations seen in the data as materials for discussion on the physiotherapist dashboard to make the short consultation time effective instead of solely reviewing general matters.

Tackled Problem

The scheduled appointment with the physiotherapist is a change in the care path that is envisioned to be in place due to implementing blended care. Currently, the home exercises are not adapted by the physiotherapist because they do not have the time for it, and if they did, they had no idea what to base the adaptation on because there were no insights. But in the envisioned appointment, they can review the performance of patients with exercises as well as their experience with it, so they can easily adapt the care based on what they see on the dash-board together with the patients. The assumption is that more personal matters can be discussed by this method.

8.3 Blended CR as a Service

Some of the care must be provided at home in order to blend the CR at home and center. Consequently, this concept as a service supports that by having different phases following the CR care path.

Figure 8.8 shows the CR care pathway and the service phases envisioned in it to blend the care in which patients receive home care more and more as they go through rehabilitation.

8.3.1 Service Phases

This concept supports the CR care in multiple phases as a service: Entry, Center care which consist of training in the center and the appointments with physiotherapists, and finally Home Care consisting of training at home and supporting patients in everyday life.

Entry

The service starts after the patients are referred to CR by their cardiologist, and are past the Pre-program stage in which the intake, exercise test, intensity level, and the other modules needed for the patient are already assigned, and they are ready to do the intake by the physiotherapist to make goals and start the training sessions and the care.

Therefore, the service officially starts when patients are about to set physical goals with the physiotherapist in the physical intake. However, they could already download the app and get the patient-specific code from the CR center in the intake Consultation sub-stage with either the physician assistant or the cardiologist.

The main interaction with the app in the phase before the Entry is the onboarding & seeing their medical data, such as the results of their Exercise test and intensity level.

In this phase, the initial profile of the patients is understood by the concept and is corrected by the opinion of the physiotherapist in the intake session.

Center Care

Training at the Center:

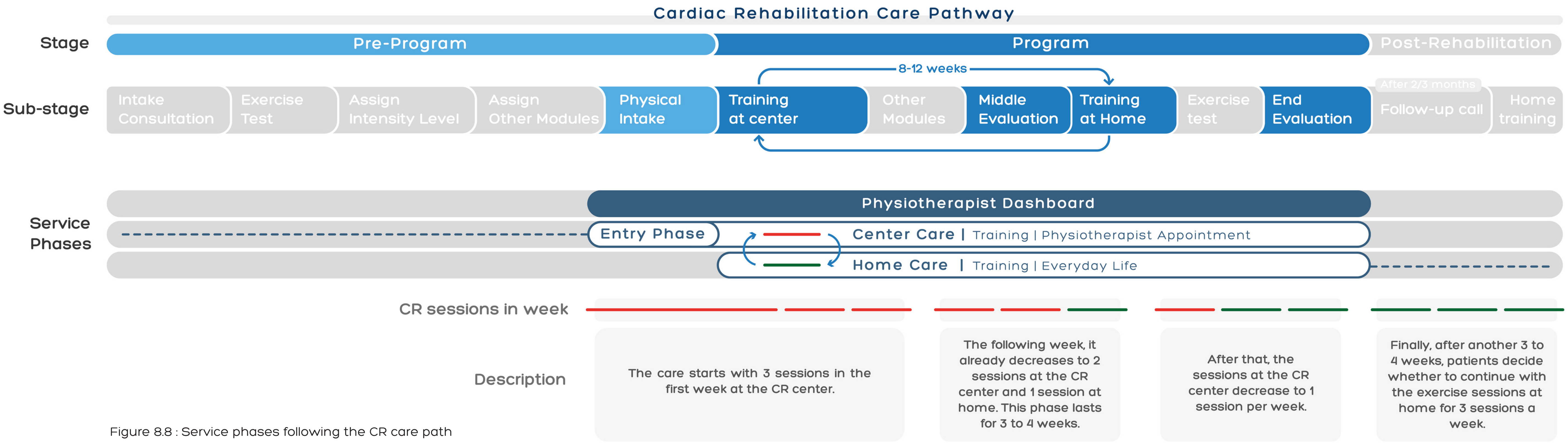
After the Entry, in this phase, patients start their rehabilitation training at the center, in the same way they do currently (in the status quo), consisting of going to the center, doing exercises, reporting Borg scores, and logging them in their special bracelets in the center.

The only difference the concept makes in the workflow in this phase is that the patient's data will be transmitted to their app automatically, meaning that they do not have to do anything. After that, they do a check-in after rehabilitation to review their performance data and reflect on it.

However, no interaction with the app has been envisioned when the patient is at the center and training. The reason for that is that (based on observation in CR training) the social contact and group situation in the training sessions in the CR center is assumed to be a big part of social support and they are really present in the sessions. Therefore, making an interaction point with the intervention in that sub-stage is risky and compromises the experience of patients, and it was never the intention to make them busy with the app during CR center sessions.

Physiotherapist Appointment:

In this phase, patients come to the center to have their appointment with a physiotherapist, which was part of the vision for blended care to have official supporting moments from the physiotherapist. In this appointment,



The care starts with 3 sessions in the first week at the CR center.

The following week, it already decreases to 2 sessions at the CR center and 1 session at home. This phase lasts for 3 to 4 weeks.

After that, the sessions at the CR center decrease to 1 session per week.

Finally, after another 3 to 4 weeks, patients decide whether to continue with the exercise sessions at home for 3 sessions a week.

Figure 8.8 : Service phases following the CR care path

the most relevant data from the patients based on predictions and correlations elicited from the after-rehabilitation check-in moments where patients reflected on their performance data is suggested to be discussed.

In this phase, the patient and physiotherapist also evaluate the goals together.

In the current care, there are certain appointments with the physiotherapist through the Program stage (At the start/intake, in the middle, and the end), in which the patients reflect on their goals and evaluate them. However, in the envisioned blended care in which the home CR training begins to increase weekly, these appointments are envisioned to become more frequent with more materials to cover instead of only the goals and how things are going generally.

Thus, the physiotherapist's dashboard is used in these appointments with the relevant data coming from the patient's app concerning the care at home.

Home Care

Training at Home:

On the days that rehabilitation is scheduled to be done at home, the Physitrack website is used (as currently in the status quo) to do the exercises. Patients should log the level of exertion they put into their exercises into their app, much like they do in the center, in an effort to homogenise care between the home and health center and to also to gain insights into the home environment. The patients should complete a brief check-in as well, much like in the center's care, to facilitate drawing conclusions from their data.

Everyday Life:

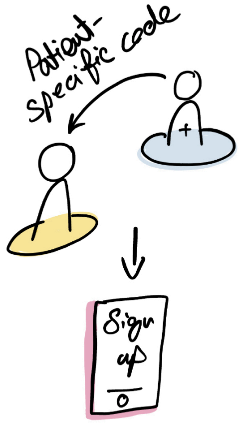
This phase comprises all the moments in which the patient is enrolled in CR but is not rehabilitating (at home or center). Therefore, it covers the daily life of the patients and is meant to provide them with personalized insights regarding their condition, progress, performance, and goals, while using the input from the goal-setting and after rehabilitation check-ins to make the personalisation.

8.4 User Storyboard

The concept modules (briefly introduced in previous chapters and elaborately explained later in this chapter) operating in the service phases are meant to implement the concept effects earlier introduced on the stakeholders. In order to get a grasp of the whole picture of this service in the CR care path, I made the following user storyboard in which a hypothetical patient undergoes the CR service from start to finish. Note that this storyboard does not cover the intelligence of the system in which understanding and adaptation occur to personalize the care, but shows the overall journey of any patient.

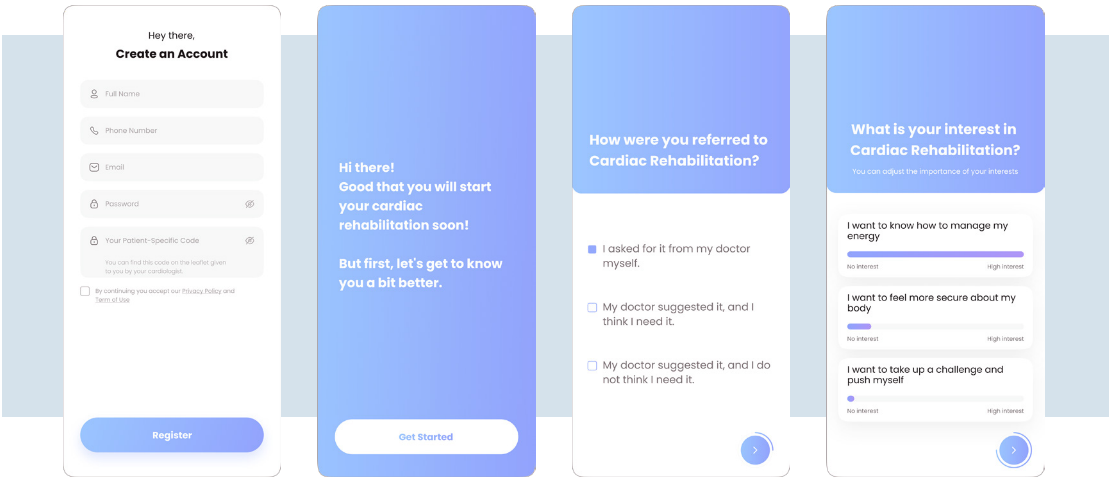
Entry

(a)



The patient is referred to CR and goes to Basalt center to do the intake with the cardiologist. There, the cardiologist gives them a leaflet containing information about the service and their care with a patient-specific code for registration.

Patients get the code, download the app, and register before the start of their rehabilitation. After registration, they do the onboarding on the app by answering a few questions so that the app shapes an initial understanding of the patient.



Hey there,
Create an Account

Full Name
Phone Number
Email
Password
Your Patient-Specific Code
You can find this code on the leaflet given to you by your cardiologist.
☐ By continuing you accept our Privacy Policy and Term of Use

Register

**Hi there!
Good that you will start your cardiac rehabilitation soon!**

But first, let's get to know you a bit better.

Get Started

How were you referred to Cardiac Rehabilitation?

☑ I asked for it from my doctor myself.
☐ My doctor suggested it, and I think I need it.
☐ My doctor suggested it, and I do not think I need it.

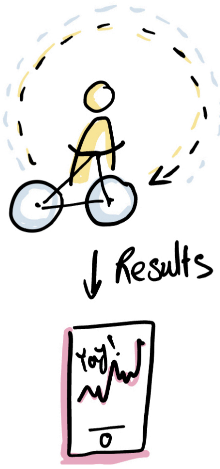
What is your interest in Cardiac Rehabilitation?
You can adjust the importance of your interests

I want to know how to manage my energy
No interest — High interest

I want to feel more secure about my body
No interest — High interest

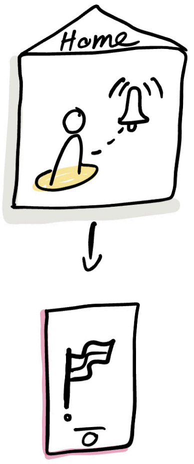
I want to take up a challenge and push myself
No interest — High interest

(b)



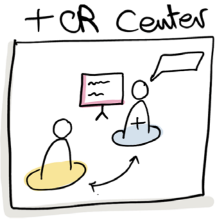
Before starting the training, the patient can see their data, results from their tests, as well as their schedule and care plan.

(c)



Before the intake with the physiotherapist, they receive a reminder about their schedule and a suggestion to make goals before going to the intake.

(d)



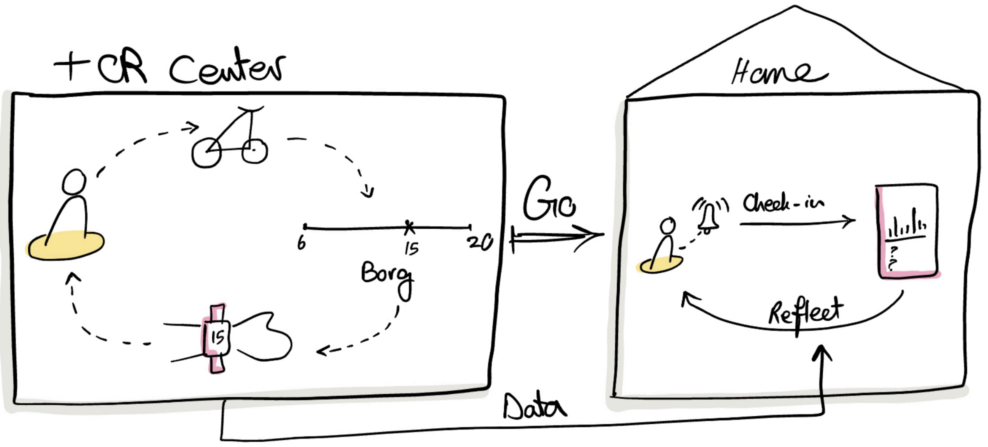
Patients use the app to make some preliminary goals to discuss in the intake, which corresponds to their interest in CR detected by the app. This way they are invited to participate in the care they want to receive.

Figure 8.9 : User story board (entry)

Center Care

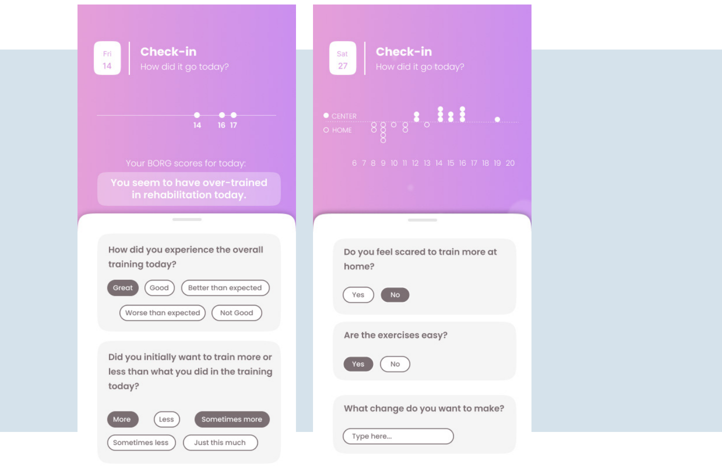
Training at Center

(e)



Patient needs to start rehabilitation, so they go to the center for the first time to train. They train, log their RPE using the Borg score via their bracelet, and come home when it is finished.

When at home, at a time convenient for them they receive a notification saying something about their rehabilitation that day and inviting them to do a brief check-in to review their data.



Fri 14
Check-in
How did it go today?

14 16 17

Your BORG scores for today:
You seem to have over-trained in rehabilitation today.

How did you experience the overall training today?
[✓ Great] Good Better than expected Worse than expected Not Good

Did you initially want to train more or less than what you did in the training today?
[✓ More] Less [✓ Sometimes more] Sometimes less Just this much

Sat 27
Check-in
How did it go today?

● CENTER
○ HOME
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

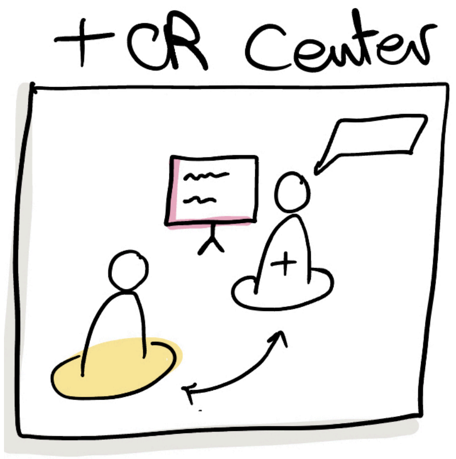
Do you feel scared to train more at home?
Yes [✓ No]

Are the exercises easy?
[✓ Yes] No

What change do you want to make?
Type here...

Appointment

(f)



On the days that the patient trains at home, they need to use the Physitrack website and their app to do the exercises after which they need to log their Borg scores to bring insights into their performance.

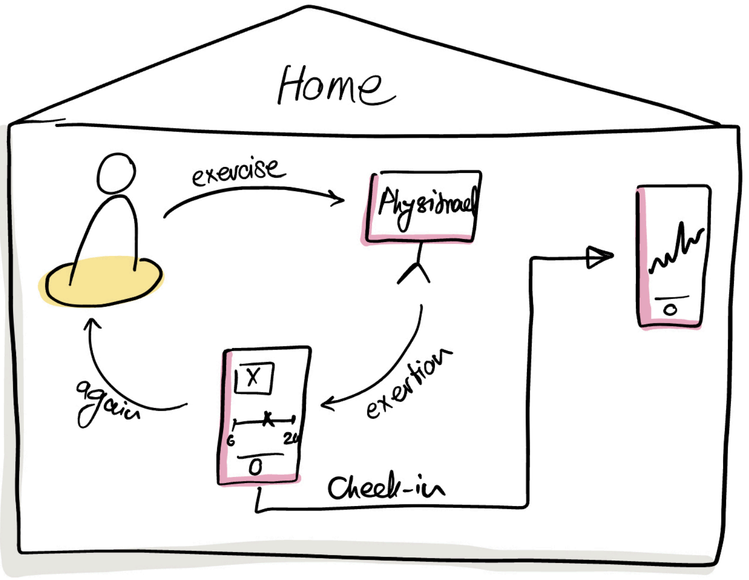
After finished, they again do the check-in to review their data and take necessary actions.

Figure 8.10 : User story board (training at center)

Home Care

Training at Home

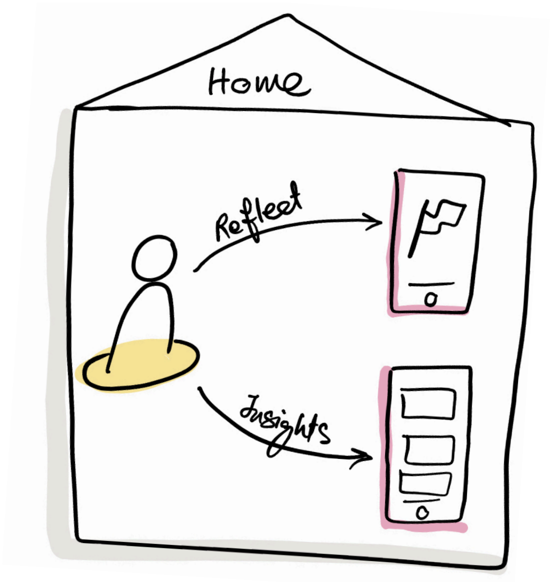
(g)



On the days that the patient trains at home, they need to use the Physitrack website and their app to do the exercises after which they need to log their Borg scores to bring insights into their performance.

Everyday Life

(h)



On the days that the patient trains at home, they need to use the Physitrack website and their app to do the exercises after which they need to log their Borg scores to bring insights into their performance.

Figure 8.11 : User story board (training at home)

8.5 Concept Modules

As explained earlier, the modules built in the concept are meant to implement the effects explained earlier, where each has its own Understand and Adapt loops. As argued in chapter 6, the final loops for the system with the relevant data points were devised as shown in figure 8.12 (as a recap in this chapter).

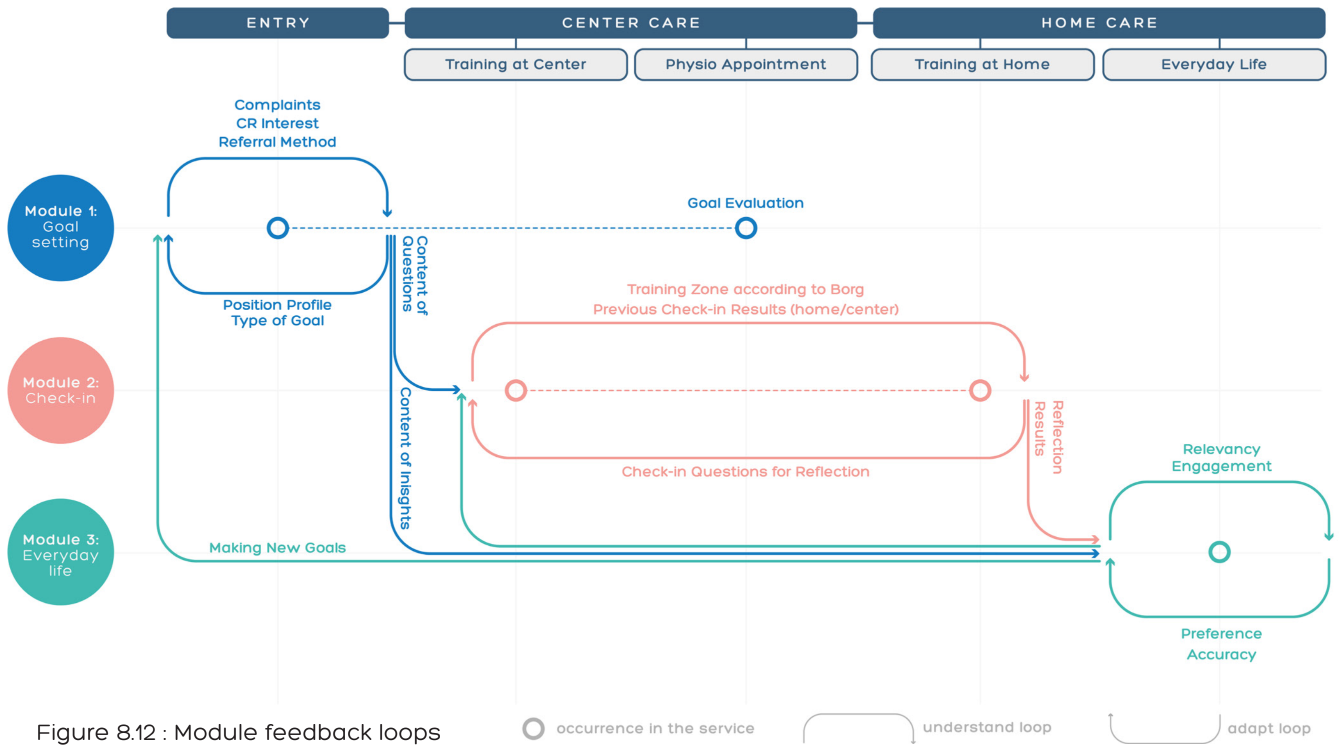


Figure 8.12 : Module feedback loops

8.5.1 Module 1 : Goal-setting

This module occurs at the start of the CR care path (Entry phase of the service) in which patients have to make goals for their rehabilitation and are about to start the CR training.

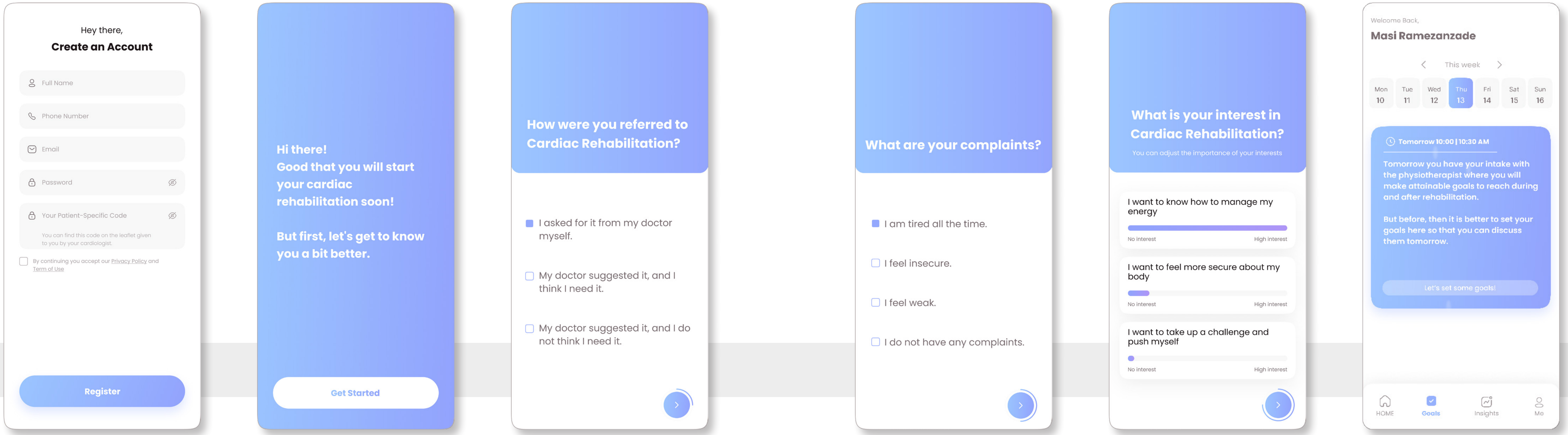
During this phase, patients use their app to complete the onboarding process first, allowing the system to learn their profile and make changes for them to set their goals. They had obtained the patient-specific code for this app during the initial intake with the cardiologist.

The goal-setting (type of goal) is envisioned to be done rather differently for the distinct profiles, but generally, it revolves around setting activities that they want to be able to do by undergoing rehabilitation and rating them using the Borg score regarding how hard they find it. The idea is that periodically they have to reflect on the goals by rating them again to observe that the numbers are lowering as they are getting stronger as motivation to keep them going.

The most important data points identified from the research for this module were the referral method, complaints, and the CR interest, which need to be reported by the patients themselves.

These questions in the onboarding process position the patient somewhere on the profile. For example, when patients report that they asked their doctor themselves to be referred to CR, the system positions them firstly somewhere on the top of the matrix. The second question asking about the complaints positions the patients on the horizontal axis, shaping their initial profile, which is corrected by the adjustment of CR interests predicted by the system.

In the onboarding process other data points such as age, condition, gender, etc. are integrated to conduct the prediction as well. However, here they are not mentioned because they would be transferred from the patients' medical data.



Hey there,

Create an Account

Full Name

Phone Number

Email

Password

Your Patient-Specific Code

You can find this code on the leaflet given to you by your cardiologist.

☐ By continuing you accept our Privacy Policy and Term of Use

Hi there!
Good that you will start your cardiac rehabilitation soon!

But first, let's get to know you a bit better.

How were you referred to Cardiac Rehabilitation?

- ■ I asked for it from my doctor myself.
- ☐ My doctor suggested it, and I think I need it.
- ☐ My doctor suggested it, and I do not think I need it.

What are your complaints?

- ■ I am tired all the time.
- ☐ I feel insecure.
- ☐ I feel weak.
- ☐ I do not have any complaints.

What is your interest in Cardiac Rehabilitation?

You can adjust the importance of your interests

I want to know how to manage my energy
No interest — High interest

I want to feel more secure about my body
No interest — High interest

I want to take up a challenge and push myself
No interest — High interest

Welcome Back,

Masi Ramezanzade

This week

Mon	Tue	Wed	Thu	Fri	Sat	Sun
10	11	12	13	14	15	16

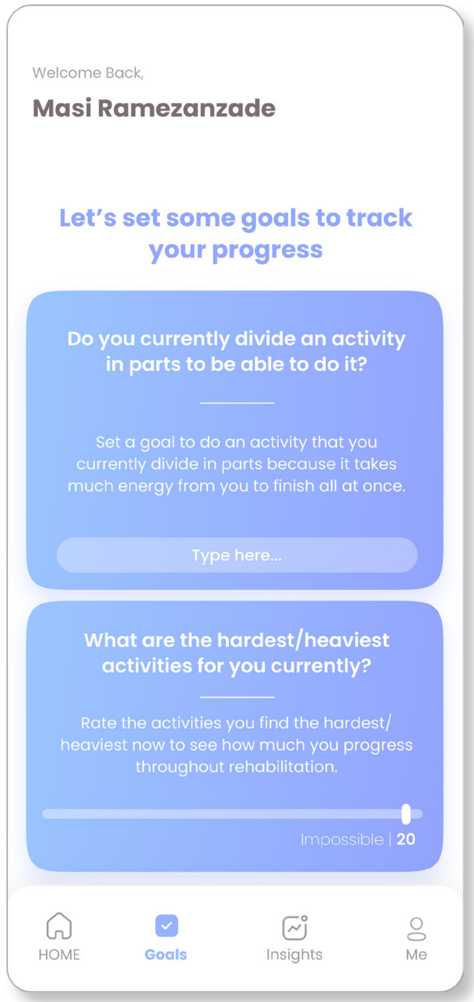
Tomorrow 10:00 | 10:30 AM

Tomorrow you have your intake with the physiotherapist where you will make attainable goals to reach during and after rehabilitation.

But before, then it is better to set your goals here so that you can discuss them tomorrow.

(a) (b) (c) (d) (e) (f)

Figure 8.13: Onboarding



Welcome Back,

Masi Ramezanzade

Let's set some goals to track your progress

Do you currently divide an activity in parts to be able to do it?

Set a goal to do an activity that you currently divide in parts because it takes much energy from you to finish all at once.

What are the hardest/heaviest activities for you currently?

Rate the activities you find the hardest/ heaviest now to see how much you progress throughout rehabilitation.

Impossible | 20

Figure 8.15: Goal-setting (green profile)

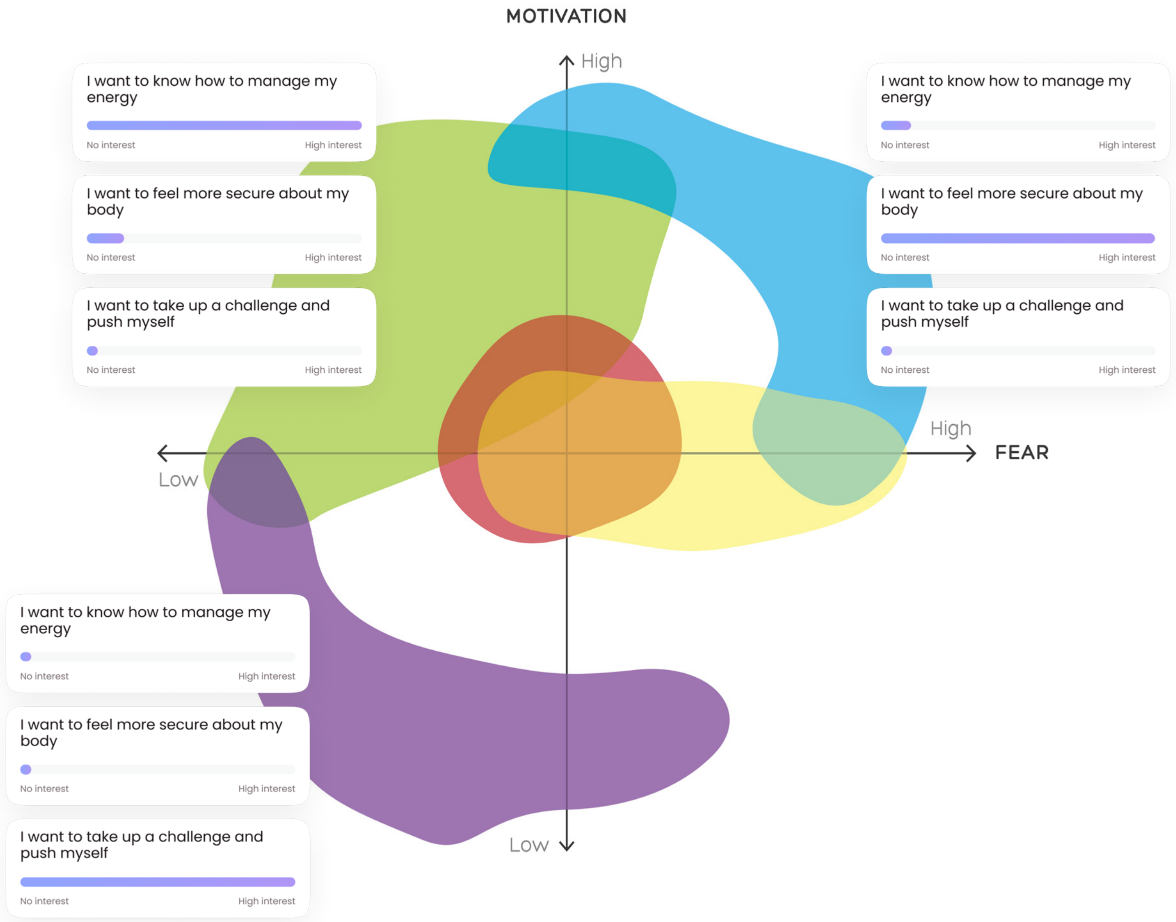


Figure 8.14: CR interests of different profiles

8.5.2 Module 2 : Check-in

This module occurs when the patient has finished rehabilitation, either at the center or at home, by answering some check-in questions. It aims to provide overviews of the exertion data of the patients during rehabilitation to help them do short and long-term reflection and take necessary actions (figure 8.16).

If they are training at the center, they receive a notification to do a brief check-in to diagnose their exertion data and annotate it by answering a set of questions that the system has adapted based on understanding their exertion zones (under, over, and enough exertion). For example, if they have overtrained, they would be asked about their exhaustion and lack of energy, and if they have undertrained, whether that is because of insecurity.

The data points used in this module are the training zone of the patient and the results of their previous check-ins, which allows the system to adapt the next check-in questions. The questions themselves follow the data analytics introduced in chapter three, consisting of descriptive (what happened), diagnostics (why did it happen), predictive (what will happen), and prescriptive (make it happen) analytics. Meaning that the check-in starts with the visualization and showing the Borg data(descriptive), then it tries to diagnose to help patients know why they did what they did(diagnostic), and it continues with predicting what might happen based on previous correlations(predictive), and help the patient take necessary actions(prescriptive).

This module follows the framework of personal informatics in which the preparation and collection are already done (at the center or at home). The integration step, which prepares the data from different sources and contexts together (in this case, the exertion data from the home and center care), is followed by preparing it for the patient to reflect upon. The facilitation is achieved by making inferences based on their data and also their CR interests.

The results of this module could potentially adapt the profile of the patient on the matrix.

8.5.3 Module 3 : Everyday Life

This module uses the input from the first two modules and provides patients with insights, and advice related to their interests and according to their engagement.

This module is meant to help patients transition to home care and build trust in their bodies by seeing their progress or the personalized content and insights. This module is meant to use the output of the first two modules (their position on the motivation and the insecurity level) to make personalized content.

8.6 Service Blueprint

In order to generate an overview of the underlying system supporting the storyboard, I created a service blueprint to visualize the relationships between different service components. The blueprint can be found in figure 8.17 in which the interaction of the core elements of the service is demonstrated. To provide an overview of the aforementioned information, the service phases and the user storyboard are presented in the blueprint as well as the flows of the different modules highlighted with their associated colors.

Patient's actions describe the things that a hypothetical patient has to do as they undergo the service in the CR care path.

Line of Interaction classifies the interactions in the system that are visible to the patient and with which they interact. In this section the interactions of the patient with the cardiologist, physiotherapist, and the patient's application are evident.

The Line of Visibility separates the interaction and activities that occur behind the scenes (invisible to the patient) on the system level. This section shows the decisions that the feedback loops of the module take in order to not only understand the patient but also to make their own capabilities better by learning about their mistakes.

Finally, the Line of Internal Interactions separates the activities that rely on other sources and are external, but the system relies on them.

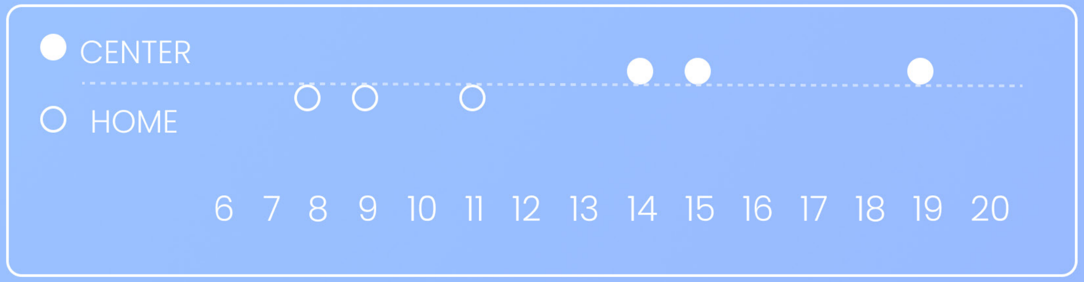
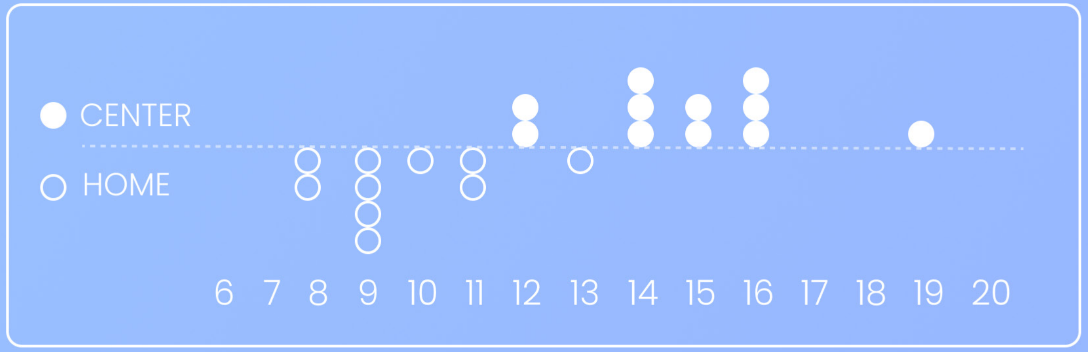
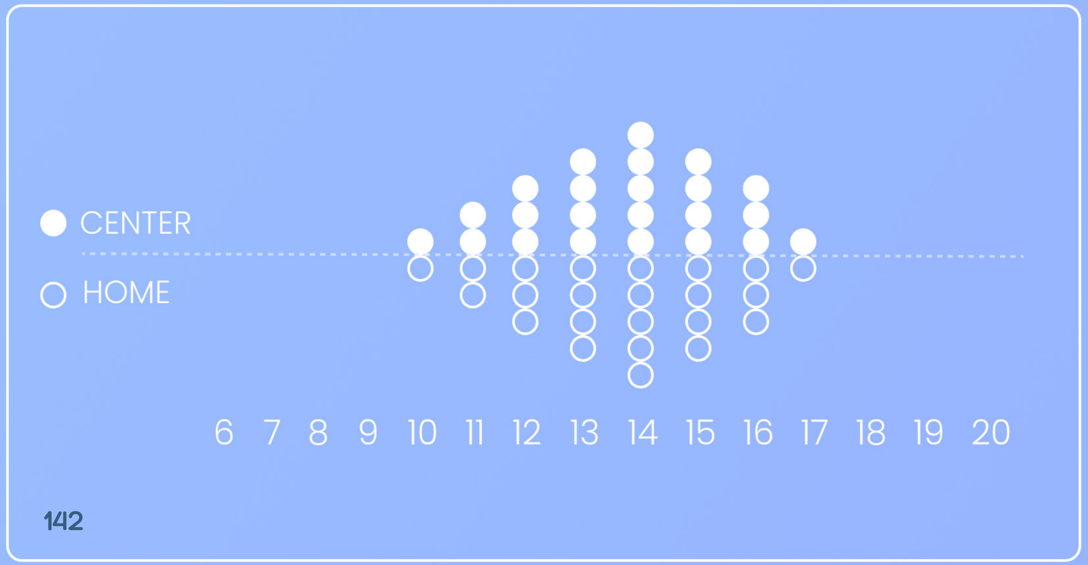
What happened?	Why did it happen?	What will happen?	Make it happen?
You over-trained!  	*Liked the exercise so much?* ✓*Wanted to push yourself?* *Found it really hard?* *Were you tired?*	*You might be tired for the rest of the day or even tomorrow.*	*If you do feel more tired than usual, log that in so that we can make better predictions* *Next time take it easier. It is normal to want to do more especially at the start of rehabilitation, but the secret is to do just enough!*
You under-trained!  	✓*Trained less today because you were tired from yesterday?*	✓*Do you have an activity that you do daily that you find it to be 19?* ✓*Do you feel out of energy after that for the day?*	*Maybe try to divide it next time.*
You are under-training at home!  	*Exercises easy at home?* *Scared to do more at home?* ✓*Got a scared partner?* *Don't have equipment to exercise?*	*You might face a slower progress with your goals if you keep under-training.*	*Wanna share your progress with them?* ✓*Wanna invite them to the next training at the center?*
You are doing great!  	*Keep going!*		

Figure 8.16: Example for the content of the check-in module

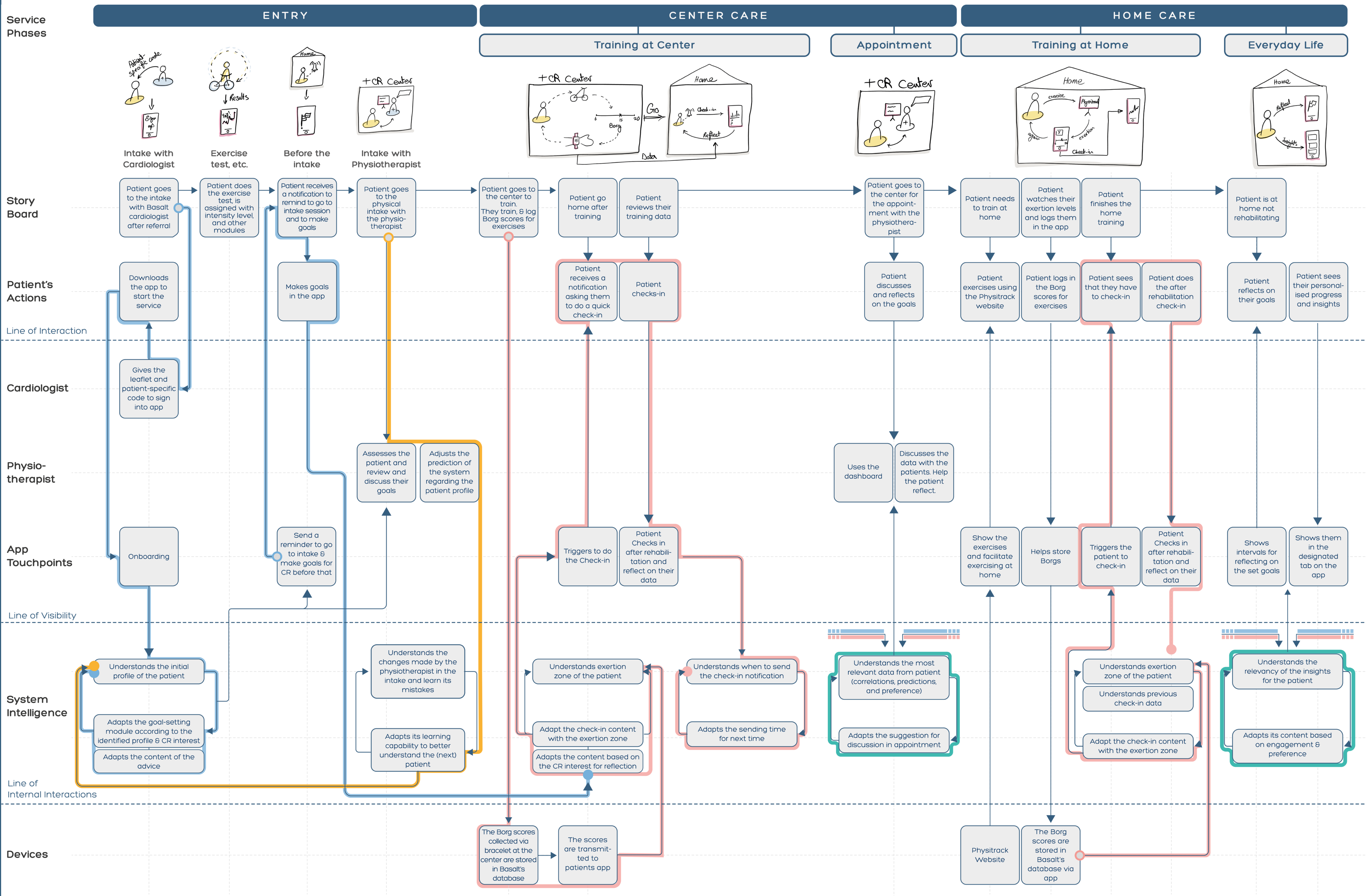


Figure 8.17: Blueprint

Chapter 9

DISCUSSION

This chapter aims to wrap up the project with a general discussion, arguing how the design answers the design goal. The chapter concludes by presenting limitations, recommendation, and finally, reflection.

9.1 General Discussion

The proposed design aims to support blended CR care for the patient and physiotherapist by homogenizing the care in the center and home context while centralizing the patients by making them active and responsible for their care. Moreover, it personalizes the CR care path, not in terms of exercises or changes in the workflow, but in a way that makes sense to the patient following their CR interests.

This way of personalization might not apply to all health domains, but I argue that it works in the cardiac rehabilitation care pathway because it is such subjective care.

It is interesting that the care is the same for everyone (they do exercises) but the way different people approach and see CR makes the difference for them. According to my study, patients tend to reflect on their exercises and activities based on their interest in CR and what they wish to get out of them. These differences cannot be ignored in CR because although the care seems objective, the care path is generally very subjective, which is evident by its goal. After all, it envisions helping patients learn about their bodies, how to manage their energy, and see the benefits of the care.

The proposed solution was specifically made for the ecosystem of Basalt, which is the only rehabilitation center that I found to have already tried to implement blended care. Therefore, I foresee many centers wanting to do this but lacking the knowledge about their system and the needs of their patients.

The part of this concept that is envisioned to support blended care is a generalizable part for any CR care path because, to my knowledge, all rehabilitation centers (at least in the Netherlands) use the Borg score and find it an effective way of knowing how the patient is doing. Therefore, regardless of the differences seen in the CR care pathways in different centers, I believe that this part of the concept can be used by any rehabilitation center.

In this project, I set out to explore the two feedback loops of an intelligent system to understand the user and adapt to them. However, as I worked towards the implementation of such a system as explained in chapter 7, I realized that it is ambitious to want to address both and have concrete conclusions at the end of a graduation project. The way I saw it, I could either propose some adaptation regarding what to return and give back to users or explore the learning and understanding capability of the system. It seems that these two are dependent on each other, meaning that there should be some conclusion about the learning capability of the system to know what sorts of adaptations could take place. Otherwise, it would be similar to proposing concepts without knowing the infrastructure or how the system works, hindering their implementation. Therefore, as I was creating the dataset with the patient, I started with the first loop and explored to see how the personalizations could be captured and had little time to test the adaptations the way I tested the first one because of the timeframe of the project.

I faked the operation of AI to classify the patient profiles to make the basis for care adaptation to see whether it has any value. Although the sample size of the patients I worked with was small, I could see that there were already correlations between different data points. For example, three of my participants were diagnosed with cardiac arrhythmia, and all of them had complaints of not having energy throughout the day. Therefore, if this dataset gets bigger and bigger, there could be more levels of personalization for patients, which is of course hard in this case because we are dealing with subjective data instead of objectives.
In conclusion, I see this concept as a companion for patients starting rehabilitation to support them throughout the care path and approach them when needed. This means that patients might only need to check in after rehabilitation when there are some irregularities in their data and the system can not understand why. Therefore, it was never the intention to make a design to engage patients all the time, but I envision it to approach them when needed. This means that a perfect patient might only use the design to check their schedule, and that is OK as well.

9.2 Addressing Design Goal

The design goal made for this project was to help patients perceive the homogeneity of the care at home and center while being personalized to help them be more active and engaged in their care. This was envisioned to help them have a smoother transition to the third phase of CR from the second phase.

How does it support blended care?
The proposed concept supports blended care by providing a means for the patient to rehabilitate at home and center while having an overview of all the care path and their performance in it, which centralizes them in the care by making them more active and giving them responsibility for their own body gradually at home. The concept allows the physiotherapist to have an effective conversation with patients during the consultation moments in order to adapt their care because the irregularities and their preferences are already detected by the design, facilitating the diagnosis and the conversation.

How is it personalized?
The concept understands the level of motivation and the exertion tendency of the patients s at the start of CR. And during CR, it learns about their behavior by their levels of exertion and associated annotations helping patients give meaning to their behavior and performance by providing reflection moments and opportunities to make goals relevant to their interest in CR.

9.3 Recommendation and limitation

One limitation of this project was not being able to run the DED exploration explained in chapter 7. I see that as a big addition to this project since fewer conclusions were able to make regarding the second module because it could not be tested in real life but was made based on the insights from the research and the general opinion of the stakeholders. Therefore, I foresee many insights coming from a test in which patients are recruited from the start of the care path(like I did) and continue with them for the 6-8 weeks of rehabilitation. I think the insights would be marvelous in that case that might (partially) reject or validate my conclusions in this project.

Another recommendation is to check the perceptions of the patients regarding their needs and their actual needs from the medical point of view. The physiotherapist involved in this project shared that they had once a patient with low motivation and insecurity levels (patients positioned in the bottom left part of the patient profile not thinking that they do need CR and are doing fine themselves), but they found out that the patient's test results were so much lower than normal. This proposes a friction in the system, and I wonder how it could be therefore I recommend exploring it.

9.4 Reflection

The intangibility of services and intelligence of the system:
This project was my first experience designing things counting more as intangible. Coming from a hardcore industrial design background in my bachelor's and then being a student in the Integrated Product Design program here in Delft left me little room to mess around with intangible things such as a service or a system. Therefore, I encountered the complexity of designing services in this project in which the topic was so much integrated into the healthcare system. Service is intangible in itself and hard to communicate but it gets even harder when you add intelligence into the system with multiple feedback loops for the stakeholders involved. I found this quite hard and it took me a while to find a way to communicate and show it. I think we lack tools and knowledge in this regard in the curriculum in the university which is unfortunate because it is a needed skill for a designer.

Data-enabled design:
This project was initiated by the data-enabled design department of Philips, and I took the project on because of my interest in data and its inclusion in the design process and concept. Throughout the project, I tried to incorporate data-related practices in the design process as it was one of my learning objectives. However, I was not able to collect data from the users because of unexpected events which were unfortunate. But I had a great experience learning about the theory and the experience of my mentor.

Ill-defined state:
The project started with no clear set-up which took a lot of time and energy and put a lot of pressure on me feeling like I had to arrange most things. In this case, I was the case that I would be so happy to get an interview with a stakeholder much less do data-centered activities with them. In this regard, I was amazed by the open attitude of health professionals to doing interviews and giving me tour visits.

Sense of agency:
Throughout the project, I felt a great sense of agency which could be either good or bad. Sometimes, I was happy about it because it gave me the freedom to do as my intuition says, and sometimes not so happy because it was too open.

Working iterative and agile:
This was my first experience doing iterative design and I generally found it great because it facilitated the project in terms of making concepts and generating knowledge. However, it brought some challenges as well. Sometimes it got very messy and chaotic, especially for writing. In this process, I learned the importance of setting goals for iterations and narrowing its focus and making conclusions at the end.

Target group:
Throughout the project, I really struggled with getting participants because no initial set-up for the project. Moreover, due to the inaccessibility of my target group it only had to be done through health professionals. In the end, I got in contact with the participants, through my own doctor who was back then treating my broken finger at the hospital. I was amazed how very personal connections could help in this regard.

Staying true to research questions:
Throughout the project, I realized that sometimes I lose my way in the myriad of insights where everything seems very interesting. However, I realized that I should take my research questions as my map to find the way, otherwise a lot of time and resources are wasted and I feel confused.

Explorative and Educative:
I am super happy that I approached my master's project very explorative and educative. I learned many things that I did not use in my project, and I did activities that I did not include in my thesis. I saw it as my last learning opportunity in my master's program and I am happy with my decision.

Focus on user experience:
Focusing on the users was one of my learning objectives in this project, as I had never before focused on them. I am now happy to see that I did a lot regarding user research and have definitely reached what I was aiming for.

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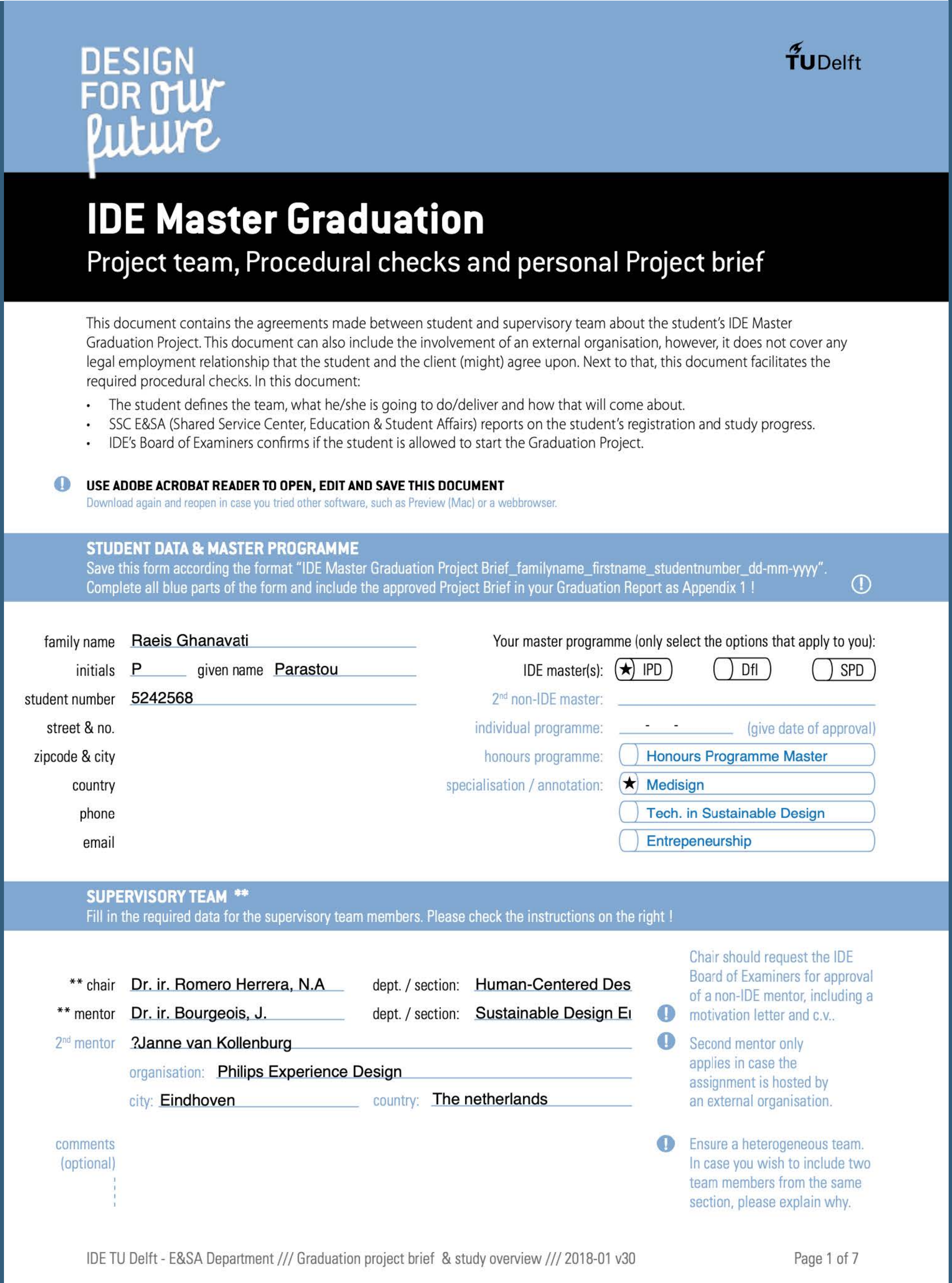
APPENDIX

Table of content:

(A)
-PROJECT BRIEF-



DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name Raeis Ghanavati
initials P given name Parastou
student number 5242568
street & no.
zipcode & city
country
phone
email

Your master programme (only select the options that apply to you):
IDE master(s): ★ IPD ○ DfI ○ SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ○ Honours Programme Master
specialisation / annotation: ★ Medisign
○ Tech. in Sustainable Design
○ Entrepeneurship

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair Dr. ir. Romero Herrera, N.A dept. / section: Human-Centered Des
** mentor Dr. ir. Bourgeois, J. dept. / section: Sustainable Design E
2nd mentor ?Janne van Kollenburg
organisation: Philips Experience Design
city: Eindhoven country: The netherlands

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30

Page 1 of 7

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Dr. ir. Romero Herrera, N.A date - - signature

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 46 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC

List of electives obtained before the third semester without approval of the BoE

☑ YES all 1st year master courses passed

○ NO missing 1st year master courses are:

name Colinda/Monique date 28/2/2022 signature MvM

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ☑ APPROVED ○ NOT APPROVED

Procedure: ☑ APPROVED ○ NOT APPROVED

- also approved for Medisign

comments

name Monique von Morgen date 15/3/2022 signature MvM

Tailored and Adaptive Rehabilitative Care Pathways for Cardiac Patie project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 11 - 02 - 2022 25 - 07 - 2022 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Cardiovascular disease is a prevalent disease among people with common modifiable risk factors such as high blood pressure, physical inactivity, overweight, etc. which initially make patients prone to the disease. Particularly, they should monitor and control the risk factors (secondary prevention) after a cardiac event to avoid any recurrences. In addition, they might become cognitively or physically impaired to a certain extent due to their condition. Therefore, knowingwhatandhowto change becomes challenging. Cardiovascular Rehabilitation (CR) is a set of recommendations that cardiac patients follow to maintain a normal life with a cardiac condition, aiming to minimize the risk factors through the change of behavior.

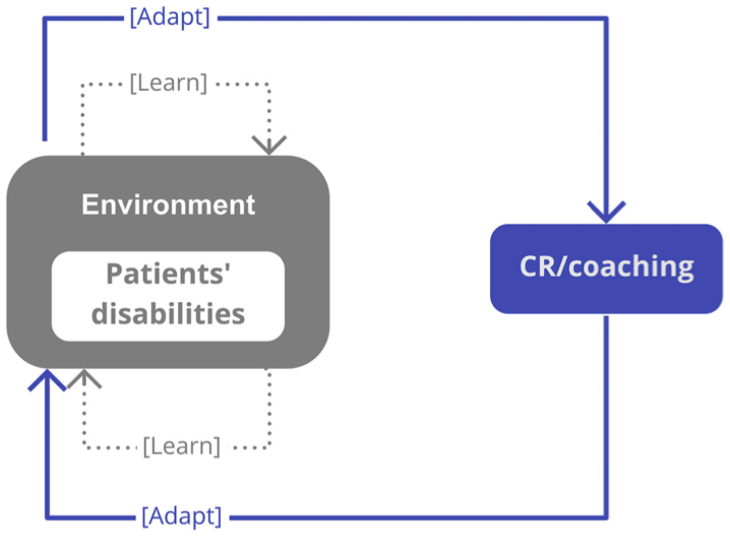
These programs usually have four different phases based on the condition of patients:
Phase 1 (acute phase) starts immediately after a cardiac event when the patient is still in the hospital.
Phase 2 (outpatient phase) starts immediately after the discharge of the patient.
Phase 3 (continuing outpatient phase) is where patients continue the care pathway at home, start self-monitoring symptoms, and practice more independent exercises.
Phase 4 (independent ongoing maintenance) is where patients perform unsupervised activities and build independence in their daily life again.

The higher the phase of CR, the more it moves to the context of the patient's home, with more dependency on the patient's daily life, resulting in lower levels of adherence.
Clinics may utilize personalization and coaching to provide CR adherence. They attempt to tailor the plans by including an interdisciplinary team of doctors, nurses, physiotherapists, nutritionists, etc. to coordinate the rehabilitation progress and adjust the program if necessary. As a result, patients have to visit the clinic more frequently (2,3 times a week) to receive CR revisions and coaching, making them less accessible.

As a measure to increase accessibility, Tele-rehabilitation (delivery of rehabilitation services via information and communication technologies) provides more flexibility and coaching moments for patients. Therefore, they find it easier to adapt to their abilities and prior lifestyle since they have more opportunities to obtain a revised plan. However, tracking the progress of patients in this method is challenging due to the nature of such care. In either case, the interaction moments are infrequent, discontinuous, and lack an understanding of the nuances of patients' lives, condition, and progress to provide a tailored care pathway.

In general, CR plans could benefit from integration in the patients' life, which could be achieved by understanding their (dis)abilities and daily life to ensure more adherence.Generating understandability(of the patient/environment) and adaptability(of the CR plans/coaching) could be explored with the data-enabled(DED) approach. It can potentially orchestrate a continuous pipeline of acquiring and processing data from the patient or environment, resulting in actionable insights to provide better care.

space available for images / figures on next page introduction (continued): space for images



PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

It is decided to focus on cardiac patients in the 3rd and 4th rehab phases due to time limitations and the majority of CR programs devised in these phases.

The major improvement opportunities are as follows:
1. Tailoring:Tailored CR plans can be realized by a system that understands the capabilities of the patients and the opportunities lying in their context. 2. Adaptation:Adapted CR plans can be realized by a system that continuously monitors the patient and adapts to the progress/changes of the patient.

The envisioned solution would follow the work of the data-enabled design department of Philips(project partner), in which intelligent solutions are developed by exploring data from the field, being both qualitative and quantitative, to gain rich insights to fuel new innovations. It is foreseen that a product-service system (PSS) concept as an intelligent solution(following DED principles) would be designed to tackle the identified problems, with the design process being explorative and iterative together with end-users.

- What are the contextual factors to consider, and how to capture them?

- How can data reveal the (dis)abilities of the patients?
    - How to translate that into a base on which the system adapts itself?

- How to capture and respond to the rehabilitation progress?
    - What are the CR/coaching elements in need of adaptation?

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Designing an intelligent PSS providing tailored and adaptive rehabilitative care pathways to cardiac patients by learning about their (dis)abilities and lifestyle.

In order to approach the research questions, the role of data as the major element in the iterative design of the PSS will be explored. This is both in the discovery/explorative as well as the concept creation part. Therefore, the exploratory state of the project would be maintained using experiential prototypes and concept iterations inspired by relevant data. This vision will be realized with the guidance from the Data-Centric Design Lab, TU Delft together with the Data-enabled design department, Philips Experience Design as the two parties involved in the project.

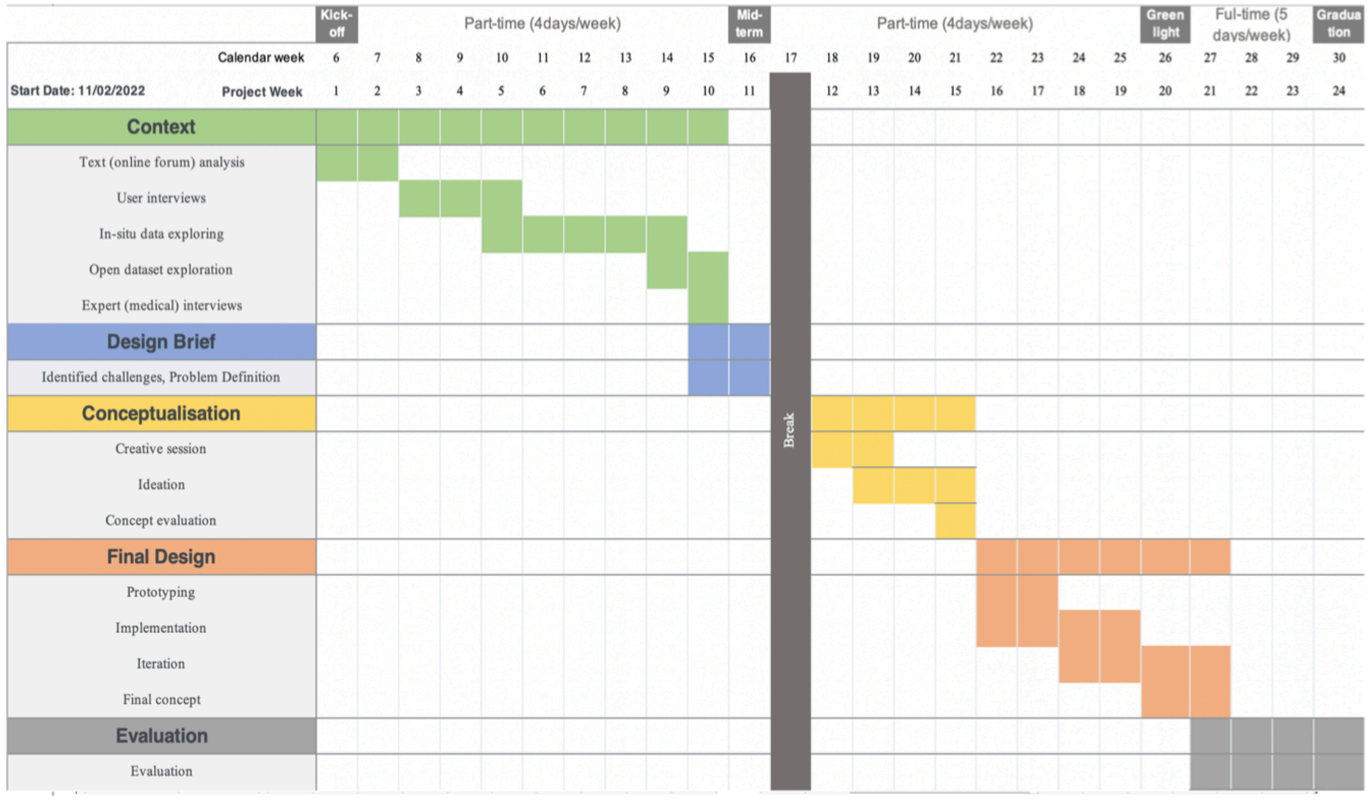
The designerly iterations will continue to reach proof of the concept, envisioned to identify different adaptive pathways based on patients' physical and contextual conditions.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date - -

- - end date



The whole process is envisioned to be iterative and experiential, running multiple iterations of context, brief, conceptualisation, and designing.

After the first activity in the plan, being analysis of the patient stories and understanding barriers and facilitators, the scope of the project will get more specific since interesting directions are revealed and one can be chosen.

[redacted]

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

There are certain competences that I aim to acquire in my graduation project. In my elective semester, I participated in courses with much focus on user research and making the design process human-centered. As a result, I am interested in putting more emphasis on exploring the user and their context to hone this skill. In addition, my prior interest in data and including it in the process and the design itself brought me to the data-enabled design methodology, which I would like to further explore through this project. Personally, I follow courses from other disciplines than design, such as statistics, artificial intelligence, and computer science techniques, while keeping an eye on how they could be used in the design world. Therefore, I want to include such techniques where applicable in the project to further explore their potential, for example analyzing texts or open datasets.

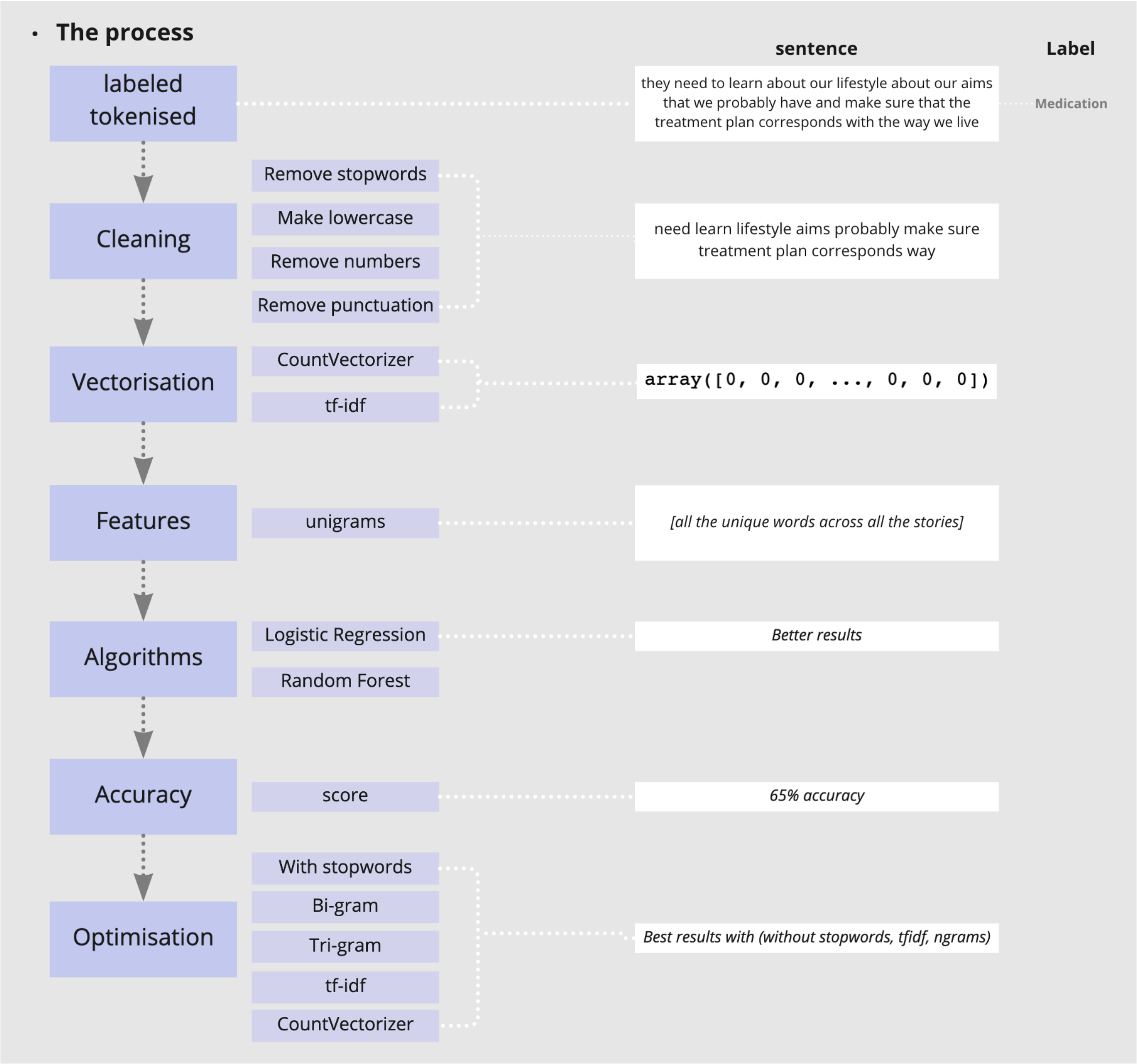
FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

(B)

-NLP Pipeline-

- **The process**



they need to learn about our lifestyle about our aims that we probably have and make sure that the treatment plan corresponds with the way we live

need learn lifestyle aims probably make sure treatment plan corresponds way

`array([0, 0, 0, ..., 0, 0, 0])`

[all the unique words across all the stories]

Better results

65% accuracy

Best results with (without stopwords, tfidf, ngrams)

461 patient stories

all data

112 manual

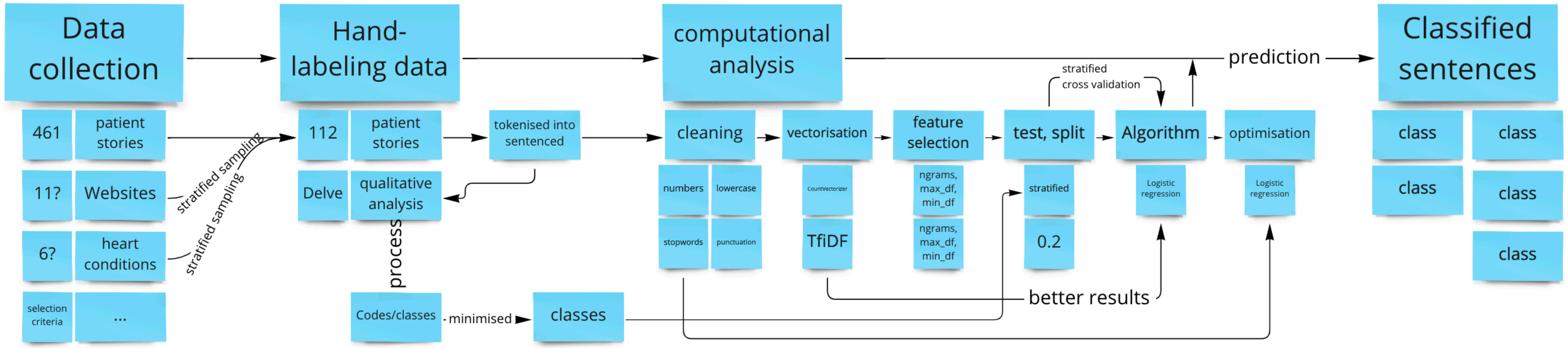
349 computational

websites

```
health talk                     193
american heart association       61
heart-failure.net                54
heartfoundation.org              47
dailystrength                    30
stin.nl(dutch)                   28
british heart foundation         23
peterjemmet                       9
esc                               7
stopafib.org                      5
newlifeoutlook                    4
Name: website, dtype: int64
```

heart conditions

```
heart attack            166
heart failure           103
heart disease            64
stroke                   53
atrial fibrillation      50
tia and minor stroke     25
Name: heart condition, dtype: int64
```



Thematic (manual) analysis

In order to make the training data for the machine to learn from in the computational analysis (next step), I manually analyzed a sample of the stories (this step) thematically and identified recurring themes.

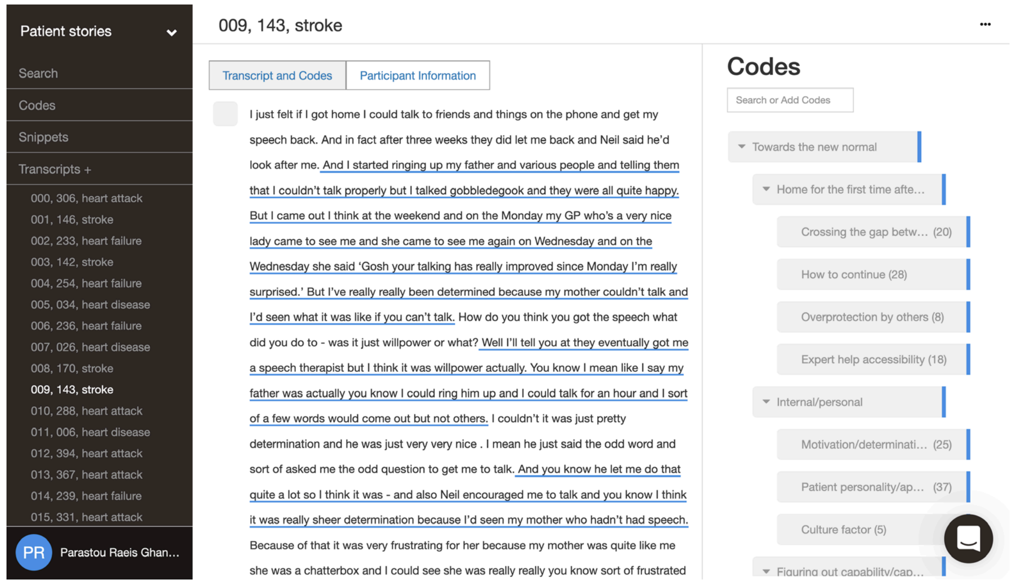
The Sample

To prevent any bias in the training data, I decided to take a sample (n=112) from the population of the stories (N=461) using the Proportionate Stratified Sampling method based on the cardiac condition and the origin website.

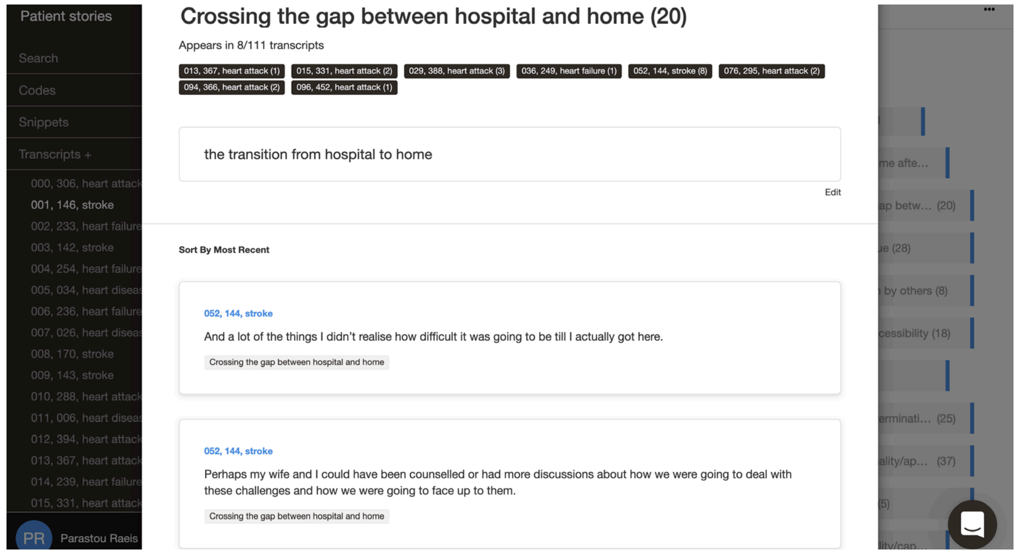
Procedure

To manage the themes and codes in the stories, I used Delve website, which is a software to analyze qualitative data (Delvetool, 2022). Therefore, it was easier to manage the identified codes and sub-codes. Figure 0.3 shows an impression of the website and the workflow.

This tool automatically divides the text into sentences based on the full stop(.) after each sentence. Thus, I used multiplications of sentences to give a single code or sub-code, ie. assigning a code to either one or two sentences instead of 1.5 sentences. The reason for this was to make a single unit for identifying sentences so that I can further use for the tokenisation process in the computational step to analyse the rest of the stories.



I just felt if I got home I could talk to friends and things on the phone and get my speech back. And in fact after three weeks they did let me back and Neil said he'd look after me. And I started ringing up my father and various people and telling them that I couldn't talk properly but I talked gobbledegook and they were all quite happy. But I came out I think at the weekend and on the Monday my GP who's a very nice lady came to see me and she came to see me again on Wednesday and on the Wednesday she said 'Gosh your talking has really improved since Monday I'm really surprised.' But I've really really been determined because my mother couldn't talk and I'd seen what it was like if you can't talk. How do you think you got the speech what did you do to - was it just willpower or what? Well I'll tell you at they eventually got me a speech therapist but I think it was willpower actually. You know I mean like I say my father was actually you know I could ring him up and I could talk for an hour and I sort of a few words would come out but not others. I couldn't it was just pretty determination and he was just very very nice . I mean he just said the odd word and sort of asked me the odd question to get me to talk. And you know he let me do that quite a lot so I think it was - and also Neil encouraged me to talk and you know I think it was really sheer determination because I'd seen my mother who hadn't had speech. Because of that it was very frustrating for her because my mother was quite like me she was a chatterbox and I could see she was really really you know sort of frustrated



Crossing the gap between hospital and home (20)

Appears in 8/111 transcripts

013, 367, heart attack (1) 015, 331, heart attack (2) 029, 388, heart attack (3) 036, 249, heart failure (1) 052, 144, stroke (8) 076, 295, heart attack (2) 094, 366, heart attack (2) 096, 452, heart attack (1)

the transition from hospital to home

052, 144, stroke

And a lot of the things I didn't realise how difficult it was going to be till I actually got here.

Crossing the gap between hospital and home

052, 144, stroke

Perhaps my wife and I could have been counselled or had more discussions about how we were going to deal with these challenges and how we were going to face up to them.

Crossing the gap between hospital and home

Findings

Finally, a total number of 56 codes and sub-codes were identified in the sample of the stories, which are illustrated in figure 0.4, together with the corresponding number of frequencies. The sub-code with the most frequency is about Describing Cardiac Rehabilitation (n=97), and Independance with the least frequency (n=6).

To understand the recovery of patients, I made a sequence for the codes and sub-codes to make a complete journey, which is evident in

Code/sub-code	Frequency
describing cr	97
making peace	80
life changes made in retrospective	73
disability meaning	69
(un)sure about capacity/capability	67
emotional/cognitive impact	64
being heard/understood	57
patient personality/approach	56
initial disabilities and limitations	55
progress made	54
support	53
causes	51
activities of daily living	46
side effects	37
how to continue	37
progress in cr	35
experiencing the new normal	34
crossing the gap between hospital and home	33
life-long disabilities	33
assistive products	32
considerations (both sides)	30
change/adjustment	30
relationship with partner	30
motivation/determination	30
relaxation	28
medication	27
being understood by others	26
self-adjusting medication	24
expert help accessibility	23
received advice	23
personalisation	22
my/our choice	21
till the rest of my life	20
missing the old normal	20
ICD complications	20
another episode	20
introduction to the outside world	19
caregivers	19
self-response to episode	19
understanding the process +-	17
proceeding after cr	16
children	16
check-ups	16
overprotection by others	14
being valued	13
prospects of the new normal	12
cr impression	10
other rehabilitative methods	9
fear	9
managing the condition	9
(un)sure/aware of the progress	9
culture factor	8
emotional impact on family	8
Logistics	7
independance	6

Computational Analysis

To analyze the rest of the stories, I used the codes and sub-codes from the previous step to train the machine to classify the rest of the stories.

In order to do this, I used Natural Language Processing(NLP) which is a branch of artificial intelligence that enables computers to understand text data (IBM-NLP, 2021). It has multiple methods, including supervised methods needing labeled data(text) such as topic classification and sentiment analysis, and unsupervised methods such as topic modelling.

I chose to do topic classification, which requires labeled data (the outcomes of the previous step) to be able to classify the other stories. The reason for choosing this method was the suitabilty of the outcomes of this method with the desired outomce I wanted have from this activity. That is classifying the rest of the stories based on the themes I had found during manual analysis, in contrast to other methods such as topic modelling, which cluster similar stories or sentences together.

Procedure

As stated above, I used topic classification to analyze the remaining 349 stories. Therefore, I followed a general NLP pipeline (figure 0.6) consisting of the following steps:

Data acquisition, Text cleaning, Pre-processing, Feature engineering, Modeling, Evaluation, Deployment, Monitoring, and model updating (Morioh, 2022).

Data Acquisition:

The first step consists of collecting the dataset to work with, which I had already done prior to the manual analysis.

Text Cleaning:

This step consists of removing parts of the text that do not have much meaning, thus not helping the machine learn from them. Due to the highly unstructured nature of text data(compared to other data types), I applied multiple data-cleaning steps:

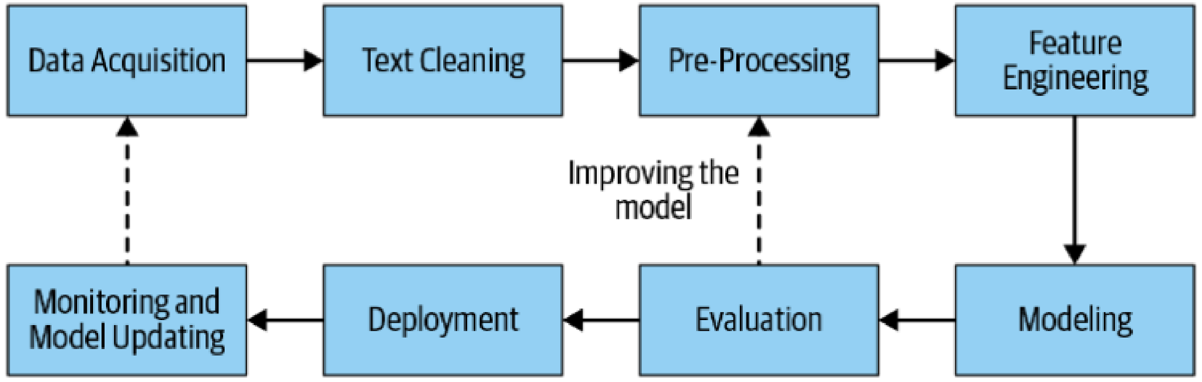
Removing stopwords: These are repetitive words such as I, that, the, a, etc.

Making lowercase: To remove any distinction between the same words with different capitalization because the machine considers them as two distinct words, such as "Heart" and "heart".

Removing numbers: Numbers are also considered as excess data.

Removing punctuation: In this analysis, the punctuation also carries little meaning. Before removing the punctuations, I split all the stories based on the full stop(.) to tokenize them according to the tokenization in the manual step. After that, I removed all the punctuations.

I chose the cleaning processes based on what I assessed to be helpful for this analysis specifically, and it was a repetitive process of cleaning and visualizing using wordclouds to see excess words or characters.



Removing short sentences: I deliberately removed sentences having 5 words or less to reduce the number of data.

heart condition	stories
heart attack	that is good
stroke	I can only assume that

The following figure shows an example of the cleaned data, ready to be pre-processed:

target	stories_sw
Logistics	cardiac rehab allowed participate condition heart critical supporting systems

Pre-processing & Feature Engineering:

This step consists of making the data ready to be analyzed. It includes turning the text data into numerical representation so that the computer can understand it. There are two methods to do it, both of which I tried:

CountVectorization: Counts the number of occurrences of each word in each document and returns a matrix with the columns being unique words in all documents and rows the frequencies of words.

TF-IDF: Stands for term frequency-inverse document frequency and returns a number from 0 - 1 to score the most unique words in each document in relation to all the documents.

The former can be used to teach the machine based on the most recurrent words and the latter based on the most unique ones.

(C)
-Patients' Recovery Periods-

While reading about the experience of patients, I identified three main phases in the recovery of cardiac patients being the following:

1- Towards the New Normal.
2- Transition to the New Normal.
3- Experiencing the New Normal.

The names were inspired by the quotes of patients in which they implied that their recovery process was a journey to get to know their new self in the new normal.

1- Towards the New Normal:

Right after being discharged from the hospital and coming home, cardiac patients experience some often temporary disabilities and limitations. This coupled with the fear of episode recurrence and overprotection by others makes them not exert themselves.

The insecurities felt in this phase are assumably due to their capabilities being unknown to them.

It starts from the first time they are home and have to deal with their condition until the realization of how the new normal might be for them.

2- Transition to the New Normal:

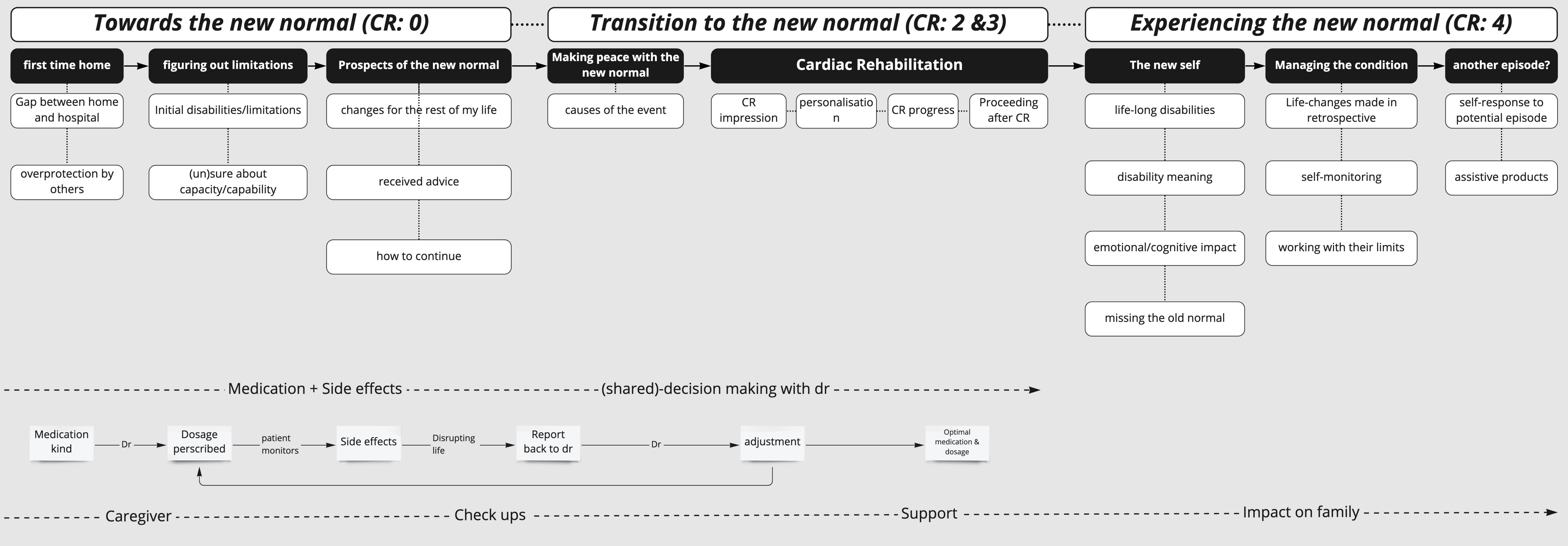
After accepting the event and the current situation and hopefully knowing the causes of the event, patients start working towards improving their condition via methods such as cardiac rehabilitation.

This phase is about regaining confidence by learning about the patients' capacity and capabilities which is ideally accomplished in cardiac rehabilitation.

3- Experiencing the New Normal.

This phase starts after cardiac rehabilitation graduation, where the remnants of the condition stay with them, such as life-long disabilities, which has different meaning for different patients.

Here they experience what their new normal is, which is shaped by the consequences of their condition.

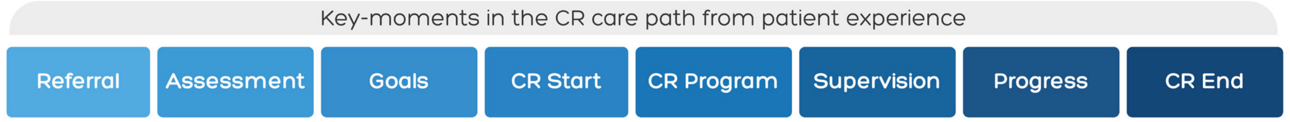

Towards the new normal (CR: 0)
Transition to the new normal (CR: 2 &3)
Experiencing the new normal (CR: 4)
first time home
Gap between home and hospital
overprotection by others
figuring out limitations
Initial disabilities/limitations
(un)sure about capacity/capability
Prospects of the new normal
changes for the rest of my life
received advice
how to continue
Making peace with the new normal
causes of the event
Cardiac Rehabilitation
CR impression
personalisation
CR progress
Proceeding after CR
The new self
life-long disabilities
disability meaning
emotional/cognitive impact
missing the old normal
Managing the condition
Life-changes made in retrospective
self-monitoring
working with their limits
another episode?
self-response to potential episode
assistive products
Medication + Side effects
(shared)-decision making with dr
Medication kind
Dr
Dosage perscribed
patient monitors
Side effects
Disrupting life
Report back to dr
Dr
adjustment
Optimal medication & dosage
Caregiver
Check ups
Support
Impact on family

(D)

-CR Experience Journey-

Patient Experience

The CR journey consists of the experience of patients from starting the care until the finishing part of the second phase of CR in the rehabilitation center. The user study that resulted in this patient journey is comprised of multiple key moments shown in figure



(1) Referral:
The patient is either referred or not referred to a CR center by their doctor.

As mentioned earlier, Referral is already a big problem in the patient experience and is the first point of frustration from the perspective of the patients. "Long CR waiting lists" and even simply "not being referred to CR" were deemed as barriers.

(2) Assessment:
Patients are assessed by the health professionals to obtain a baseline assessment of their condition.

The main points of barriers and facilitators at this moment are regarding the realization of (un)suitability of the CR Program and activities to the condition of the patient after assessment. The communication method of the assessment to the patient is deemed problematic as well because of the objectivity of the evaluation.

(3) Goals:
Patients set goals to achieve within a timeframe in CR with a health professional.

The goals are generally considered a facilitator in the CR process by the patients since it gives a sense of accomplishment that comes with rewards (progress). Besides, the goals are closely associated with the patient's own limits, so it helps them realize the boundaries of their capabilities.

(4) CR Start:
Patients start with the CR for the first time (first session).

This moment is associated with much supervision from the health professionals while patients execute the CR program. The reason could be both from the patients and the health professional side. With the patients being scared to push themselves because of their insecurities and the health professionals not yet knowing the capabilities of the patients, the supervision here is at the highest level

(5) CR Program:
Patients receive a care plan to carry out within a timeframe.

Most of the negative aspects of this moment are associated with the unsuitability and inadapta-bility of the care plan to the needs and conditions of the patients. In this regard, the variety of ex-ercises to choose from was considered a facilitator, probably because the patients can choose the one fitting them the best.

(6) Supervision:
Patients are fully/partially supervised while doing the activities in the CR program.

This moment was mentioned considerably by the patients. The monitoring and supervision provided by the health professional during CR are closely linked to the sense of confidence and reassurance of the patients. The reason behind this feeling could be the insecurities and the unknown nature of the condition to the patient.

(7) Progress:
Patients reach the goals set throughout the program and progress with their condition.

The progress realization moment is the rewarding part of the patient experience throughout the CR journey, and patients would like to intensify it by celebrating and sharing them with their loved ones. However, the progress made during CR seems to be slow and invisible, making it a frustrat-ing experience at the same time. This could be due to the short duration of CR or because the progress is intangible to the patient.

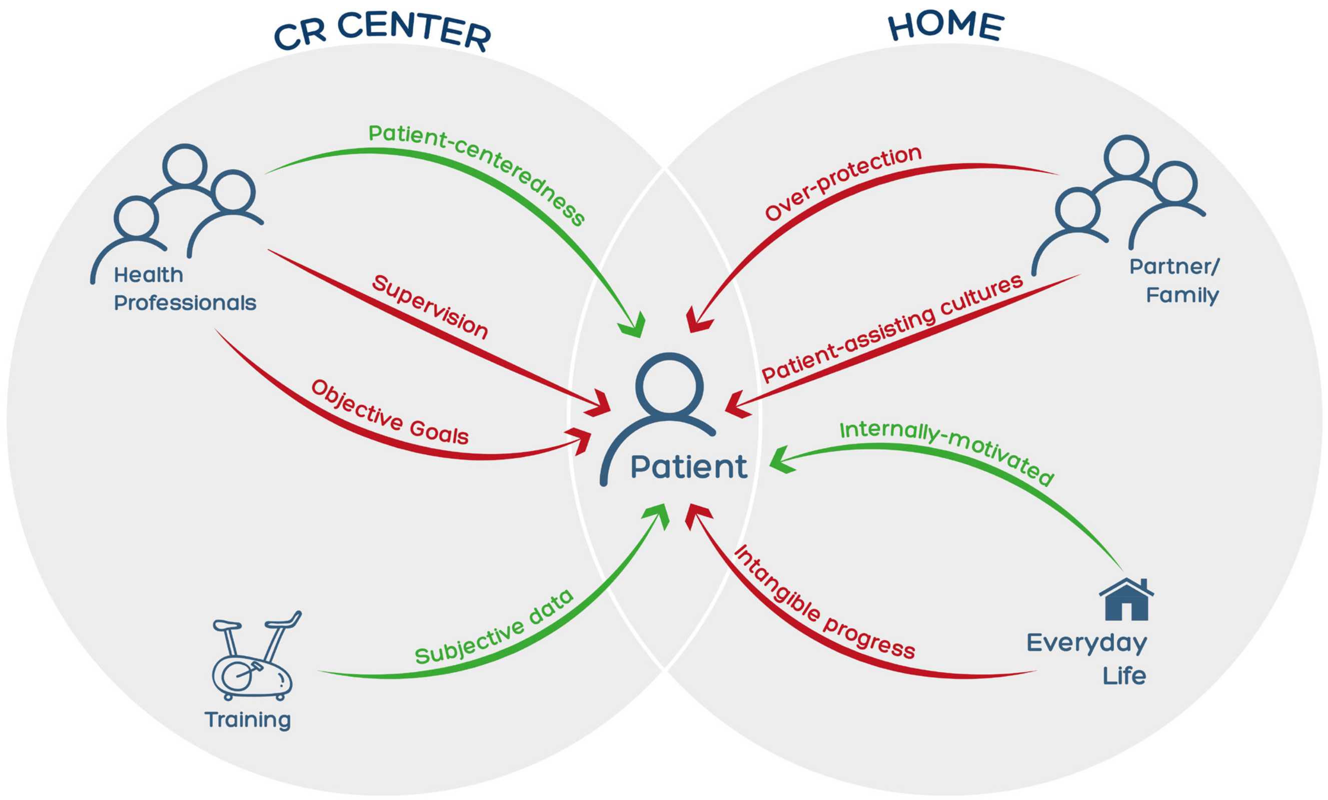
(8) CR End:
Patients finish the CR program after 6-8 weeks of training.

This is a big moment in the CR experience. The finishing part means leaving the safety net of being supervised by health professionals and not having the responsibility of dealing with the condition themselves. After the finishing point, most patients lack the guidance and supervision provided during CR and search for similar options and that limits their activities post-rehab. They become scared of being on their own and having to deal with the uncertainties alone

(E)

-Contextual Factors-

Chapter 4:
Contextual factors influencing the CR care at home limiting the recovery of patients



Patients

Motivation and goals:
In the patient stories, there was a clear distinction between the very goals-oriented people towards rehabilitation and others. These patients showed a positive attitude towards CR, meaning that they did not see rehabilitation as a set of exercises or a definite program but primarily as a means to achieve their highly personalized goals.

This perspective demonstrates how they see and perceive CR, which positively influences their recovery and adherence to CR care because they make their rehabilitation only part of the bigger picture of recovery by making goals. As a result, patients' goal-orientedness influences their commitment to and adherence to CR care with the hope of achieving their goals.

> “So anyway, when my doctor suggested doing rehabilitation, I enjoyed the idea of cardiac rehab because it had personal goals set up, and you graduate from the program at the end.
>
> [Patient with heart attack]”

> “Continually setting goals for myself has been really important in my recovery. I started with small attainable goals and went from there.
>
> [Patient with heart attack]”

> “SMART goals were to become an important part of the recovery plan throughout the year more than I realized at this stage, but it was by using this ideal that I have kept challenging myself to make continued improvements.
>
> [Patient with heart disease]”

Despite the fact that the majority of patients were notable in this regard, it should be noted that this may have been biased, since typically, the more optimistic or active patients are the ones that participate in online forums, research, and experience sharing.

CR Center

Health Professionals (non-patient-centered):
In the patient stories, there were many quotes concerning the fact that patients did not feel like being addressed as human beings. Thus, they felt demotivated and not understood by the health professionals, which was a hindrance for them.

> “When the doctor was about to prescribe me my medicine, he asked the nurse what's the weight? Because he wanted to know my weight to determine the dosage. But it was like what's the weight of this body, not this patient or this person. What he said stuck with me for a while actually.
>
> [Patient with heart failure]”

Health Professionals (objective goals):
Part of this non-patient-centered way of dealing with patients was the objective goal-making process of health professionals for patients. They tend to set objective and clinical goals for the patients because they can relate to and understand them better. This is as opposed to the last mentioned point about the motivation and goals of patients, which argued that they have very personal and subjective goals, which makes them feel that they cannot relate to the objective goals established by the health professionals.

> “My heart rate was 59, blood pressure 15396, weight 982 kg, height 177cm, BMI 3134, and waist 107cm. The Cardiac Prevention and Rehabilitation Team set long-term targets against these measurements for me to reach: blood pressure of 14090, weight of 58783kg, BMI 18525, and waist 94cm.
>
> [Patient with heart attack]”

Constant supervision:
The constant supervision of the health professionals made the patients quite happy and satisfied temporarily for the duration of the CR care path, but it impaired their sense of self-efficacy at the end of the program. This might be one of the reasons for finding the transition from phase two to three difficult for patients.

> “I was sad to leave my safe net of workouts when this rehab was over.
>
> [Patient with heart failure]”

Tests & scores in CR:
There are several tests and scores that provide data in the CR care pathway, as was discussed in the previous chapter. The patients, however, often find this information confusing and hard to relate to.

> In a repeat of the shuttle walk test, I achieved a score of 530 I hope this is an improvement on the 440 at my initial assessment but I was certainly feeling better and far more confident in myself.
>
> [Patient with heart attack]

> I scored 280 meters at 60 on the max oxygen uptake test. I'm not too sure what this actually means but know I had to concede defeat once the beeps became too rapid and I could not continue.
>
> [Patient with cardiac arrest]

On the other hand, when it becomes subjective, patients may relate to it, which is expected based on the results of the previous chapter.

> I was advised to exercise at a heart rate of between 100, 120 bpm this is worked out using the following calculation 220 max heart rate minus your age minus your resting heart rate and minus 30 if you are on beta blockers this gives you your HRR heart rate reserve. To get my training heart rate in the zone to exercise, I then, need to work out 40 and 70 of my HHR and add the resting heart rate. This is all a fairly complicated way of determining the level of exertion, and it is far easier to use the RPE (BORG)scale to monitor the exercise intensity because I can tell it myself.
>
> [Patient with heart attack]

> The nurses teach me about my heart rate. They tell me that I should be aiming for my HR to stay below a certain number, and I've learned to recognize the connections between my HR and my level of exertion.
>
> [Patient with heart attack]

Progress:
According to the patients, their progress in CR is very slow and intangible, which could be either because of setting unattainable goals or not training enough in the rehabilitation training. In any case, they tend to realize their progress by reflecting on where they were before starting CR and where they are now (probably after finishing CR).

> It's just that after time when you look back, you realize you have improved. It's not as debilitating as before. I was, you know, really breathless really clammy, and any exertion was just too much.
>
> [Patient with atrial fibrillation]

Over-protection of family:
Often when people experience a cardiac event, they do not remember that much about it. However, their families, being the ones usually there when it happens, undergo a traumatic experience which results in over-protective behavior in the recovery period of patients. This inhibits the progress of the patients because their families are scared for them and do not allow them do that much at home.

> Well, personally, I think it's more difficult for the partner really because it's frightening, isn't it? Of course, I was anxious as well when I got home, because it was all down to her then, which was worrying, and she wouldn't let me do a thing which was frustrating. But everyone kept saying no to me, no you can't eat that, no you can't do that.
>
> [Patient with heart attack]

Effect of culture:
Different cultures have different perspectives on treating with patients. Some cultures(especially in the east) necessitate caregivers and families to help the incapable patients and do everything for them out of love and support. However, this is in contrast to making cardiac patients capable in real life, which is the vision of CR because someone else is doing everything for them.

> Because in our culture we always as soon as somebody is struggling we try to help them if they can't drink... So I try to feed him[my husband], and they[doctors] said don't treat him like a child, let him do it.
>
> [Patient with heart attack]

(F)
-Iteration 1-

Ideas generated from iteration 1:

This iteration was quite early in the project, which started with a list of assumptions based on the key moments of patients' experiences in the CR care path. Then different possibilities were explored in terms of concepts to answer the identified problems at that stage, which revealed different design directions and helped with choosing which ones (not) to take according the project scope and the envisioned impact.

Assumptions

The list of the main assumptions that informed the ideation process is as follows:

Assessment:
a. It seems that assessing the patients at the start of CR is first based on their disabilities and then their heart capacity.
b. The assessment scores are not understandable and relatable to patients.

Goals:
a. Goals are highly personalized.
b. Goals are integrated into the care pathway and also the care received by the patient (changing the care based on the goals).

CR care plan:
a. The program is personalized based on the assessment (disability and heart capacity).
b. Patients have a voice in the CR care they receive (mainly because of the goals).
c. Patients do not know "what too much exertion" is for them.
d. Patients cannot relate the tests and scores received during CR to their home and daily life.

Supervision:
a. Patients are highly supervised during the CR program.
b. Patients seek to be supervised by health professionals during CR to eliminate the uncertainties and dangers.
c. The feeling of safety for patients is generated through constant supervision at the center.

Progress:
a. Progress in CR is very slow. Therefore it is not tangible.
b. Most progress is evident to patients at the end of the program in retrospect via reflection.

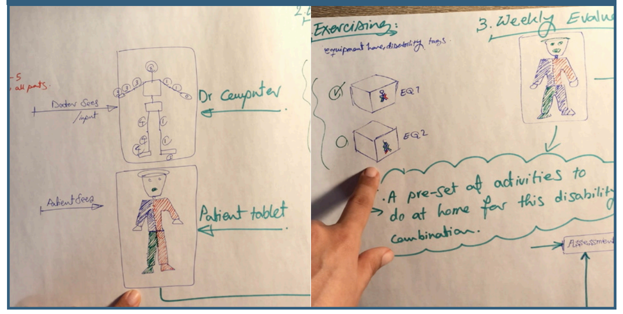
End of program:
a. The end of the program comes with many uncertainties because patients feel they are leaving their safety net.

Exploring Possibilities

In the ideation process, I attempted to integrate the assumptions formulated earlier to form different concepts. This process resulted in 6 concept videos in which the core concepts were implemented using low-fi prototyping. The following figures show screenshots of each concept with the description.

Due to the quick iteration at the early stages of the project, the ideation in this iteration was quite free, with not many concrete insights to start. Thus, although each concept had the assumptions at its core, the proposed solutions differed considerably.

Personalizing care based on the disability profile

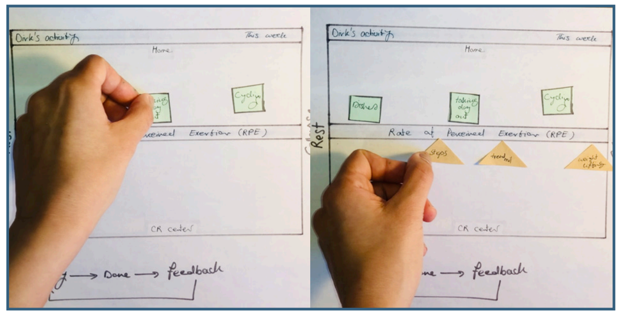


Concept 1:

This concept is about making scores meaningful to patients, which in this case is the assessment scores given to the patients for their disabilities and personalizing the care based on that.

The doctor scores the disability level of the patient's body parts from 0-5, which are color-coded for the patient for better visualization. Second, based on the scores, the disability profile is identified, and unsuitable activities are eliminated for the patient. Moreover, all equipment at the CR center are labeled with the corresponding disability profiles to indicate which patients can use them.

Making CR score meaningful by bringing relevancy

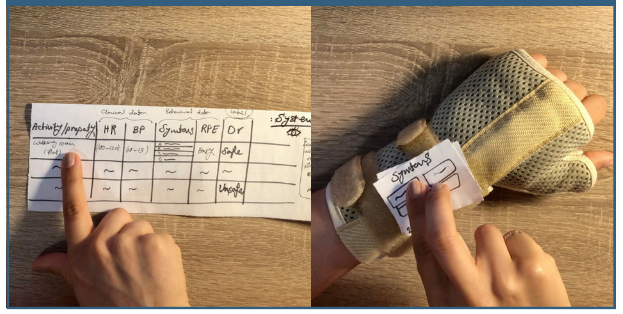


Concept 3:

This concept is about bringing relevancy and meaning to the scores, which in this case is the exertion level of different activities at the CR center and home.

Firstly, patients are provided with a blank sheet of Rate of Perceived Exertion in which they can log in their latest activities and exertion levels. Secondly, they do the same for home activities. The idea is that making this subjective comparison can provide patients with similarities allowing them to relate the care they receive during CR to home activities.

Providing supervision and safety at home

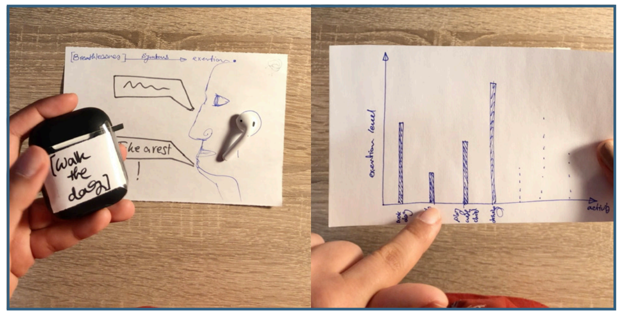


Concept 2:

This concept is about making patients feel safe at home in the same way they do at the CR center by providing constant supervision.

During exercises at the CR center, the system asks for feedback from the patients. Therefore, they need to report their symptoms and exertion level during activities to create a personal dataset, based on which the system starts to learn about the reported clinical and behavioral data. At home, the supervision and safety are provided by a bracelet that constantly monitors them, alarming patients when they deviate from their safe zone according to their personal dataset.

Coaching patients to learn about their exertion levels of home activities

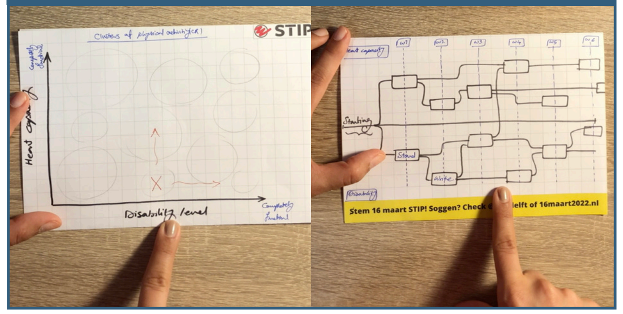


Concept 4:

This concept is about helping and coaching patients to learn how much they exert themselves throughout the day through different activities via an earphone.

First, the patient at home logs in what activity they are about to start (walking the dog in this example). Secondly, as patients are doing the set activity, the coaching program asks them to respond to a question or say something (as feedback). Based on how breathless they are while doing that, their exertion level is examined, and they are advised to stop, keep going, or slow down, for example.

Personalizing care trajectory based on the assessment and goal of the patients

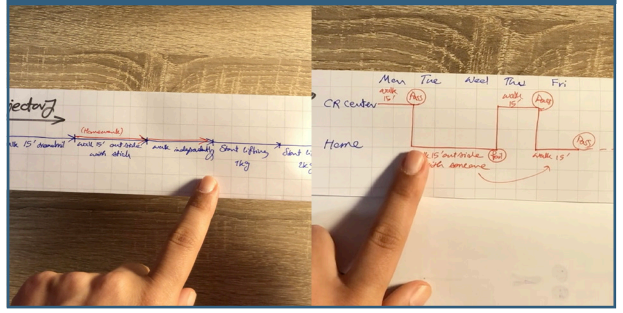


Concept 5:

This concept is about care personalization in which the main adjustments to the care depend on the goals of the patients.

In the assessment, the doctor puts the patient on a matrix based on their disability and heart capacity levels. Based on their goals (whether they need improvement in the heart of the functionality of their body parts), patients can choose a care trajectory encompassing related sub-goals starting from their position on the matrix.

Making progress more tangible by dividing goals into sub-goals for home and center



Concept 6:

This concept is about making progress more tangible and trackable by dividing the personal goal into sub-goals and providing patients with a detailed care plan.

Considering whether the goals of patients are endurance or strength goals, they are divided into sub-goals that should be done both at the home and center. The plan is envisioned to be adaptive to the progress and the adherence of the patients while reaching sub-goals

Design Directions

Stepping back from the concepts and looking at them with a more zoomed-out view made me realize that they have different design directions, Shared Decision-making (SDM), Safety through Supervision, and Condition Management.

1. Shared-Decision Making (SDM):

SDM is defined by NICE (2022) as a joint process in which the patients together with the healthcare professionals, reach a decision about the care and alter it accordingly. In the case of CR, it could be translated in a way that patients make a personalized goal, and together with the CR healthcare professionals, they see which path is more beneficial for the patients to undergo.

In this regard, concepts 1, 5, and 6 also focus on altering the care path based on the patients' goals and what they want to achieve in rehabilitation. In terms of an intelligent solution, it would understand the goals of the patients and facilitate the alterations of the care path in order to adapt to what the patients need to achieve.

From the gathered insights, as already mentioned, the CR care path is not much personalized at the moment, and the goals themselves are also an element in the care that is not the base for much change in the current care path. Therefore, because of this big gap identified, I decided not to continue in this direction in the following iterations to lower the risk of the solution uptake and address the viability part of the project.

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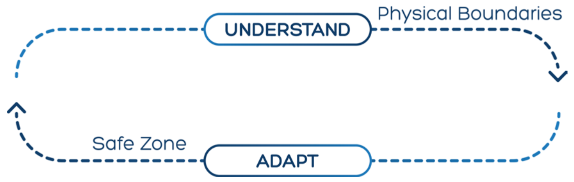

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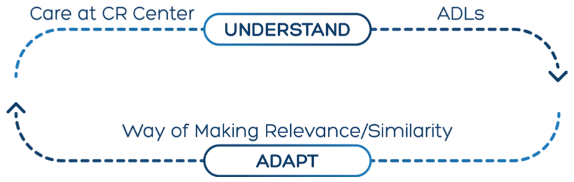
2. Safety through supervision:

Generally, patients feel safer at the CR center during training because of the supervision of the healthcare professionals and the accessibility of help and medical devices to check them when they perceive something wrong. After rehabilitation, some patients choose monitoring devices that alarm patients when something is medically wrong with them, which resembles a safe feeling.

In this re gard, concepts 2 and 4 focus on providing the feeling of safety by constantly supervising them at home. In terms of intelligent solutions, it would understand the physical boundaries of the patient and adapt the safe zone and freedom of the patient at home accordingly by alarming them.



Based on the gathered insights, many of the problems at CR originate from patients being highly supervised at the center and the big gap in place between this situation and at home. In this regard, one of the physiotherapists mentioned that "some patients describe the feeling of finishing rehabilitation as falling into a dark hole" because no one is there to look after them. As a result, I decided to exclude the direction of objectively monitoring patients to let them know if they are safe or not and preferably focus on internalizing the feeling of safety.

New Notions to Explore:

Effort and gain for relevant stakeholders in the solution:

This notion addresses the viability aspects of the project and comes from the complexity and the integration of CR inside a bigger healthcare system. Therefore, there is a necessity to research the underlying workflow and the involved stakeholders to ensure the uptake of the solution and include them in it properly. To gain insights into this topic, chapter 2 explored the CR context to provide an overview for better understanding.

The required effort and challenges in data collection/reporting:

Since some of the concepts included reporting data, the idea of the effort in data collection/reporting and the subsequent reward as engagement with data was discussed. Thus, it became a factor to consider during the next ideations.

Reflection:

Since the element of reflection on the collected data was explored in some of the concepts, more related nuanced insights were brought up, such as Reflection-in-action, and Reflection-on-action.

According to Schön (2017), Reflection-in-action occurs while still in the activity, helping the person modify it for completion. Whereas reflection-on-action is about recalling the experience in retrospect in order to see what things went the way they did.

I had integrated both reflection types into the concepts, which made me realize the different use cases they could have for further ideations.

Personal Informatics:

In the end, most of the mentioned points culminated in the framework of Personal Informatics(PI). According to Li et al. (2015), PI systems facilitate relevant personal data collection with the aim of self-reflection to learn about oneself, with the two major stages of collection and reflection which were explored in the concepts.

Concepts

Pros/cons

(+)
Understanding the disabilities,
Activities personalised by disability profile,
Making progress more tangible/visible.
(-)
No engagement or reporting from the patient(subjectivity),

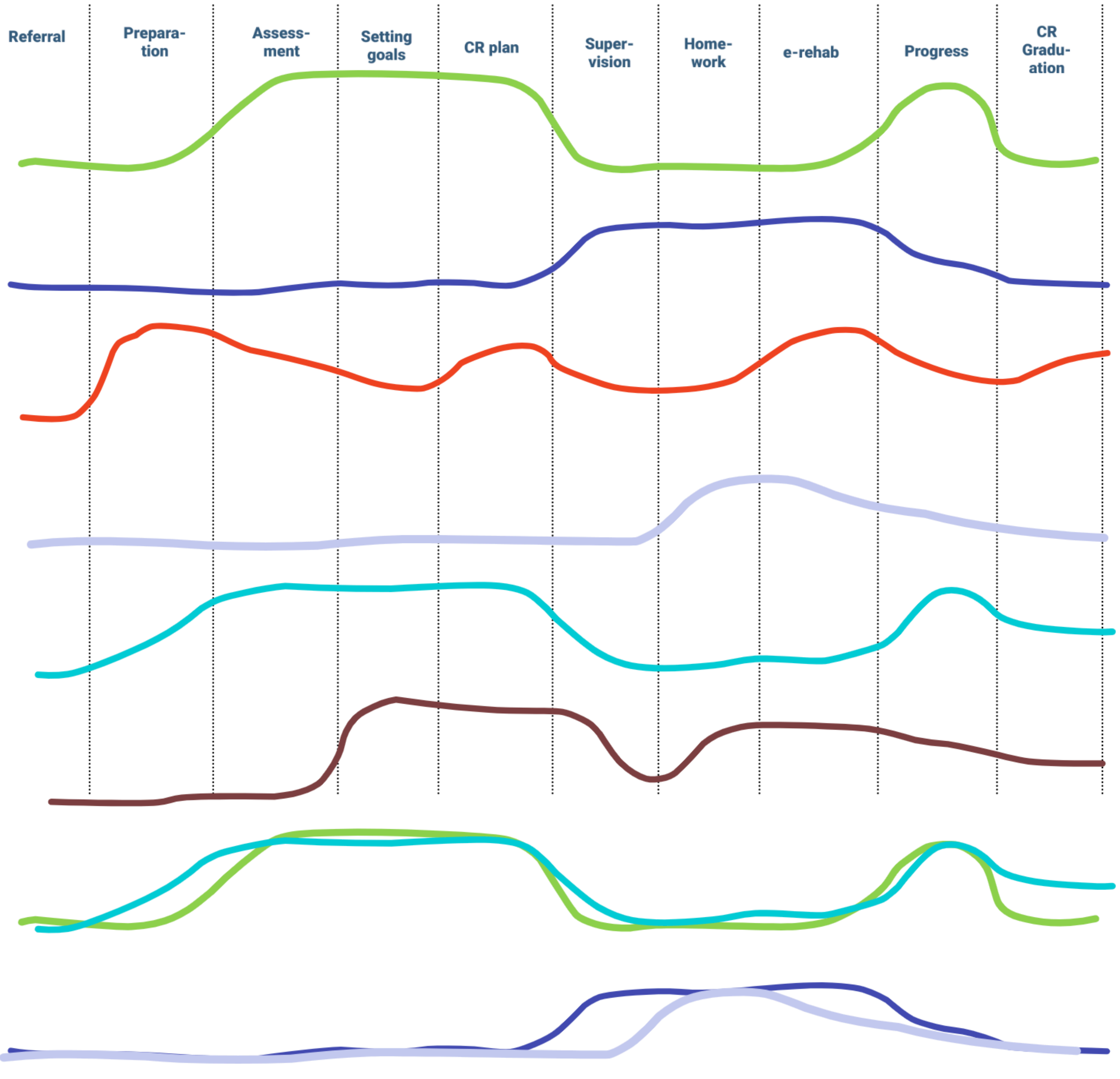
(+)
The system learning about the safe zone of patient,
Providing supervision and safety at home,
Reflection/reporting while doing the activity
(-)
More passive,
Providing the feeling of safety through constant supervision (more reliance),

(+)
Conversation starter(consultation room),
Reflection tool for the patient,
Help with SDM,
help plan the energy expenditure of the day.
(-)
Unclear application area, No reflection while doing the activity
Needs to be thought through.

(+)
Natural/effortless reporting (breath),
Easy to adapt.
(-)
reflection/engagement afterwards,
unclear user engagement,
What to do with info afterwards.

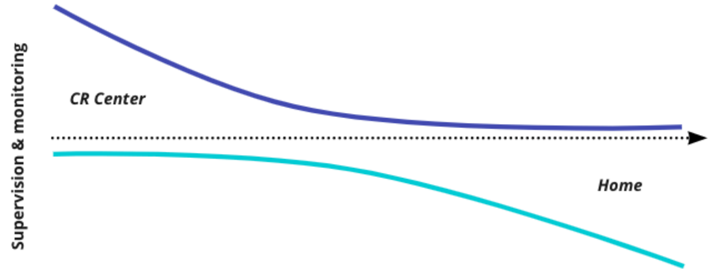
(+)
Help with SDM, making goals,
Giving a care trajectory (CR and Home),
Care plan based on where they stand on the spectrum,
tailored plan based on disability and goal.
(-)
Supervision and assessment of the Dr after goals reached,

(+)
Natural/effortless reporting (breath),
Easy to adapt.
(-)
reflection/engagement afterwards,
unclear user engagement,
What to do with info afterwards.



SDM

Safety thorough constant supervision



New questions

What are the key moments from the expert perspective?

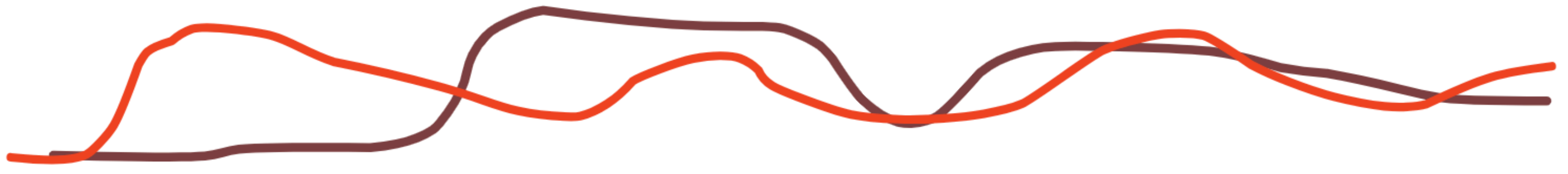
Where on the pathway is there the most demand?

What are the values?

Direction I am interested about

Self management

Making progress extendable to real life



(G)
-Iteration 2-

This iteration explores some design opportunities.

Adjusting Assumptions:

In order to make conclusions from the information in this chapter, it is helpful to revisit the assumptions made in this iteration to define how to move forward with them. The adjustment happened in iterations where new information came to light or feedback from stakeholders was received.

The assumptions that are not mentioned here are the ones validated. Therefore, here only the adjustments and doubts are presented.

Assessment:
a. The initial assessment takes place in order to understand the patient's heart capacity (using the Exercise Test) and whether they need other modules such as diet control or smoking cessation. Disability is not a factor based on which the patients get assessed in the CR care path. In fact, that is mostly the case for patients starting Neurological Rehabilitation (for patients suffering from a stroke).
b. The assessment scores are still under the question of whether they make sense to the patients or not.

Goals:
a. Although goals are highly personal per patient and they are an integrated element in the CR care path, they do not change the care path much for the patient to reach their goals.
b. CR healthcare professionals are somewhat excluded from this process, and it relies heavily on the patients themselves.

CR care plan:
a. The CR care plan is much less personalized than already assumed.
b. The only personalization of the CR care plan is first by the Exercises test in which patients divide into four groups based on their heart capacity a very low, low, moderate.

Design Opportunities

Using the biking test as the baseline clinical assessment to make personalizations. (This idea is assumed in the other design opportunities as well)

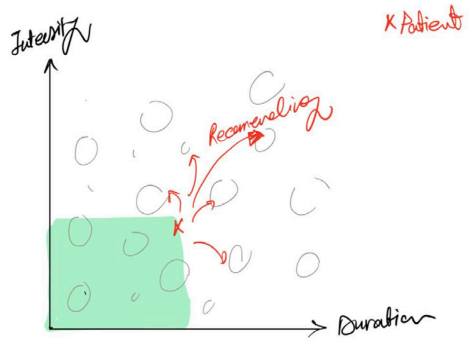
* Making personal/trackable goals based on capabilities (baseline assessment):

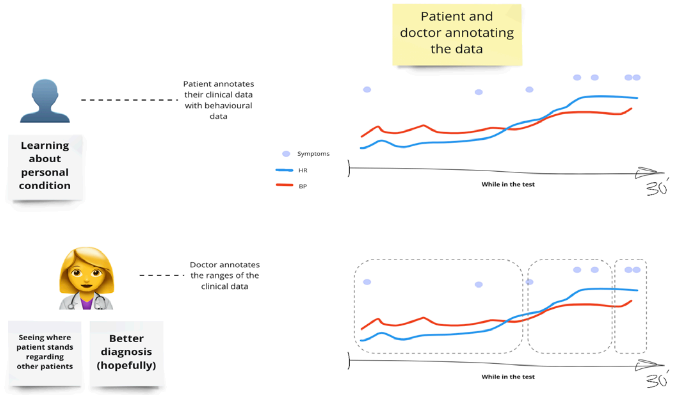
- Recommending activities based on classification to do (home/CR center)
- Keeping the HP and let the patient explore.

* Self-experimenting in the safe zone to figure out limitations and capabilities:

- Making the boundaries based on the baseline assessment.
- Providing more reassurance.

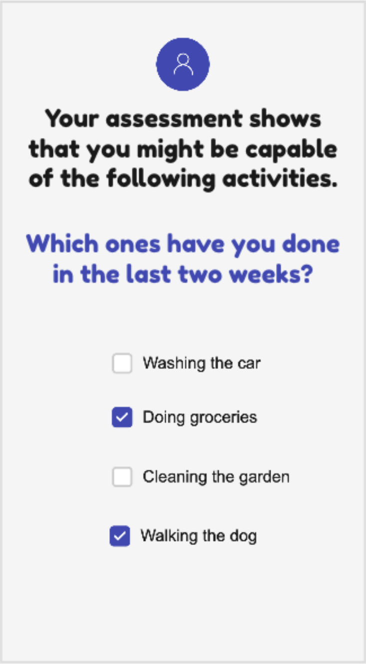
* Learning about the symptoms and exertion levels:
- Education about it.
- Diagnosting after doing the activity by helping them reflect on it.





(H)
-Iteration 3-

1.a



Your assessment shows that you might be capable of the following activities.

Which ones have you done in the last two weeks?

☐ Washing the car

☑ Doing groceries

☐ Cleaning the garden

☑ Walking the dog

1.b

Rank the activities on the scale below.

How hard/heavy did you find them?

1.c

You ranked this activity very hard/heavy

Why?

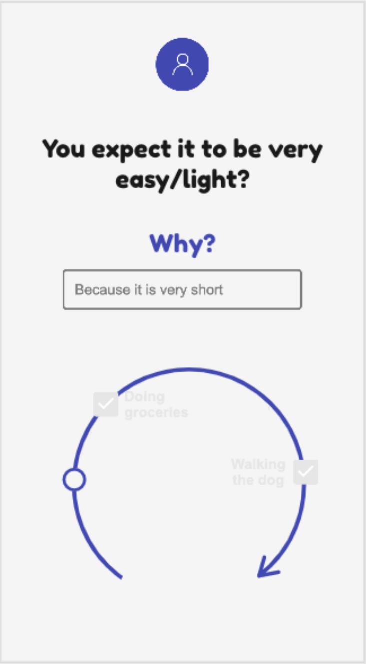
Because I was afraid for my dog

2.a

Are you going to do your laundry today?

How hard/heavy do you expect it to be?

2.b

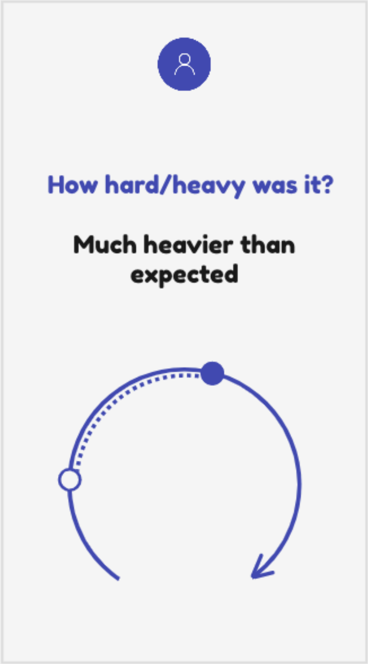


You expect it to be very easy/light?

Why?

Because it is very short

3.a

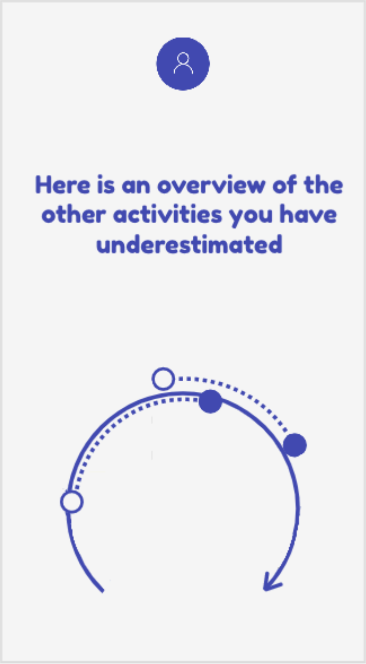


How hard/heavy was it?

Much heavier than expected

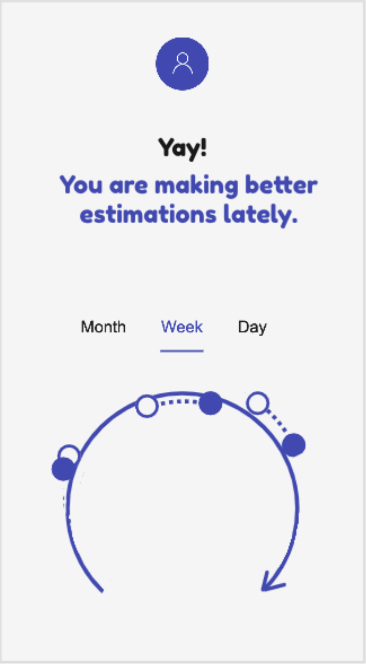
3.

4.a



Here is an overview of the other activities you have underestimated

4.b



Yay!

You are making better estimations lately.

Month Week Day

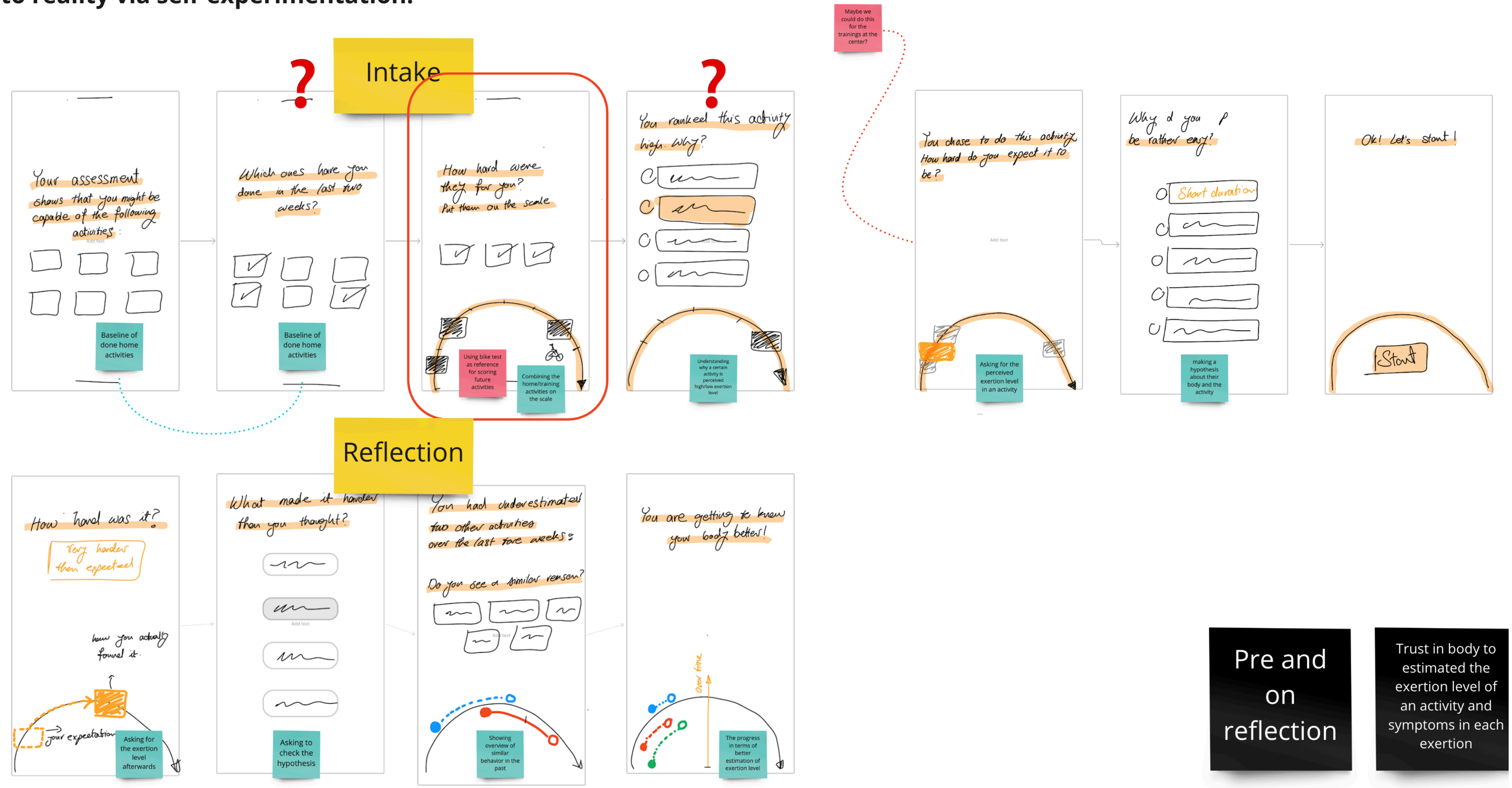
(I)

-Iteration 4-

The concepts in this iteration are used in later iterations by breaking them down and prototyping their elements for test and feedback.

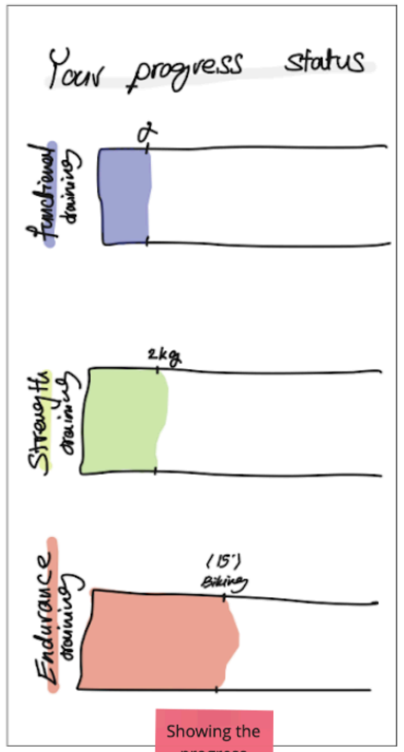
Concept 1

Help patients build inner trust in their bodies by making their expectations(self-efficacy) from themselves (their bodies) closer to reality via self-experimentation.

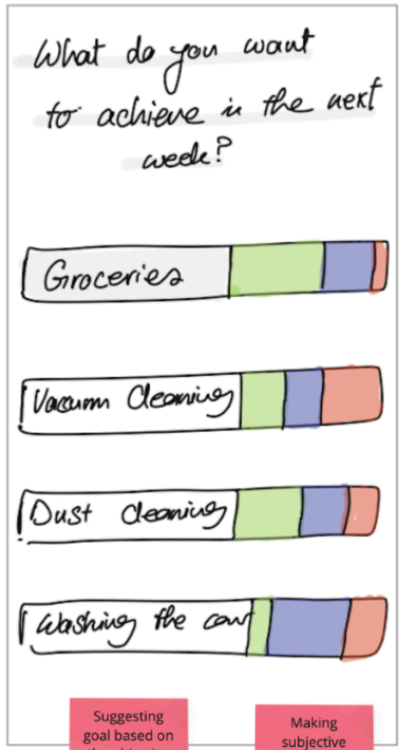


Concept 2

Help patients build inner trust in their bodies by relating the training in the CR program to household activities, by making goals that are classified based on endurance, strength, and functional interval training.

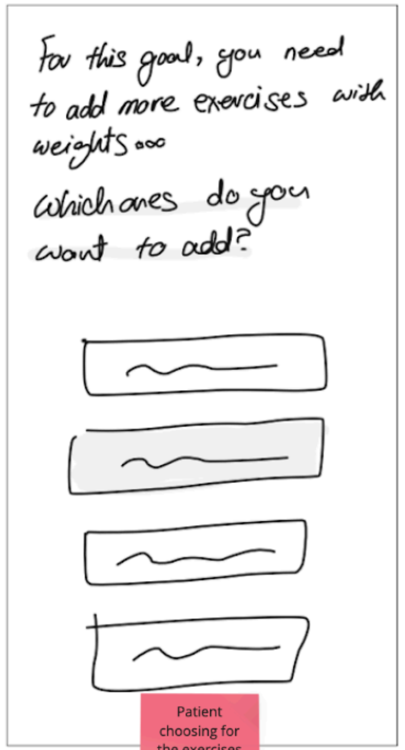


Showing the progress objectively in the CR

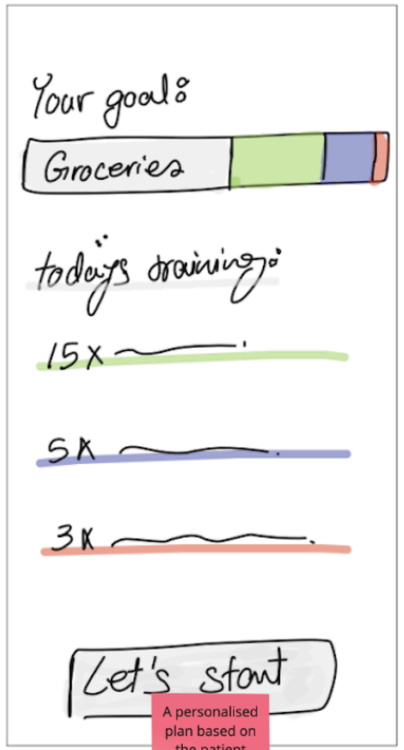


Suggesting goal based on the objective progress (status)

Making subjective goals based on the objective training

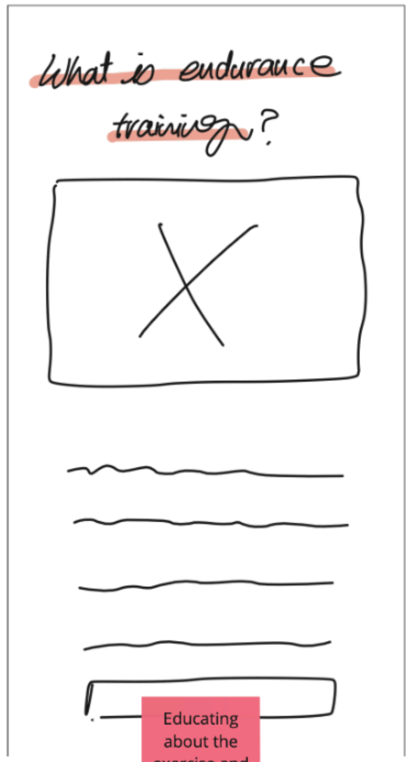


Patient choosing for the exercises they want to do



A personalised plan based on the patient status and the preferences

Choosing goal



Educating about the exercise and training

Educating about the relevancy of the exercise to the patient

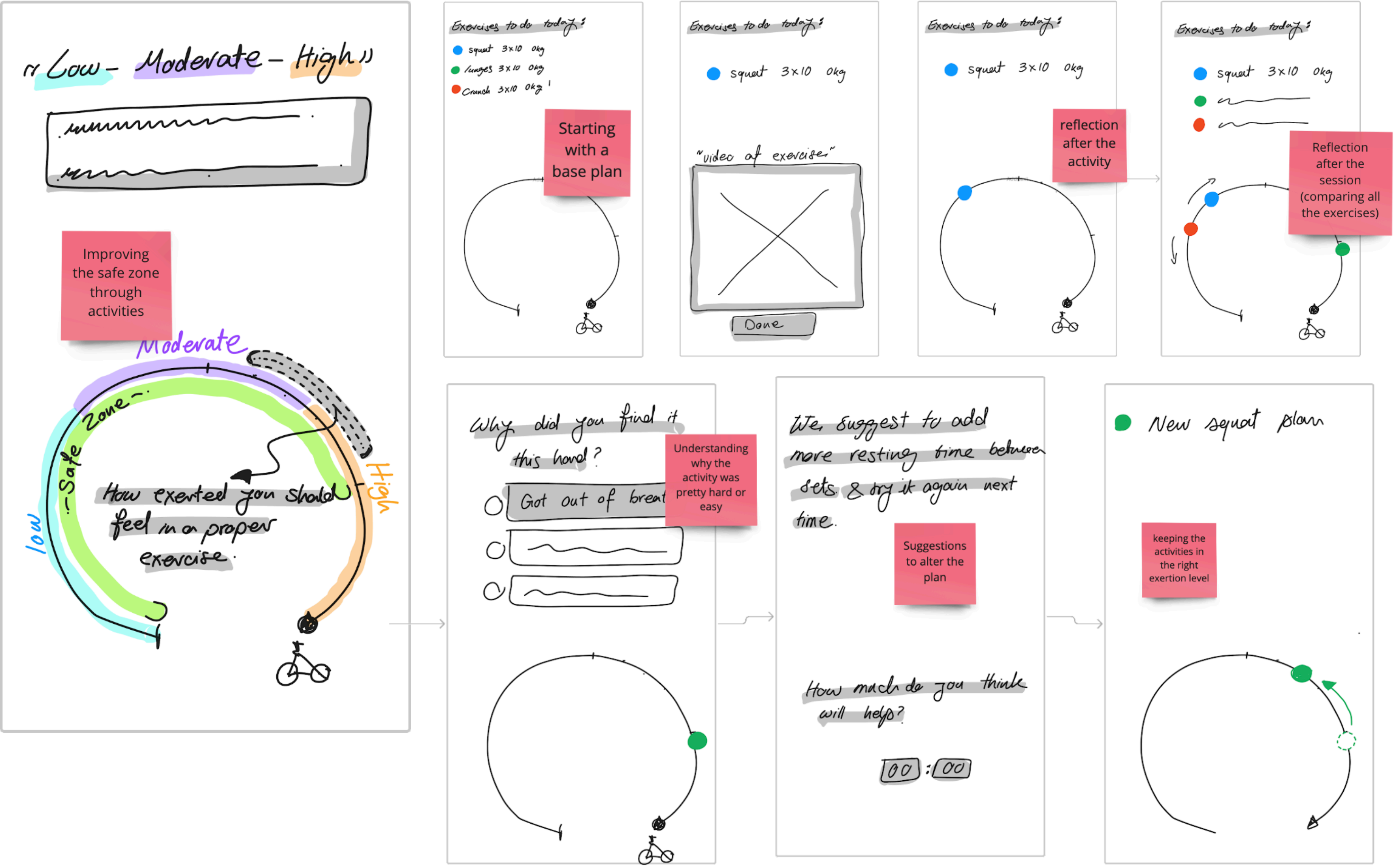
A conversational agent walking them through

No reflection

Trust in body to do an activity based on traning

Concept 3

Help patients build inner trust in their bodies by learning about the different exertion zones to be at the right exertion level while training at home/center. (to be able to progress with their condition) The idea is to be able to know and push to their limit actively to make better health outcomes in the end. (training to the standards of the health professionals)



Improving the safe zone through activities

Starting with a base plan

reflection after the activity

Reflection after the session (comparing all the exercises)

Understanding why the activity was pretty hard or easy

Suggestions to alter the plan

keeping the activities in the right exertion level

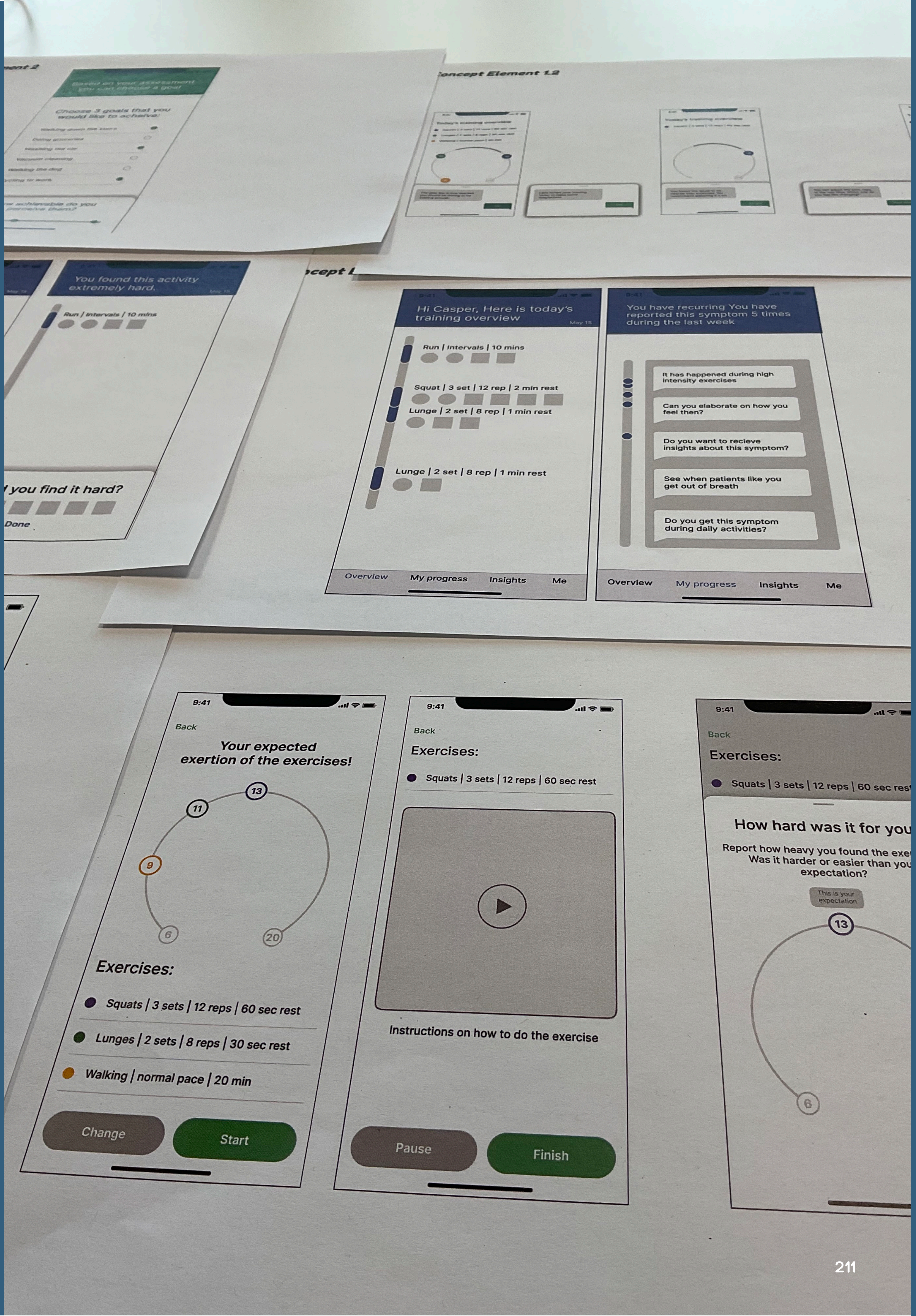
The broken link in personal informatics

On reflection

Trust in body to be in the right exertion level when training (more effective)

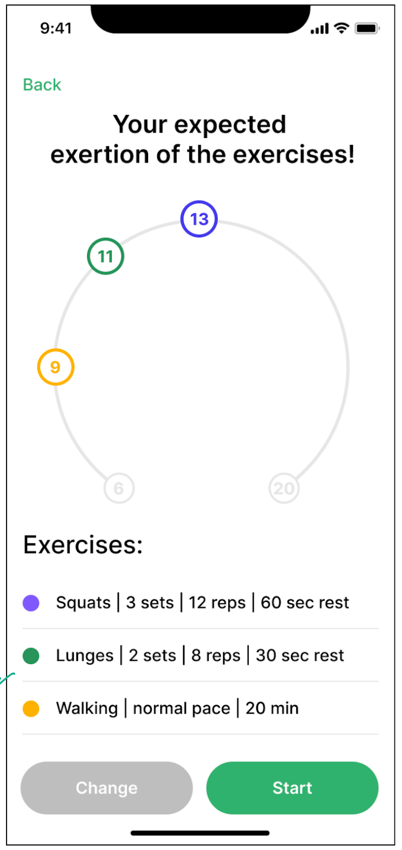
(J)
-Iteration 5-

In this iteration, I protoypes the concept elements and used it in the feedback session at Philips with DED designers.



CE 1 : Expected & Actual Exertion Level

Cycle ② testing.



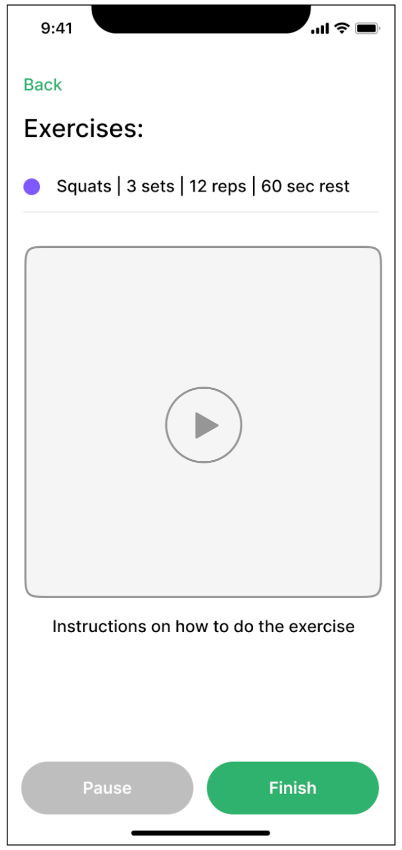
9:41

Back

Your expected exertion of the exercises!

Exercises:

- Squats | 3 sets | 12 reps | 60 sec rest
- Lunges | 2 sets | 8 reps | 30 sec rest
- Walking | normal pace | 20 min



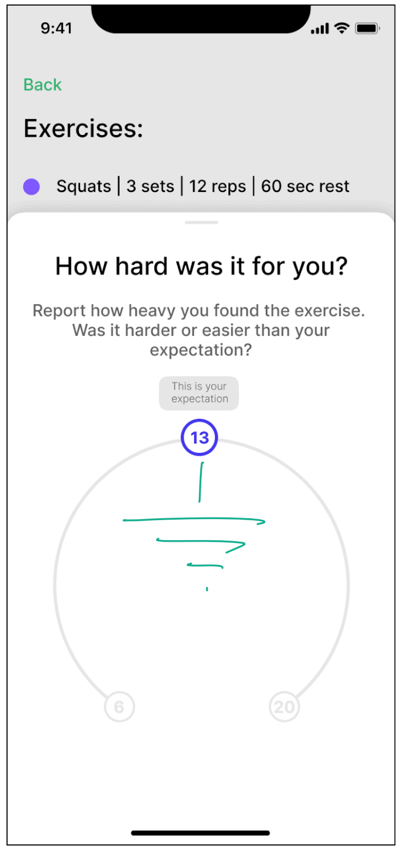
9:41

Back

Exercises:

- Squats | 3 sets | 12 reps | 60 sec rest

Instructions on how to do the exercise



9:41

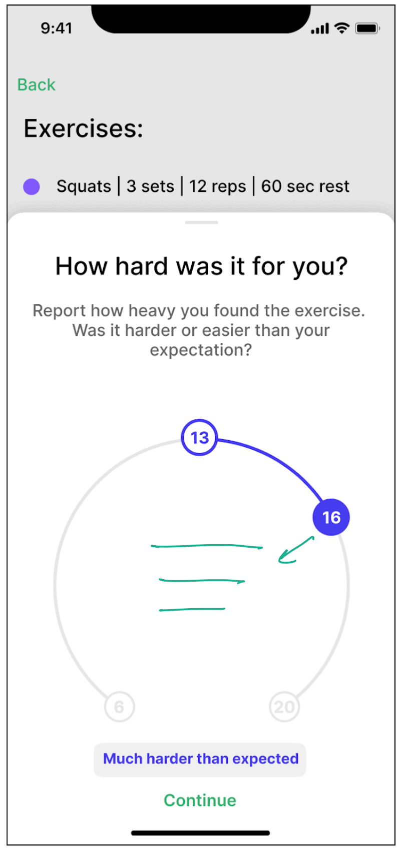
Back

Exercises:

- Squats | 3 sets | 12 reps | 60 sec rest

How hard was it for you?

Report how heavy you found the exercise. Was it harder or easier than your expectation?



9:41

Back

Exercises:

- Squats | 3 sets | 12 reps | 60 sec rest

How hard was it for you?

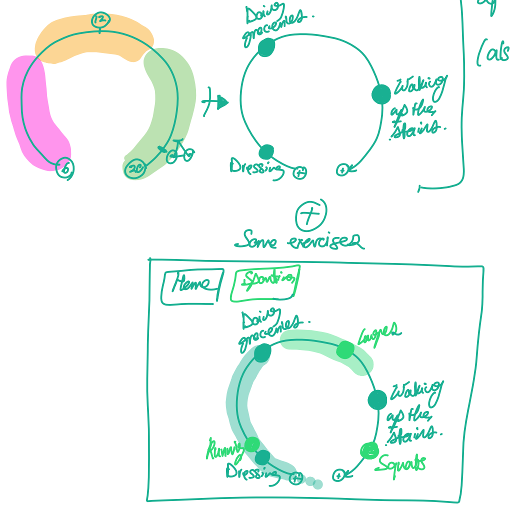
Report how heavy you found the exercise. Was it harder or easier than your expectation?

* Adjustments based on Limitation (more home activities) → :

- Home activities. ✓
- Home work activities. ✓
- In place for experimentation / adding new exercises (When / how?) → (At the start) first time doing activities.
- Exertion + The activity done + add completion feedback ✓

Home Activities : →

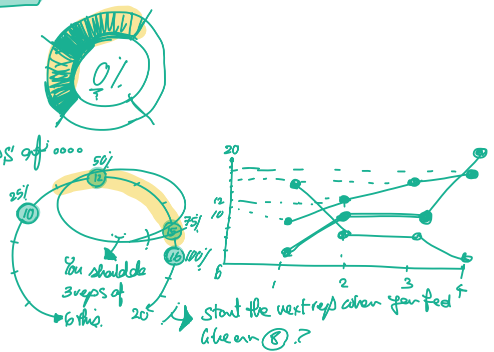
which activity do you expect to be in this region?



capability expectation of activities :

(also goals)

Homework / home exercises. → The same thing could apply :



→ start the next reps when you feel like an ⑧ ?

* expectations? →

→ The overall after expectation?

→ try something new?

+ Feedback :

* Distinguishing between close numbers → Adding quotes for the scores.

* When you should score? (middle / during / after).

* In the moment scoring / Retrospective scoring → Interesting to explore

Depending on the goal of study.

* Already gathering data anyhow (expectation / actual)

→ Big assumption: « People cannot score it correctly).

→ Another data point ⇒ When is it used? at which interval?

* Steps + Physical activity. → Adding some objective data.

* When the activity started,

what they have been doing,

& when they stopped. → Drawing a line of exertion during activity.

(Different experience rather than giving a number to an activity.

* The training / exercises → the reps/sets → How many did you do?

* ⓔⓧ: it was a 20 so I had to stop after one reps.

(what the score is about?) → how long.

* Giving a comment box to put stuff in.

✿ Action Point : →

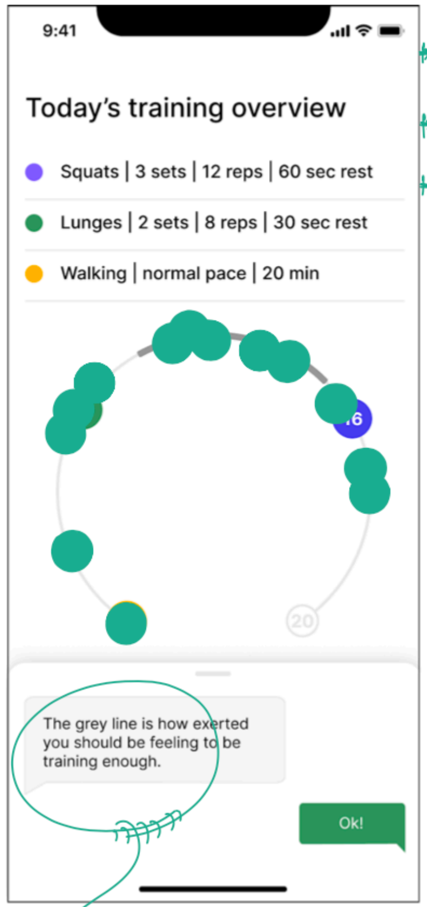
- ☑ + Adding quotes for scores: (of course! :D)
- ? + (Maybe) show previous reported activities on that numbers:
- ☑ + The moment of scoring : Get exertion during activity.
  (during / after) → during cycling test / after each rep.
- ☑ + By using the concept, data is gathered anyhow? (test my big assumption) → Test with physitrack.
- ☑ + Including more objective data (activity trackers, HR, steps)
  (The increment times of cycling test.)

Plan for testing mode

Cycle 2. CE 1

CE2: Training the right exertion level.
Adapting exercises based on that.

→ Make suggestions to change something in plan. (adapt)



9:41

Today's training overview

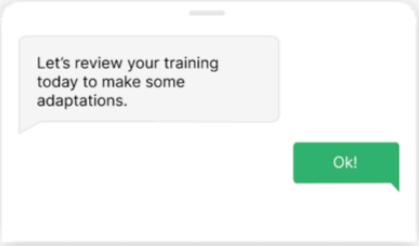
- Squats | 3 sets | 12 reps | 60 sec rest
- Lunges | 2 sets | 8 reps | 30 sec rest
- Walking | normal pace | 20 min

The grey line is how exerted you should be feeling to be training enough.

Teaching about the scale!

- I cannot give out medical advice.
- Only maybe suggestions to ask doctors.
- Adaptation based on exertion in reps.

Stepup suggestion
+
Physiotherapist approval



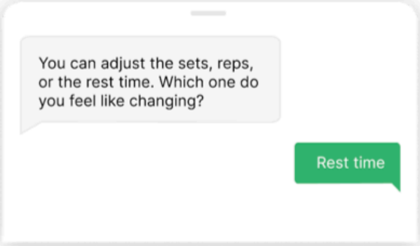
Let's review your training today to make some adaptations.

9:41

Today's training overview

- Squats | 3 sets | 12 reps | 60 sec rest

You found the squat to be heavier than expected. We recommend adjusting it a bit.



You can adjust the sets, reps, or the rest time. Which one do you feel like changing?

9:41

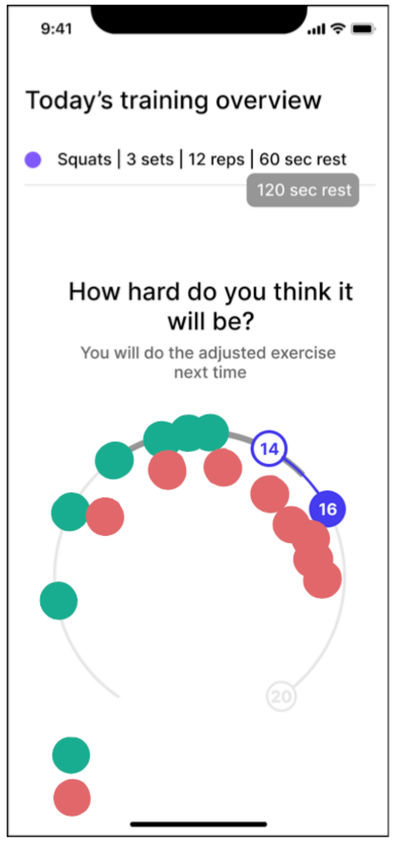
Today's training overview

- Squats | 3 sets | 12 reps | 60 sec rest

120 sec rest

You can adjust the sets, reps, or the rest time. Which one do you feel like changing?

CE3: Exertion expectance of the adapted exercise.
Progress in terms of better estimations.


9:41

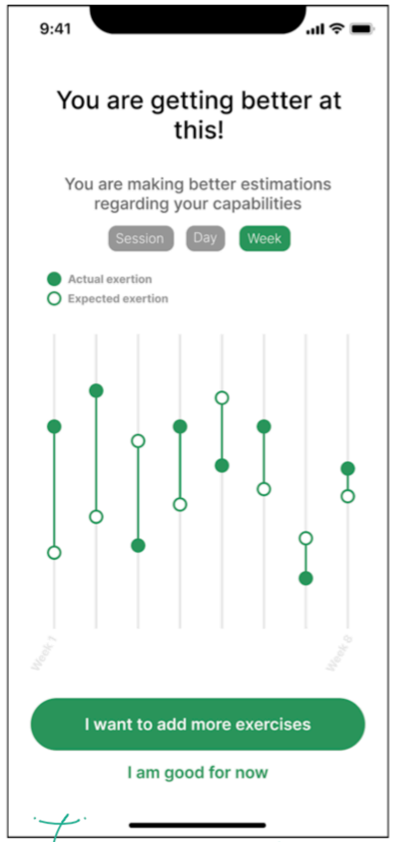
Today's training overview

● Squats | 3 sets | 12 reps | 60 sec rest

120 sec rest

How hard do you think it will be?

You will do the adjusted exercise next time


9:41

You are getting better at this!

You are making better estimations regarding your capabilities

I want to add more exercises

I am good for now

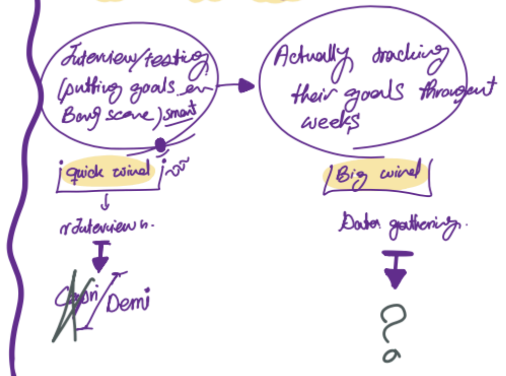
+ Feedback: →

- * Tracking the goal based on the borg scene.
  - → (Weekly / Bi-weekly tracking goal progress).
- * Internal motivation of why you want to do this?
- * Seeing the progress of numbers lowering (a motivator to do goals)
- * Scoring the goal throughout time, increasing knowledge in body.
  - → High level motivation.

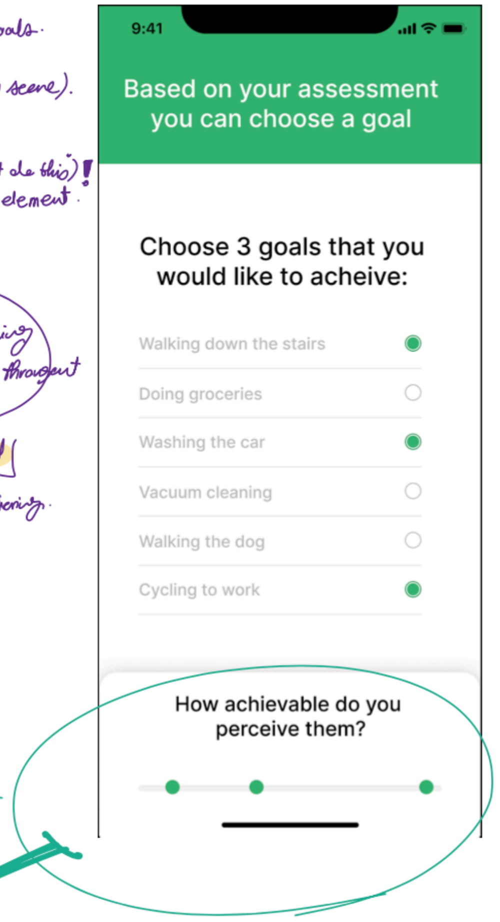
+ Action Points:

- + facilitate making short term, smart goals.
- + Periodic goal tracking (using borg scene).
- ↓
- + Showing progress based on this.
  ("a month ago, you though you cannot do this")!
- + (maybe) find a connection to the other element.

*** two part testing:**



CE4: Making Attainable goals.
How attainable they find them.


9:41

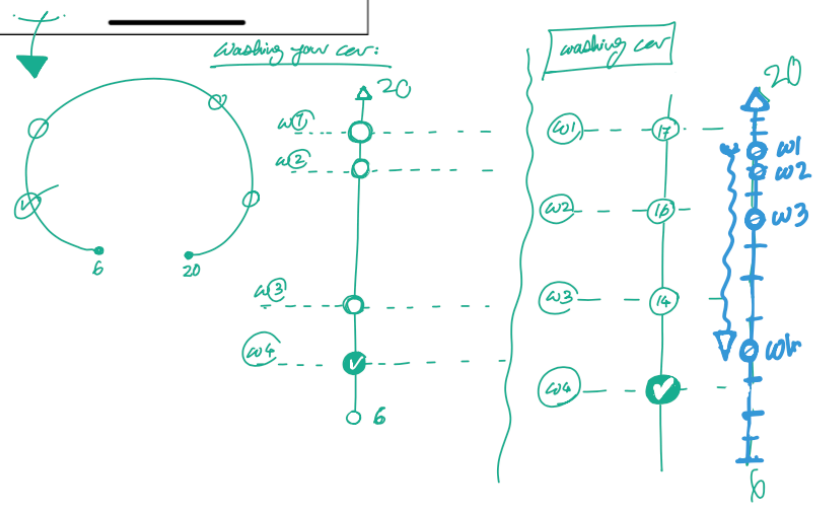
Based on your assessment you can choose a goal

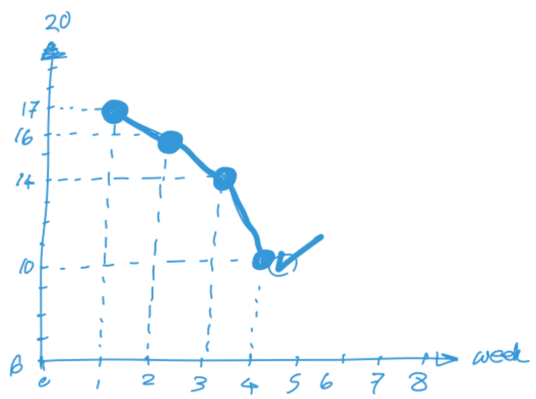
Choose 3 goals that you would like to acheive:

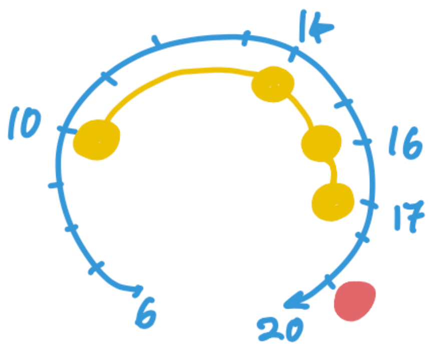
- Walking down the stairs ●
- Doing groceries ○
- Washing the car ●
- Vacuum cleaning ○
- Walking the dog ○
- Cycling to work ●

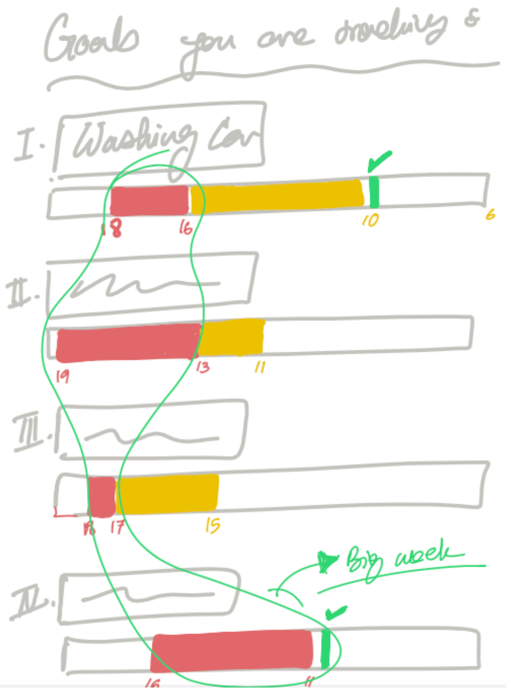
How achievable do you perceive them?

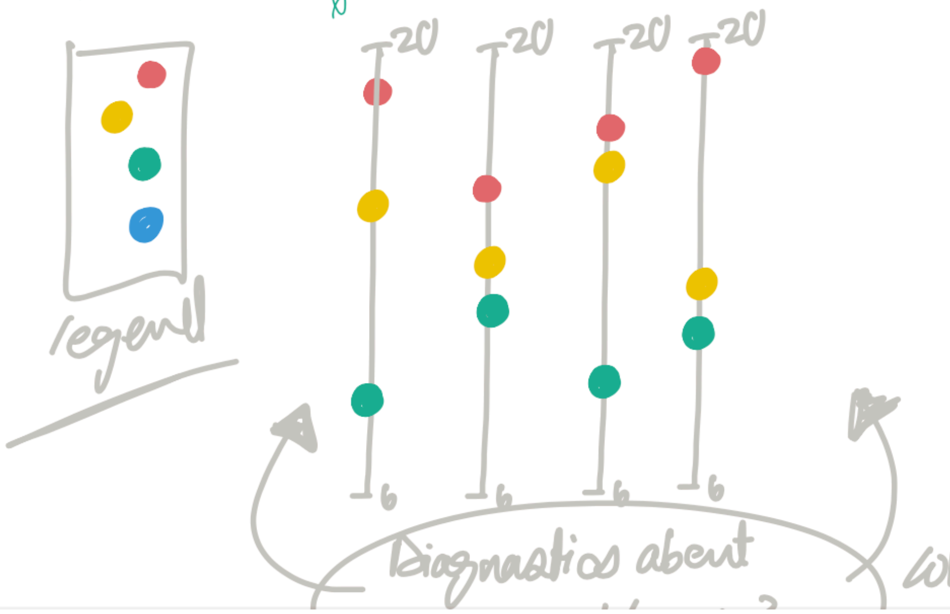
Plan for testing mode
Cycle 1.1 CE 3

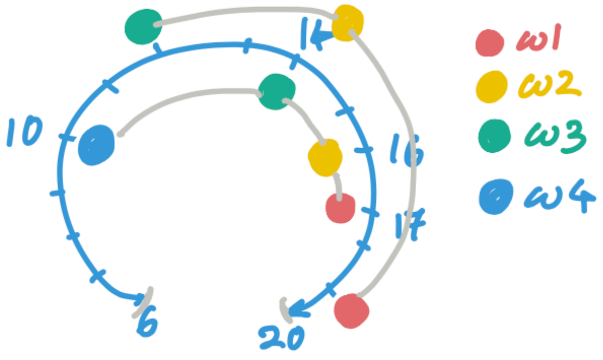












why hard/easy:

CE 5: Diagnostics about hard/easy activities. + Symptoms

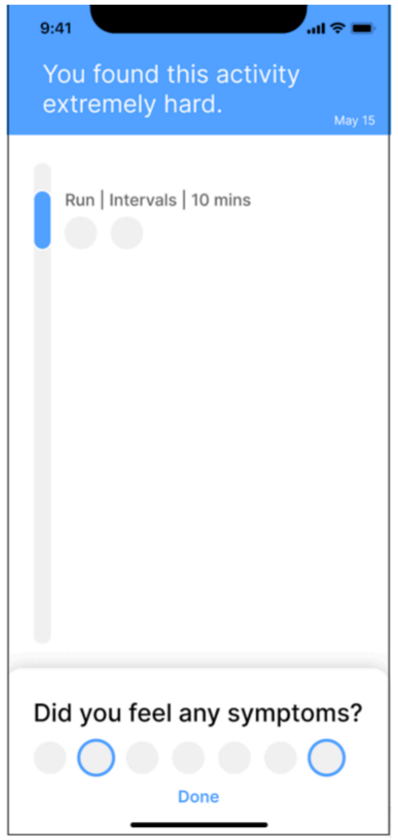

9:41

Hi Casper, Here is today's training overview

May 15

Run | Intervals | 10 mins

Let's take a look at your activities

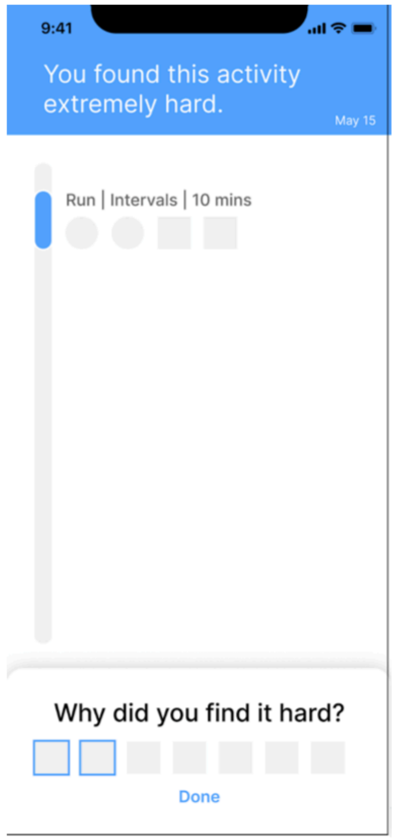

9:41

You found this activity extremely hard.

May 15

Run | Intervals | 10 mins

Did you feel any symptoms?

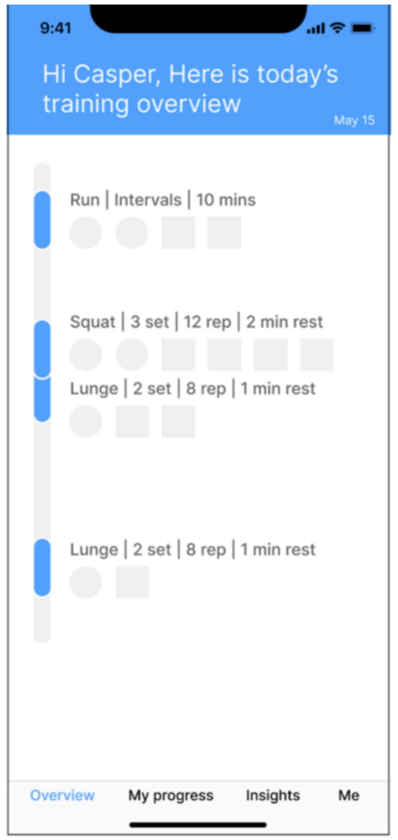

9:41

You found this activity extremely hard.

May 15

Run | Intervals | 10 mins

Why did you find it hard?


9:41

Hi Casper, Here is today's training overview

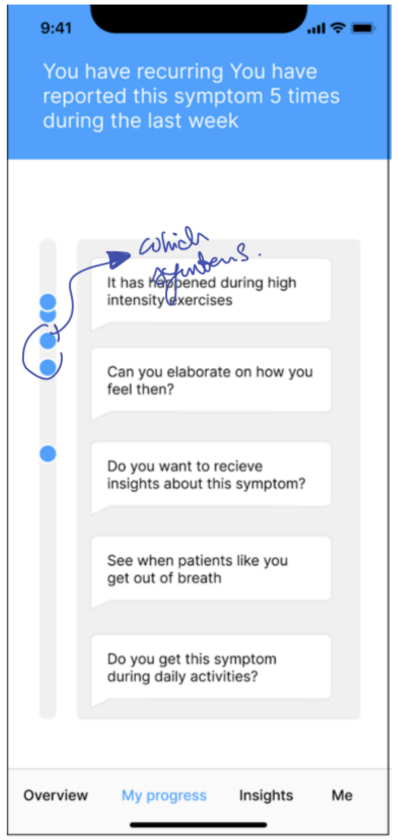
May 15

Run | Intervals | 10 mins

Squat | 3 set | 12 rep | 2 min rest

Lunge | 2 set | 8 rep | 1 min rest

Lunge | 2 set | 8 rep | 1 min rest


9:41

You have recurring You have reported this symptom 5 times during the last week

which symptoms.

It has happened during high intensity exercises

Can you elaborate on how you feel then?

Do you want to recieve insights about this symptom?

See when patients like you get out of breath

Do you get this symptom during daily activities?

+ Feedback:

- * Making wrong links
  (some things not corelating) → could show insecurity)
- * Some things have correlation but not causation.
  (Patient like me get out of breath & have asthma)
- * Which sets of symptoms appear when on the scale?
  (Personal symptoms attached.)
- * Symptom (negative word) → Physical Indicators.
- * Log it in the moment (symptoms)

General Insights:

+ Make it a set of screens to work with (gather data)

+ Metadata would be more relavant to me.
  - How much they use it?
    Do they really open it during activity?

} In case of evaluation.

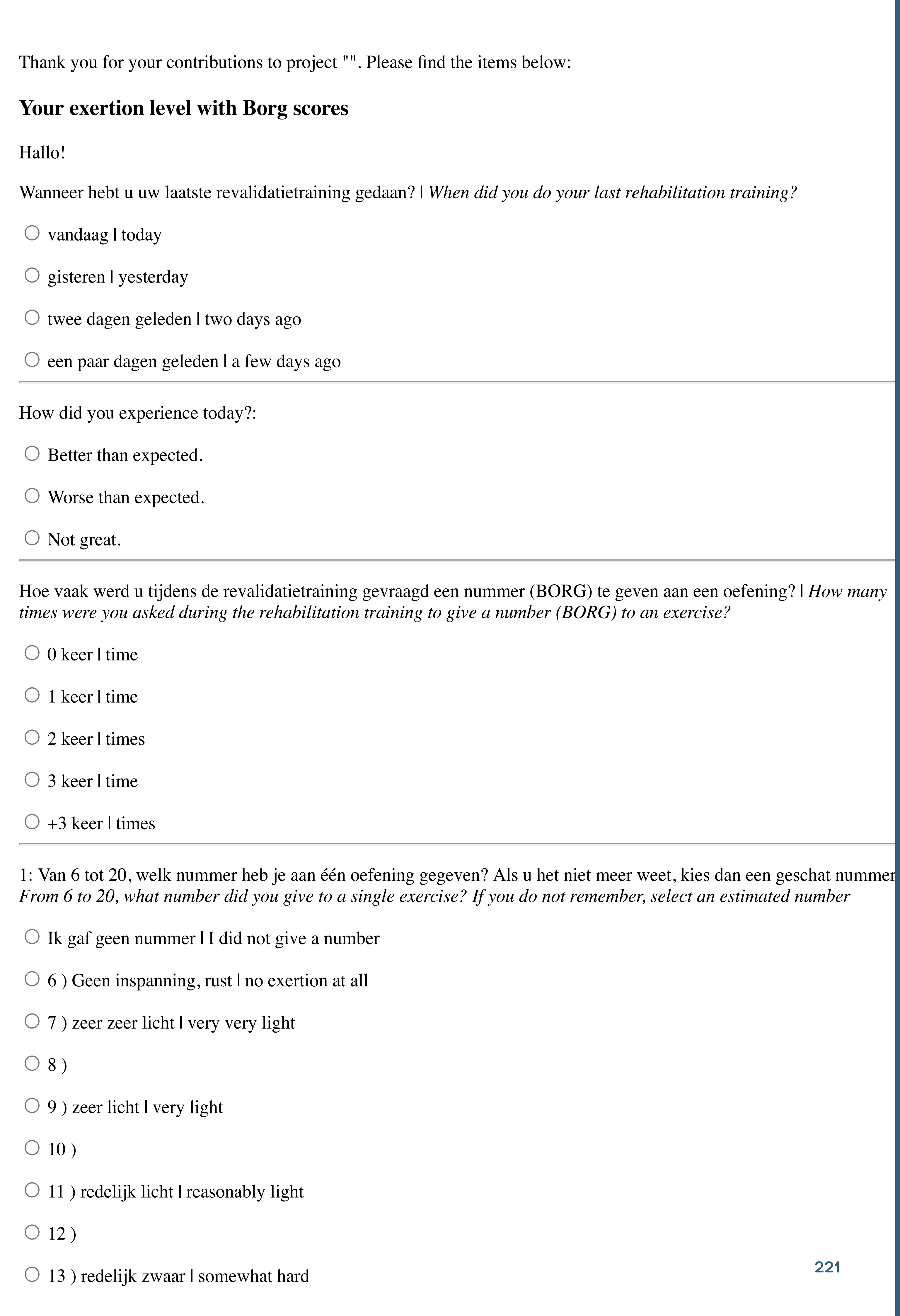
+ Evaluate concepts → "Framer", + Data Foundry.
  - usage data.

+ Start a bit easy, (DED) → more time than august.
  - Build a module based on insights (update)
  - Starting simple
  - 3/4 patients use it for a week → Then everyone is happy.
    - My Goal :D YAY!

+ Action Point:

+ logging the symptoms that occur on the scale
+ Symptoms/Physical Indicators.
+ Figure out the loggin in thing.
+ Check out "Framer" & "DF".
+ Do a phased-in approach.

(K)
-Form for submission of Borg data-



Thank you for your contributions to project "". Please find the items below:

Your exertion level with Borg scores

Hallo!

Wanneer hebt u uw laatste revalidatietraining gedaan? | *When did you do your last rehabilitation training?*

○ vandaag | today

○ gisteren | yesterday

○ twee dagen geleden | two days ago

○ een paar dagen geleden | a few days ago

How did you experience today?:

○ Better than expected.

○ Worse than expected.

○ Not great.

Hoe vaak werd u tijdens de revalidatietraining gevraagd een nummer (BORG) te geven aan een oefening? | *How many times were you asked during the rehabilitation training to give a number (BORG) to an exercise?*

○ 0 keer | time

○ 1 keer | time

○ 2 keer | times

○ 3 keer | time

○ +3 keer | times

1: Van 6 tot 20, welk nummer heb je aan één oefening gegeven? Als u het niet meer weet, kies dan een geschat nummer
From 6 to 20, what number did you give to a single exercise? If you do not remember, select an estimated number

○ Ik gaf geen nummer | I did not give a number

○ 6) Geen inspanning, rust | no exertion at all

○ 7) zeer zeer licht | very very light

○ 8)

○ 9) zeer licht | very light

○ 10)

○ 11) redelijk licht | reasonably light

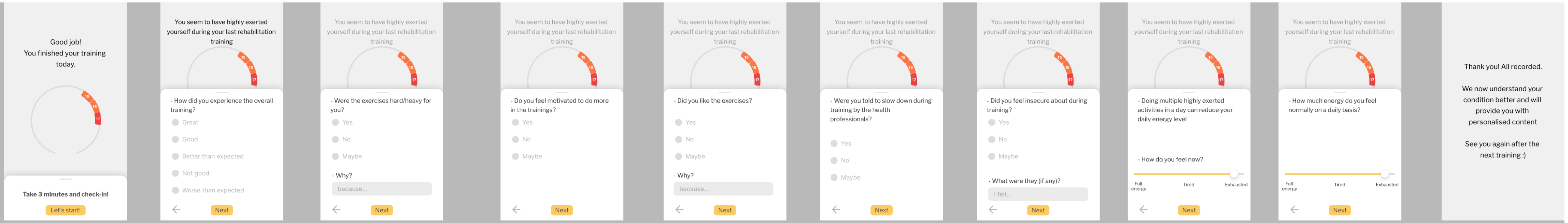
○ 12)

○ 13) redelijk zwaar | somewhat hard

(L)

-Check-in module adaptation-

Over train en



Good job!
You finished your training today.

Take 3 minutes and check-in!

You seem to have highly exerted yourself during your last rehabilitation training

- How did you experience the overall training?
  ○ Great
  ○ Good
  ○ Better than expected
  ○ Not good
  ○ Worse than expected

You seem to have highly exerted yourself during your last rehabilitation training

- Were the exercises hard/heavy for you?
  ○ Yes
  ○ No
  ○ Maybe
- Why?
  because...

You seem to have highly exerted yourself during your last rehabilitation training

- Do you feel motivated to do more in the trainings?
  ○ Yes
  ○ No
  ○ Maybe

You seem to have highly exerted yourself during your last rehabilitation training

- Did you like the exercises?
  ○ Yes
  ○ No
  ○ Maybe
- Why?
  because...

You seem to have highly exerted yourself during your last rehabilitation training

- Were you told to slow down during training by the health professionals?
  ○ Yes
  ○ No
  ○ Maybe

You seem to have highly exerted yourself during your last rehabilitation training

- Did you feel insecure about during training?
  ○ Yes
  ○ No
  ○ Maybe
- What were they (if any)?
  I felt...

You seem to have highly exerted yourself during your last rehabilitation training

- Doing multiple highly exerted activities in a day can reduce your daily energy level
- How do you feel now?

You seem to have highly exerted yourself during your last rehabilitation training

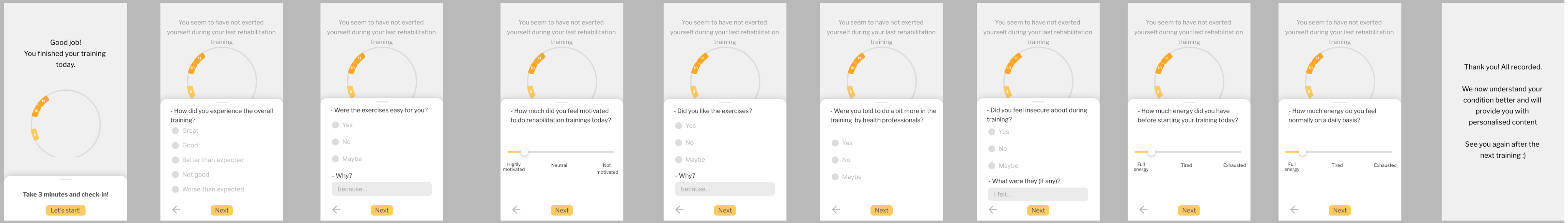
- How much energy do you feel normally on a daily basis?

Thank you! All recorded.

We now understand your condition better and will provide you with personalised content

See you again after the next training :)

Under train en



Good job!
You finished your training today.

Take 3 minutes and check-in!

You seem to have not exerted yourself during your last rehabilitation training

- How did you experience the overall training?
  ○ Great
  ○ Good
  ○ Better than expected
  ○ Not good
  ○ Worse than expected

You seem to have not exerted yourself during your last rehabilitation training

- Were the exercises easy for you?
  ○ Yes
  ○ No
  ○ Maybe
- Why?
  because...

You seem to have not exerted yourself during your last rehabilitation training

- How much did you feel motivated to do rehabilitation trainings today?

You seem to have not exerted yourself during your last rehabilitation training

- Did you like the exercises?
  ○ Yes
  ○ No
  ○ Maybe
- Why?
  because...

You seem to have not exerted yourself during your last rehabilitation training

- Were you told to do a bit more in the training by health professionals?
  ○ Yes
  ○ No
  ○ Maybe

You seem to have not exerted yourself during your last rehabilitation training

- Did you feel insecure about during training?
  ○ Yes
  ○ No
  ○ Maybe
- What were they (if any)?
  I felt...

You seem to have not exerted yourself during your last rehabilitation training

- How much energy did you have before starting your training today?

You seem to have not exerted yourself during your last rehabilitation training

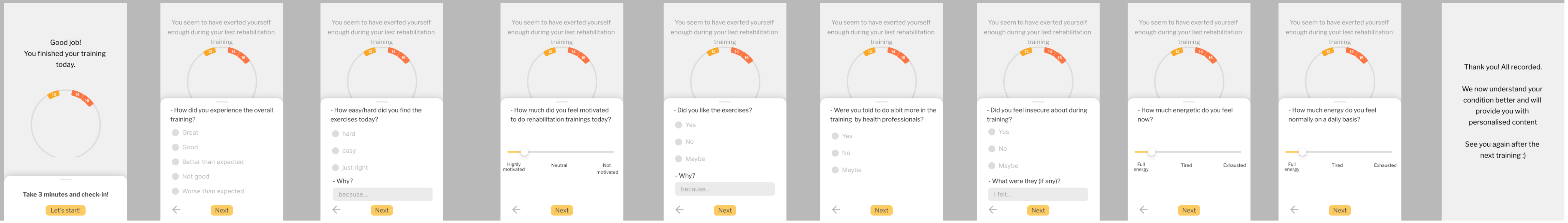
- How much energy do you feel normally on a daily basis?

Thank you! All recorded.

We now understand your condition better and will provide you with personalised content

See you again after the next training :)

enough train en



Good job!
You finished your training today.

Take 3 minutes and check-in!

You seem to have exerted yourself enough during your last rehabilitation training

- How did you experience the overall training?
  ○ Great
  ○ Good
  ○ Better than expected
  ○ Not good
  ○ Worse than expected

You seem to have exerted yourself enough during your last rehabilitation training

- How easy/hard did you find the exercises today?
  ○ hard
  ○ easy
  ○ just right
- Why?
  because...

You seem to have exerted yourself enough during your last rehabilitation training

- How much did you feel motivated to do rehabilitation trainings today?

You seem to have exerted yourself enough during your last rehabilitation training

- Did you like the exercises?
  ○ Yes
  ○ No
  ○ Maybe
- Why?
  because...

You seem to have exerted yourself enough during your last rehabilitation training

- Were you told to do a bit more in the training by health professionals?
  ○ Yes
  ○ No
  ○ Maybe

You seem to have exerted yourself enough during your last rehabilitation training

- Did you feel insecure about during training?
  ○ Yes
  ○ No
  ○ Maybe
- What were they (if any)?
  I felt...

You seem to have exerted yourself enough during your last rehabilitation training

- How much energetic do you feel now?

You seem to have exerted yourself enough during your last rehabilitation training

- How much energy do you feel normally on a daily basis?

Thank you! All recorded.

We now understand your condition better and will provide you with personalised content

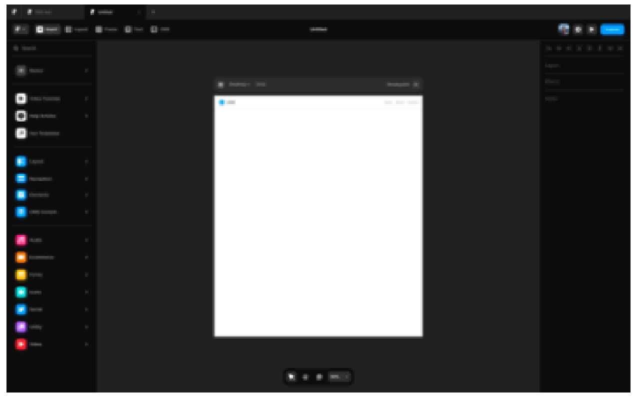
See you again after the next training :)

(M)

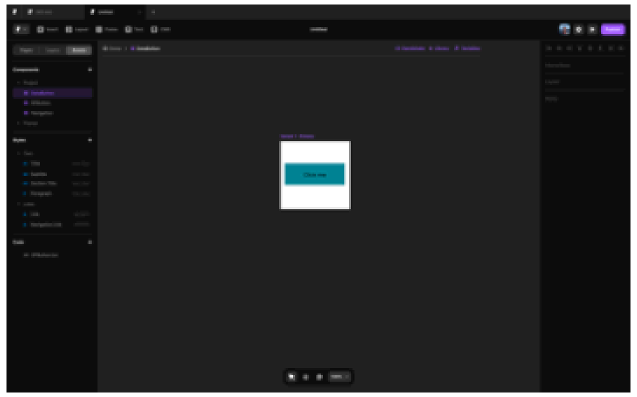
-Data Foundry-

The tutorial presented here was made by Peter Lovei, data designer at Philips

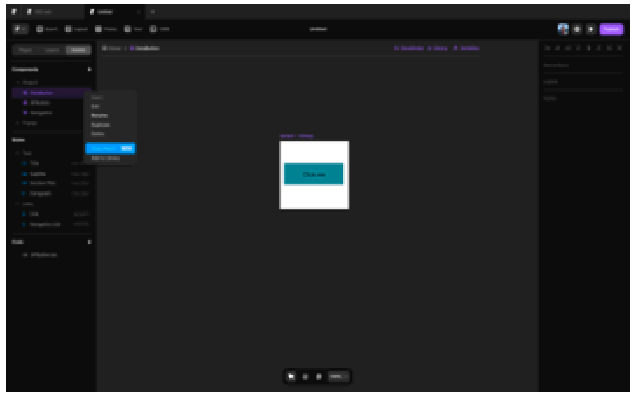
Framer prototype with a button that collects data



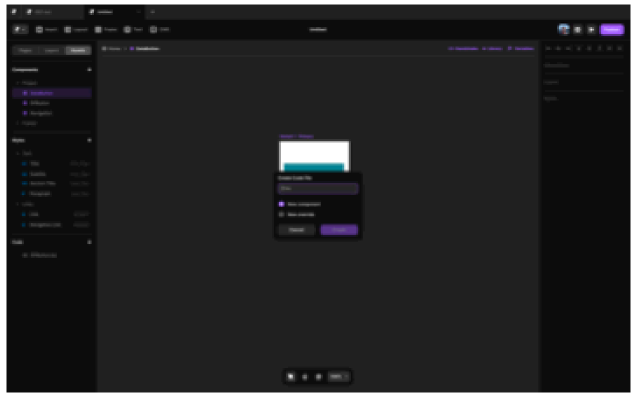
Step 1:
Create a new prototype



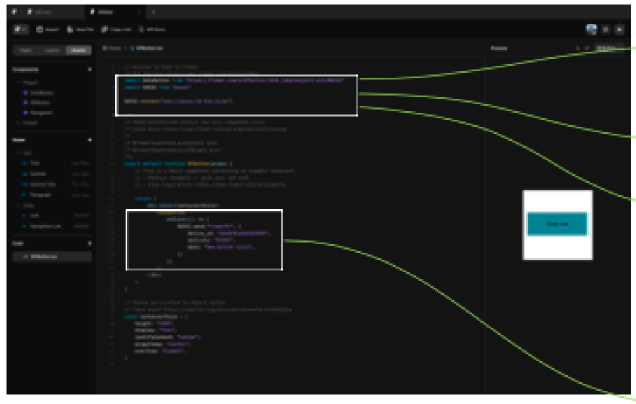
Step 2:
Change to assets, create and design a new component



Step 3:
Copy the component's import



Step 4:
For adding data collection create a code file with a different name than your component



Step 5:
Let's code a bit :)

Copy over the component import will look like this:

```
import DataButton from
"https://framer.com/m/DFButton-INiN.js@q14vp1uFtLvo1LdMQfbC"
```

Add an import for OOCSI node.js library:

```
import OOCSI from "oocsi"
```

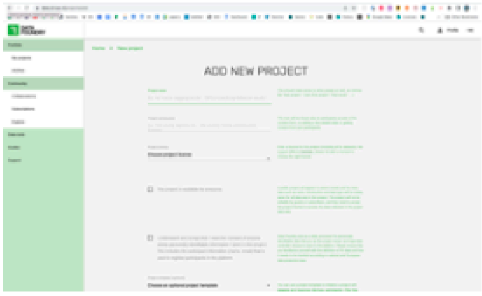
Connect to the OOCSI websocket:

```
OOCSI.connect("wss://oocsi.id.tue.nl/ws")
```

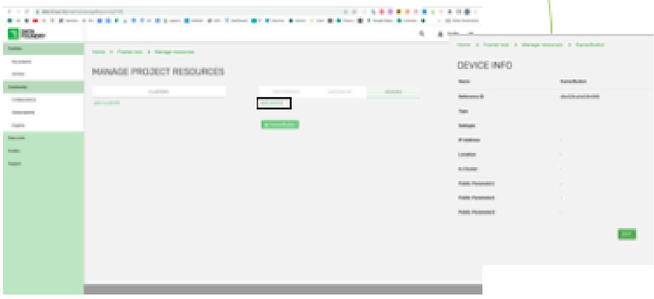
Add the DataButton component to the code, and define what happens when clicking on it (sending some data):

```
<DataButton
onClick={() => {
            OOCSI.send("framerPL", {
              device_id: "dbe629ca0a53b4988",
              activity: "EVENT",
              data: "New button click",
            })
          }}
       />
```

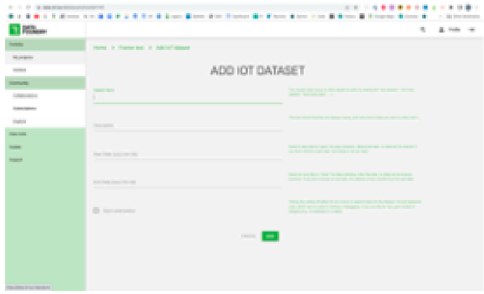
Store data



Step 6:
Create a new project

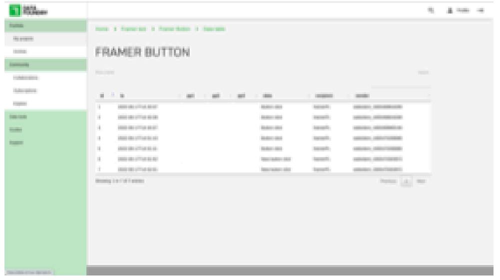


Step 7:
Add a new device, copy over the deviceID



Step 8:
Create an IoT Dataset

Step 9:
In the IoT Dataset select OOCSI stream for the data collection, use the channel name you defined in Framer, in this example framerPL



Step 10:
View incoming data