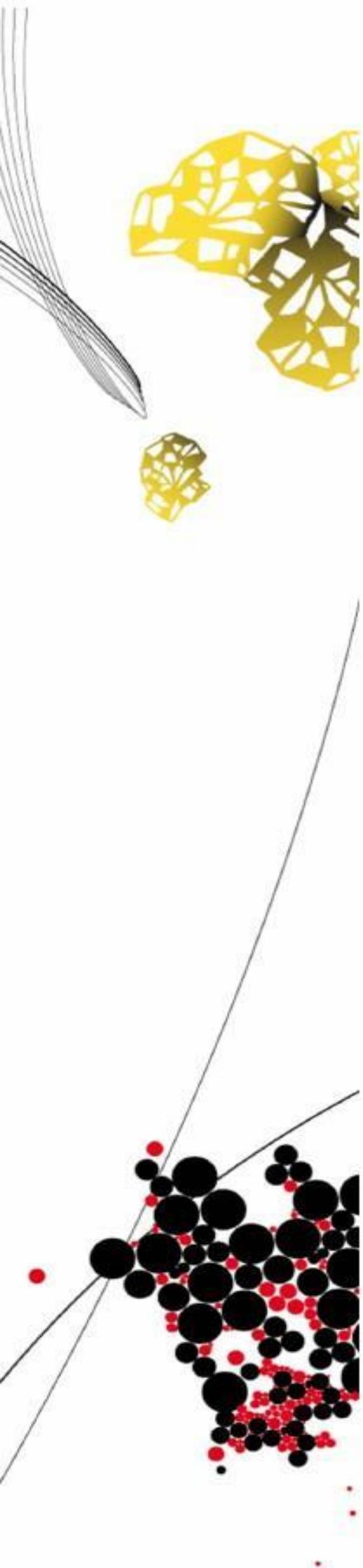


Self-management in older adults who are temporarily admitted to a nursing home for rehabilitation after a lower limb fracture and how this can be supported by technology.

Tess Goolkate
M.Sc. Thesis Health Sciences
January 2018

Supervisors:
Prof. dr. M.M.R. Vollenbroek-Hutten
Dr. Ir. B.J.F. van Beijnum

Health Sciences
Faculty of Science and Technology
University of Twente
7500 AE Enschede
The Netherlands



Self-management in older adults who are temporarily admitted to a nursing home for rehabilitation after a lower limb fracture and how this can be supported by technology.

A qualitative study

Thesis

Master Health Sciences

Track Human centered e-health and Healthcare services design

February 2017 – January 2018

Student

Tess Goolkate
S1784919

Institutions

University of Twente
Faculty of Science and Technology

ZGT (Ziekenhuis Groep Twente), Almelo
CarintReggeland, TriviumMeulenbeltZorg, Zorgaccent

Supervisors

Prof. dr. M.M.R. Vollenbroek-Hutten
Dr. ir. B.J.F. van Beijnum

UNIVERSITY
OF TWENTE.



Abstract

Background. This study aims to get a better understanding of self-management in older adults who temporarily rehabilitate in a nursing home after a lower limb fracture and how technology can support self-management. The concept of self-management in these older adults is still a relatively underexposed area. The literature has been consulted about the Dutch word “eigen regie”. There is no proper English translation for “eigen regie” and that is why components were searched that could properly describe “eigen regie”/self-management. Based on components of self-management, concepts related to self-management, and the Self-Determination Theory the term self-management for rehabilitation came up and will be used in this research. Self-management for rehabilitation included the components Knowledge, Skills, Motivation, Competence, Autonomy and Relatedness.

Participants and setting. This study was carried out in the rehabilitation wards of four nursing homes in the Province of Overijssel, the Netherlands. A total of nine older adults (>65 years) with a lower limb fracture participated in this study (8 women and 1 men, aged 79-91). During the expert-meeting a total of 8 researchers were present, working at: Roessingh Research and Development (RRD), Ziekenhuisgroep Twente (ZGT), and the University of Twente (UT).

Methods. To investigate self-management for rehabilitation, a qualitative semi-structured interview study was held. The topic list, created as a guideline for the interview(s), was based on the components of self-management for rehabilitation. A thematic analysis was carried out for the analysis of the interviews. For the expert meeting, the design for lost habits was used. This design served as a tool to come up with a design idea for a technology that supports self-management. All the ideas and opinions from the expert meeting were eventually elaborated and bundled. All outcomes were reviewed and placed next to the literature to come up with potential ideas for technologies that fit the older adults and its context.

Findings. The older adult is highly motivated in their rehabilitation process, but the components autonomy, knowledge, skills and competence are lacking. It is therefore hard to perform self-management for rehabilitation. A model has been developed for explaining the relationship between the different components. Requirements were found for a technology that might support self-management for rehabilitation. The technology should start the interaction. In addition, it should provide the lacking components; knowledge skills competence. The technology must (1) act safely or act like the nursing staff which gives the feeling that they can rely on it. (2) transfer knowledge to overcome their knowledge gap, it should act as an extension of the older adults’ cognition. (3) be personalized, due to high between-patient variability in feeling of competence, the cognitive and physical skills.

Conclusion. The level of self-management is low in the older adult, despite the fact that the older adult is highly motivated. This is mainly due to the fact that the components knowledge, skills and competence are lacking. A form of technology must provide the components that are lacking, as a result of the feeling that no self-management can be experienced or can be performed. The model of self-management for rehabilitation can help to map the missing components and can make clear which components should be provided by technology. It will differ per older adult which component is lacking and to what extent. The technology must therefore be personalized.

1 Introduction

The impact of hospitalization is high among the older adults. This group is often vulnerable and does not recover as quickly and well as a middle-aged person. This is especially the case with a lower limb fracture. It is suddenly not possible to walk properly and one is dependent on the nursing staff, family or other relatives. First an operation will take place and then rehabilitation will follow. During this rehabilitation period, one will learn to walk independently again, with the help of different exercises. It is possible to rehabilitate at home, but most older adults are already aged and therefore physically unable to rehabilitate at home. The rehabilitation will take place in a nursing home, this is often only for a certain period of time. With the help of various disciplines, for example a physiotherapist, an attempt is made to recover and be able to walk independently (or with the help of a walker) so they finally can go home again. If it is possible, physiotherapy takes place every day for half an hour. Outside the half-hour of physical therapy, everything in the nursing home is addressed and seen as rehabilitation. This varies from making your own coffee or walking yourself to the gym for physical therapy (only when the physical condition allows).

In this study, the definition of Vilans¹ was used to describe self-management: “the ability and the skills of a person, even in old age, to experience some degree of balance and well-being, despite age related losses. This in order to maintain or achieve the best possible quality of life.” There are many different definitions of self-management, mostly because this concept can be used in different fields of work as well as different situations. However, the definition of Vilans is somewhat broader and related to healthcare and so the elderly sector. This research is about self-management related to older adults who have a lower limb fracture and to what extent they can take care of themselves. It is about self-management in their recover/rehabilitation process. Nevertheless, the concept of self-management in these older adults is still a relatively underexposed area. Not much is known about self-management in older adults in relation to their rehabilitation after a lower limb fracture. Nowadays, more and more technology is being used in healthcare. There are for example many different programs available in the field of rehabilitation, as well as programs to support older adults with dementia. Technology can provide support in many areas, it can give that little bit extra that we do not own as a care professional. Despite this abundance of technology, little is known about the support that technology can offer to support and stimulate self-management.

Bringing those two knowledge gaps together this study aims to investigate the degree of self-management in older adults who temporarily rehabilitate in a nursing home after a lower limb fracture, and how self-management for rehabilitation can be supported by technology. To address this, first background information will be gathered to find out what is already known about self-management (in older adults). Secondly, the concept of self-management and its components will be defined. In third place the self-management capabilities of the older adults and problems and omissions hindering proper self-management will be identified. Finally, there will be described how technology can play a role in solving problems caused by those omissions. To do so, interviews will be held with the older adults. Subsequently the results from these interviews are being used for an expert meeting to come to the definition of technologies. Eventually this will answer the main research question: *What typifies a technology that supports self-management in older adults who temporarily need rehabilitation in a nursing home after a lower limb fracture?*

2 Background

In the Netherlands, the group of people of 65 or older, will increase up to 25% of the general population in 2050, a rise of 2.7 million in 2010 to almost 4.5 million older adults in 2050². Due to the aging population and longer life expectancy, the number of hip fractures will also increase, and so will the mortality and morbidity risk in the aging older adults.³ In 2012 more than 188,000 older adults with a hip fracture were treated in the Netherlands.⁴ Due to age-related comorbidities, older adults show a functional deterioration⁵ and also an increased one-year mortality of about 25%.⁶ The functional loss of the older adult may have the effect of among others readmission, prolonged hospital stay or transfer to a nursing home.⁷⁺⁸ Based on those facts and the aging population, Ziekenhuisgroep Twente (ZGT) based in Almelo, the Netherlands, established a Centre for Geriatric Traumatology, also called Geriatric Fracture Center (GFC). The GFC should improve the treatment of frail older adults with a fracture.⁹ In the background section we will talk sometimes about hip fractures instead of lower limb fractures. This because a lower limb fracture is a quite broad concept, it could include many different fractures. The hip fracture is the most common fracture after a fall in older adults, so this will make numbers more specific when talking about fractures.

At ZGT, older adults with a hip fracture and aged ≥ 65 years, are admitted to the GFC since April 1, 2008. This group of older adults will receive a multidisciplinary treatment approach, based on an orthogeriatric treatment model for older adults with a hip fracture.⁶ Different systematic reviews have proven that this model has more beneficial effects, like decreased mortality rate, compared to other models.¹⁰⁺¹¹ This approach is characterized by the use of multidisciplinary clinical pathways, started from admission to the hospital through to the outpatient clinic.⁶ A (clinical) pathway, also known as a care pathway, is typified by a tool that will be used to guide evidence-based healthcare.¹² Care pathways minimize variance in treatment, which leads to reduced cost, increased efficiency and improved patient care outcomes.¹³ By using care pathways, you are aiming for more personalized care.

Of all older adults there is a group, between 25.000 and 30.000, that needs rehabilitation after admission to the hospital, 25% of this group concerns older adults with a hip fracture.¹⁴⁺¹⁵ This geriatric rehabilitation takes place in skilled nursing facilities, with a comprehensive rehabilitation team.¹⁶ Geriatric rehabilitation is defined as: 'a multidisciplinary set of evaluative, diagnostic and therapeutic interventions with the purpose to restore functioning or enhance residual functional capability in older people with disabling impairments.'¹⁷ Literature shows that inpatient rehabilitation, with the focus on geriatric patients, has the potential to improve health outcomes related to function, admission to nursing homes and mortality.¹⁸ It also shows a reduction of death or admission to a nursing home by using a multidisciplinary approach.¹⁹ But you should keep in mind that the geriatric rehabilitation is challenging due to age-related aspects and therefore in its coordination and continuity. A (clinical) care pathway should tackle those obstacles.²⁰

The GFC in the hospital ZGT has done a lot of research, results show a positive effect of the multidisciplinary approach. This positive effect is represented in fewer complications, a decreased hospital mortality per patient, and less consulting of other specialisms.²¹ Research from Folbert et al.,²² showed that sometimes older adults stayed longer in the hospital than necessary, waiting for treatment in a nursing home for geriatric rehabilitation. Once they receive geriatric rehabilitation in a nursing home, it seems that the likelihood that older adults aged 80 years or older can return to their former living situation is significantly lower than in younger patients.⁹ The GFC sees opportunities to improve the cooperation between them and different nursing homes, and so the quality of care. With help of the implementation of clinical pathways you will be able to monitor, control and ultimately research the rehabilitation process in nursing homes.⁹

In order to do so ZGT, in collaboration with the University of Twente, started a project with three nursing homes near Almelo, The Netherlands called “Up and go” after a hip fracture. This project aims to develop a technology supported service, that monitors progress of the older adults during rehabilitation up to 6 months after surgery and support the older adult in their self-management with regard to rehabilitation.²³ As a result of this project, more insight can be obtained in the duration, intensity, and the effects of the geriatric rehabilitation. Interesting is that the older adult himself can get more personalized motivated feedback and advices. He/she is more able to optimize his/her own rehabilitation process, which enhances the self-management of the older adult.

According to the current guidelines an older adult receives half-hour rehabilitation on a daily basis, along with a physiotherapist. In addition, the rehabilitation wards in the nursing homes try to approach every daily activity as rehabilitation. This varies from making their own coffee, to walking to the toilet instead of using a wheelchair. However, the older adults do not experience every activity as rehabilitation. They often feel that the only rehabilitation they get is in that particular 30 minutes with the physiotherapist.

What is self-management?

Due to the ageing population and rising health care costs, the long-term care will be reformed in the Netherlands. The government will put more and more emphasis on self-management of the older adults²⁴. Self-management is a complex concept, and there is no clear generally accepted definition.²⁵ Based on the literature it is related to many different definitions and also connected to different synonyms like: empowerment, self-empowerment, autonomy, self-efficacy, and perceived control. Those different definitions are often used interchangeably, but they also reinforce each other. It is most confusing in cases in which the same definition is used to refer to very different constructs. For example, research of Brody et al.,²⁶ showed improved quality of life, self-efficacy, mood and functions as desired outcomes of self-management. While the research of Koch et al.,²⁷ refers to the predominant model, which uses the concepts of medication compliance and adherence to physician recommendations as desired outcomes of self-management. Often, the emphasis in health care is about self-management in chronic diseases.²⁸ This concerns, among others diabetes, asthma, and chronic obstructive pulmonary disease (COPD). On the other hand, there is not much information about self-management in older adults or self-management of (frail) older adults (≥ 65 years of age) who need short term rehabilitation after a hip fracture /lower limb fracture.

Self-management is an interesting concept and widely used in the current health care. To avoid ambiguity about the concept of self-management, the definition of Vilans will be used in this research. Vilans¹, a national knowledge centre for the long-term care in the Netherlands, approached self-management as: “the ability and the skills of a person, even in old age, to experience some degree of balance and well-being, despite age related losses. This in order to maintain or achieve the best possible quality of life.” This definition is still quite broad and does not include the core of self-management when we relate this to the older adults, who must rehabilitate in a nursing home. In the Netherlands we talk in this context about ‘eigen regie’ which is more than just the concept of self-management. Unfortunately, there is no proper English translation of the word eigen regie. For that reason, we will talk in the rest of this paper about self-management.

Talking about self-management in rehabilitation is engaging in physical activity and has as such much resemblances with changing behaviour. This because the older adult cannot perform or to a lesser extent perform certain (physical) activities than before the lower limb fracture. The health behaviour of the past is often no longer adequate and will have to change too. In order to change the actual behaviour, there must be some motivation to change. To explain (health) behavioural changes and by this motivation of the older adults to do so, different theories and/or models have been designed. The Self-Determination Theory (SDT) is a popular and a common used theory. The focus in this theory is more on motivation than behavioural change itself. The SDT acquires the motivation for initiation new health-related behaviours and also maintaining them over time.²⁹ In the SDT, a distinction is made between the intrinsic- and extrinsic motivation. This involves stimuli from internal and external sources. The intrinsic motivation can be enhanced by three components: competence, relatedness, and autonomy.³⁰ Research from Ryan & Deci mentioned that autonomous self-regulation is central to the SDT, being autonomous refers to acting with a sense of volition and the experience of willingness. They also mention that advice or recommendations can be provided by health-care professionals in a autonomy-supportive way.³¹ Which is sometimes quite difficult, health-care professionals can be seen as authorities whereby words can be interpret as controlling. This is commonly seen phenomenon in practice. The older adults who are temporarily admitted to a nursing home, will see the health-care providers as an authority, which lead to more dependency. At that moment, it is not logical for the older adults to be autonomous, despite the fact that they are physically deteriorating. Autonomy is therefore an important component of the SDT, certainly when we look at the target group of this research; the older adults. Competence refers to the feeling that the desired activities are performed well. Relatedness refers then to a sense of security and intimacy.³² These are also two important motivational needs, related to behavioural change.

Self-management for rehabilitation

We can conclude that self-management is a broader concept than self-management as defined by Vilans. We added other components that are part of to what we call self-management. Table 1 shows an overview of all concepts and components related to self-management in our context. The most common components are knowledge, competence, motivation, and skills, which will be used in this study. This table has been established by a literature search for the concept of self-management and concepts related to this. The selection of the concepts shown in table 1 consists of self-management, patient-empowerment/self-empowerment, autonomy, self-efficacy, and perceived control. This selection took place by looking at the concepts that are most affiliated with the target group in this study. Subsequently, the focus was on finding components that support the different concepts. In addition, 3 components of the SDT were added. Because this theory is closely related to the behavioural changes the older adults should pass through and the associated motivation that is needed for this. The SDT and its components autonomy, competence and relatedness are also visible in table 1. Finally, in this study, the following components will be used: knowledge, skills, motivation, competence, autonomy, and relatedness. Based on this information, more clarity will be created by talking from now on in this study about *self-management for rehabilitation*.

Table 1: Overview of the different concepts of self-management, the SDT and their related components

	Author	Components
Self-management	Lorig et al. (2006) ³³ Battersby et al. (2003) ³⁴	<i>Knowledge</i> <i>Knowledge</i> <i>Competence</i> Attitudes <i>Motivation</i> Behaviour
Patient Empowerment & Self-Empowerment	Angelmar et al. (2007) ³⁵	Role understanding <i>Knowledge</i> <i>Skills</i> - Self-efficacy - Health Literacy
Autonomy	Sherwin et al. (2011) ³⁶ Proot et al. (2000) ³⁷	<i>Competence</i> (can decrease in older adults, due to dementia) Self-determination Independence Self-care; skills.
Self-efficacy	Hackett et al. (1981) ³⁸ & Usher et al. (2008) ³⁹	<i>Knowledge</i> <i>Skills</i> <i>Motivation</i> <i>Competence</i> Confidence
Perceived Control	Heo et al. (2015) ⁴⁰ Rodin et al. (1990) ⁴¹	<i>Knowledge</i> Barriers to Attitudes toward <i>Competence</i>
Self-Determination Theory (SDT)	Ryan & Deci (2000) ³⁰	<i>Autonomy</i> <i>Competence</i> <i>Relatedness</i>

How to improve self-management for rehabilitation

ICT is a potential innovation to realize more personal responsibility in health care.²⁸ Alpay et al.,⁴² mentioned that: “e-health is seen as an important technological tool in achieving self-management; however, there is a little evidence of how effective e-health is for self-management.” Whereby e-health can be explained by the definition of Eysenbach⁴³:

“e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.”

Or simply explained by van Gemert-Pijnen et al.⁴⁴: *“as the use of information and communication technologies, internet-technology in particular, to support or improve health and health care.”*

Due to the lack of evidence of how effective e-health is for self-management, it is important to mention the facts that can explain the relation between e-health and self-management. The Dutch government and patient organisations put more pressure on the citizens to stay in control of their own life and perform for as long as possible to be self-reliant. Technology can support this. It can support us in complex situations, and the health care stays accessible⁴⁵ It also seems that the current citizen has more interest in technologies, especially the upcoming older adults and adolescents.⁴⁵ In addition, several studies have been carried out, related to the use and acceptance of e-health in older adults.⁴⁶ Those studies aimed that older people should age in their own home environment and community This because of the expected shortage of care professionals and to avoid the option of institutional care. There has been a reduction of nursing homes and so the institutional care, because of changes in health care legislation.⁴⁷ An important improvement is the support of community-dwelling older adults using e-health. Research from Peek et al.,⁴⁸ analysed focus groups involving different stakeholders: older adults, care professionals, managers, technologists, and policy advisors and policy makers. From this point of view, of all stakeholders, it appears that implementation of technology is successful when: (1) older adults' needs and wishes are prioritized during development and deployment of the technology, (2) the technology is accepted by older adults, (3) the technology provides benefits to older adults, and (4) favourable prerequisites for the use of technology by older adults exist. This is based on community-dwelling older adults. It is therefore questionable whether these are also facilitating conditions for the older adults, who are temporarily admitted to a nursing home for rehabilitation after a lower limb fracture. The actual goal, of using e-health, remains the same for both situations: the self-management must increase for both the community-dwelling older adults, and the older adults, who are temporarily admitted to a nursing home for short-term rehabilitation.

The older adults did not grow up with the current (electronic/digital) technologies. It is therefore harder for the current older adults to accept this kind of technologies.⁴⁹ Technology acceptance can be defined as: "the approval, favourable reception and ongoing use of newly introduced devices and systems".⁵⁰ The Technology Acceptance Model (TAM) is a widely used model for predicting technology usage behaviour. Chen and Chan presented a review of technology acceptance by older adults. They found that TAM is an effective model when it is applied to older adults as well as for the young. To understand the technology acceptance of older adults, it is essential to take into account biophysical and psychosocial characteristics, abilities and problems experienced by older adults.⁵¹

3 Methods

In this research, the focus is on investigating the concept of self-management for rehabilitation in older adults aged 65 years and older who need temporarily rehabilitation after a hip fracture, and how this can be supported by technology. This research is originated from the PIHC project: “Up&go after a hip fracture”, which is originates from the Geriatric Fracture Center (GFC), ZGT in Almelo. To identify self-management for rehabilitation, qualitative semi-structured interviews were held. In order to find an appropriate technology to support self-management for rehabilitation, the expertise of different experts has been used to find technologies that fits the older adults and support their self-management for rehabilitation in a rehabilitation ward after a lower limb fracture. For the expert meeting, the design for lost habits was used. This design served as a tool to come up with a design idea for a technology that supports self-management.

3.1. Participants and Setting

This study was carried out in the rehabilitation wards of four nursing homes in the Province of Overijssel, the Netherlands. Older adults were recruited from St. Elisabeth (Carintreggeland) in Delden, Eugeria (Carintreggeland) in Almelo, Het Meulenbelt (TriviumMeulenbeltZorg, TMZ) in Almelo, and Krönnenzommer (ZorgAccent) in Hellendoorn. The potential older adults were identified in the different nursing homes via discussion with staff and review of ward lists. A total of 9 older adults participated in this study. The older adults were included if they 1) were 65 years of age or older, 2) were diagnosed with a lower limb fracture, 3) had as a goal to return to their own home or an old people’s home, 4) were able to communicate and if they were Dutch, 5) had no marked cognitive impairment(s). Older adults were excluded if they 1) had progressive neurological disease (e.g., Parkinson’s disease), 2) had severe multi-morbidity (somatic, psychiatric and/or psycho-geriatric).

In total 9 interviews were held. The group of older adults consisted of 8 females and 1 male, with an average age of 86 years. A total of 7 older adults were in the age range of 80 to 90 years, 1 older adult was younger (79 years), and 1 older adult was older (91 years). In consultation with nursing staff, physiotherapists and a geriatric specialist, the older adults were approached. In addition to the interview, the older adults were also unconsciously observed. This has led to a total picture of the various older adults.

The study was approved by the University of Twente Office of Educational Affairs (BOZ), and the Advisory Committee on Local feasibility of Scientific Research of the hospital: Ziekenhuisgroep Twente (ZGT), Almelo and is registered as a non-Medical Research Involving Human Subjects Act (WMO) research. All older adults signed informed consent prior to participating in this study.

3.2. Interviews

In order to gain information about self-management for rehabilitation, interviews were held. The interviews were based on the different components of self-management for rehabilitation. The interview format was semi-structured and developed stepwise.⁵² Based on the aim of the study and the relevant literature, a topic list was made (Appendix 1). This topic list was based on the components of self-management for rehabilitation: knowledge, skills, motivation, competence, autonomy and relatedness. The use of technology was also added to this topic list to get an idea of how the older adults think about technologies and if they use technologies. To develop this topic list, first a brainstorm session took place in which depth was sought in the different components. The brainstorm session was done by the researcher self, in which literature was consulted. Ideas about different topics and questions related to those components were written down. This resulted in a first version of questions that should be asked in the interviews. Those questions had to be adjusted and structured. To create more structure, these questions have been processed in the format of the final topic list. This format consisted of different topics, subtopics and example questions, all based on the above-mentioned components. The topic list served as a guide to the interview, it was used for keeping the conversation going. It was never used to literally ask each question. During the interviews, more information came up on how the questions were interpreted and answered by the older adults. The target group, the older adults, has been taken into account from the outset: difficult words have been omitted and the questions were mostly short and simple. The interviews with the older adults were audiotaped with a mobile phone and fully transcribed in Microsoft Word.

3.3. Data analysis of the interviews

Before the analysis of the interviews, an overview of the older adults' characteristics was made (Appendix 2). Several questions were asked, and answers were given during the interview. Based on the interaction at that moment, a certain image was obtained from the different older adults. Certain characteristics emerged, which gave an idea of how an older adult was. The characteristics in appendix 2 gives more insight in the type of fracture, their cognitive health and if/how they perform their physical activities.

A thematic analysis⁵³ was carried out for the analysis of the interviews. This is a method for identifying, analysing, and reporting patterns (themes) within data. It was carried out with the help of the following steps. First the transcripts were read and re-read, and it was checked for patterns of themes among the data. Normally qualitative data analysis consists of identifying, coding, and categorizing patterns or themes found in the data.⁵⁴

First, each transcript was re-read and again the components of self-management for rehabilitation were consulted. Second, it has been decided to drop out all unnecessary information from the interviews. The unnecessary information consisted mainly of answers that were not related to the various components. Each sentence was examined, whether this could be of value to this research. For example, many older adults talked about their past, much of that information has been dropped out because it did not have a connection with the different components and it also did not say anything about the degree of self-management for rehabilitation at all or the degree of self-management for rehabilitation at this moment. If it did say something about the degree of self-management for rehabilitation, it was included in the important quotes. Which means that in the end all important quotes have been taken from the transcripts, based on the consulted literature. These important quotes were imported in a table into Excel. Subsequently, every quote was checked whether there was a relation, yes or no, with the following components: autonomy, competence, relatedness, knowledge, skills, motivation, and technology. When the quote gave insight into, for example, the degree of autonomy, there was "yes" was filled in, if not "no" was filled in. This was also applied to the other

components. It was therefore possible that in certain quotes several components were involved. To obtain the most important results, a filter has been applied in Excel on all components. The choice has been made to mainly filter on autonomy “yes” and autonomy “no”. In this way, a clear picture could be obtained of how autonomy, and thus self-management for rehabilitation, appears within the older adults. When several components were involved, interrelationships were also considered.

3.4. Expert meeting

An expert meeting was held to brainstorm about technologies that could support self-management for rehabilitation in older adults. In order to clarify what kind of technology should support self-management for rehabilitation in older adults, assistance was requested from different experts during an expert meeting. A total of eight researchers were present, working at, among others Roessingh Research and Development (RRD), Ziekenhuisgroep Twente (ZGT), and the University of Twente (UT). The experts had the necessary knowledge about older adult(s) and technologies as well. Before the meeting a working document was created, which should serve as a tool during the meeting. This document consisted of: an agenda of the meeting, some results of the interviews and a design for lost habits⁵⁵, which served as a tool to come up with a design idea for a technology that supports self-management for rehabilitation. The document ended with a workshop section in which the researchers could think about initial requirements and a design idea of what the technology should look like. One meeting was organized, the working document was sent prior to this meeting.

During the meeting, this research was presented briefly and the results were further discussed. The document showed some important quotes from the interviews, it also showed how the interviews were elaborated and how the older adults responded to the questions asked. The quotes came from the Excel document previously described. Subsequently, the design for lost habits⁵⁵ systematically sought potential ideas for a technology that supports self-management for rehabilitation in the older adults during the rehabilitation period. The design for lost habits looks at people’s habits and how innovations can take on a loss. Which closely matches the older adults who, for example, broke their hip and thereby lost the habit of performing daily activities. The design consists of 4 steps, the first 3 steps have been worked out by the researcher. In step 4 assistance was requested from the experts. During the first 3 steps, the former situation, lost habits situation and a persona were described and developed. Eventually in step 4, the experts looked at the desired situation, which led to a brainstorm session. The experts thought about the target group and their characteristics and what the desired situation might be. The thoughts about this were written down in the workshop section of the working document. Finally, there was a common talk about possible technologies, or the possibilities that a technology has to offer which, in the end, fits the target group and increase self-management for rehabilitation.

3.5. Data analysis expert meeting

All the ideas and opinions from the workshop section in the working document were eventually elaborated and bundled. All outcomes were reviewed and placed next to the literature. By consulting the literature, the ideas of the experts could be compared with already existing forms of technology. From this, potential ideas for technologies that fits the older adults and its context will arise.

4 Results

4.1. The older adult

A total of 9 older adults have been interviewed in 4 different nursing homes, 8 women and 1 male. The interviews took place with older adults over 65 years of age who have a lower limb fracture. A total of 7 participants were in the age range of 80 to 90 years, 1 participant was younger (79 years), and 1 participant was older (91 years). First, the characteristics of the older adults will be elaborated before we look at the degree of self-management for rehabilitation in older adults. As mentioned, Appendix 2 gives an overview of the characteristics of all the older adults.

Talking about older adults, includes adults over 65 years of age. Remarkable was that almost all older adults in this study were 80 years or older, only one older adult was younger (79 years old). All older adults suffered from a fracture due to a fall, related to a low energy trauma. In general, they have fallen in their own home or in the vicinity. In the case of 7 older adults, there was a fracture in the hip area, the other 2 older adults had a pelvic fracture. All older adults still lived in their own home before admission to the nursing home, some needed help from home care and/or lived in a sheltered housing accommodation. It was striking that all older adults were quite active before admission to the nursing home, which varied from doing groceries, household chores and sometimes volunteer work. Some older adults already used a walker in the home situation. In the nursing home, all older adults actually used a walker as supporting tool. Some of the older adults were bound to a wheelchair, which was often temporary. It was often dependent on the admission time whether they could already use a walker or if they had to stay in a wheelchair. It was found that 3 older adults would no longer return to their own home, these older adults needed long-term admission into a nursing home.

"Yes, I hope that I can do everything. I could get down the stairs and get the newspaper. I hated the elevator, so I often went down the stairs instead of using the elevator." [Participant 6]

"I still cycled, did all the groceries and now I cannot do that anymore."
[Participant 1]

Certainly 3 older adults showed cognitive impairments. This was based on observations and the interviews from the researcher. Those observations and thoughts were then discussed with the nursing staff. However, no cognitive impairments were tested or assessed in the older adults. Yet interaction with these older adults was possible, the older adults could express themselves verbally and they could express many things well. Nevertheless, in these cases, answers were given that were not directly related to the question asked. A lot of interaction took place with a few other older adults, there was a lot of repetition in what they already said or what the researcher had summarized from their answers. In addition, a lot of words were often given as a reply, many details were added. In the case of only 2 older adults, no cognitive impairments were observed. This was based on observations of the researcher, interaction during the interview and how they react on questions. This has subsequently been confirmed by the nursing staff. There was a lot of interaction, questions were mostly understood well and could be answered clearly. Difficult questions were not answered during the interviews, the older adults mostly passed on to another subject. Some older adults did not react that much, the answers were sometimes very short, like 'yes' and 'no'. It was therefore hard for the researcher to get (the right) information. This resulted in relatively few interviews, in which information-saturation was achieved.

4.2. The components of self-management for rehabilitation

At the beginning of this study, the decision has been made to talk about self-management for rehabilitation, which consists of the components: knowledge, skills, motivation, competence, relatedness and autonomy. In the following, the various components will be explained briefly to show the extent to which the components returned during the interviews and how they are related. After the interviews it has been shown that the components social support and activities that matter can also be added, which is therefore visible in figure 1.

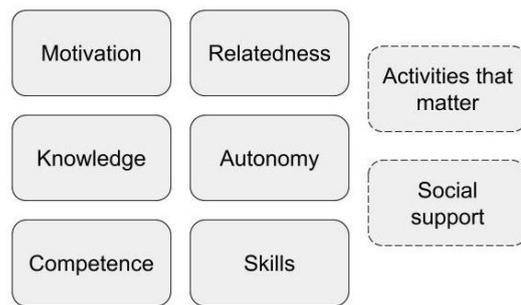


Figure 1: Components of self-management for rehabilitation

Motivation The level of motivation varies amongst the older adults. Many older adults think that they have already reached a certain age and no longer need to do a lot. What they did at home, was enough for them. The older adults do the exercises that they have to do during the physiotherapy, but none of the older adult takes the initiative to practice more or practice by their self. However, almost all older adults are highly motivated to rehabilitate if they will recover and can go home again. Do the things they have done before, like doing the groceries, household chores and other things they did at home. The older adults are intrinsically motivated to rehabilitate.

Competence When we talk about competence, we can refer to self-efficacy. Which means in this study: one's belief to achieve/succeed a task or an activity. Due to the fall, the level of confidence in almost every older adult has decreased significantly. They are afraid to fall again in almost every activity they perform, mainly activities related to walking independently. This could restrict the rehabilitation process. They trust the care professionals blindly. Due to the decrease in their physical condition, they are less able to walk a certain distance alone. In addition, the trust in the care professionals leads to less effort to actually walk that certain distance alone.

Knowledge Most of the older adults do have very limited knowledge about the rehabilitation process in general. They do not understand that everything they do during the day actually is rehabilitation. In addition, they also have limited knowledge about the different exercises offered in terms of why and how they need to be performed. The older adults do the exercises that they have to do only during the physiotherapy. This affect the degree of competence and skills.

Skills For some older adults, it was difficult to set goals and actually pursue these. Skills are often present in the older adults to perform the exercises, but mostly a little or no initiative is taken. However, as their physical condition has decreased due to the fall, their skill to go for a walk for a certain distance is insufficient. In addition, their cognitive skills are often low which hampers them to perform exercises.

Relatedness The older adults feel very related to the nursing staff and other care professionals, who are helping them during the rehabilitation process. This is not odd, because of their increased dependency after the fracture. They need to re-learn to walk independently again, they are more dependent now. This dependency creates a certain hierarchy between the nursing staff and the older adults that hampers the older adult to take initiative or ask something. The certain hierarchy was also mentioned by some older adults. They mentioned for example that they do not ask everything if it was not necessary, they thought that the nursing staff was mostly (very) busy. The degree of autonomy, motivation, competence, and skills are thereby hampered. For some older adults, it was also very important which caregiver was helping them. Depending on the relationship with that person, some questions were either asked/answered or not. Besides that, the support from family was also important. It appears that the support from family strongly motivates the older adult.

Social support This component was not found in the literature, but was found to be important during the interviews. It concerns support from family, children, friends or, for example, their neighbours. It is about being able to rely on them and get help from them if needed. This component differs from relatedness. The component relatedness is related to care professionals and the component social support is more about the closest ones. One older adult received support from her husband each day in nursing home. This strongly motivated her, but also increased the level of different components like, competence and skills to a higher level. Some older adults often referred to their children or relatives who could help them with groceries shopping for example. The degree of autonomy may still lie with the older adult, but sometimes they may need a little help from third parties.

Activities that matter This is another component that was not found in the literature, but was found to be important during the interviews. It has been found that the older adults consider it important to do activities that they are familiar with, the activity should matter. The older adults indicate that they have reached a certain age and that they do not expect much more from life, it is good at it is. There is no need for (too much) new information or (too much) new activities. The activity should matter, it should meet the needs of the older adult. One can think of, for example, knitting, household chores or grocery shopping. The older adult will pursue the valuable things in life.

Autonomy All older adults with a lower limb fracture lived in their own home before admission to the geriatric rehabilitation ward of the nursing home, some needed help from home care and/or lived in a sheltered housing accommodation. Almost all older adults were fine with this situation and the activities they could do. Once in rehabilitation after a lower limb fracture, the older adult often referred to the home situation before admission. They were fine with this situation, do not have any further expectations and hope to return to this situation again. After the lower limb fracture almost all older adults experience less or no autonomy. Autonomy increases during rehabilitation for all older adults, however, each at their own pace. The degree of autonomy varies also between the older adults. Looking at the degree of autonomy related to the rehabilitation program, this autonomy is low. With the help of the physiotherapist the exercises can be performed, but the exercises are barely pursued independently. No or only little own initiative was taken to fulfil exercises or an activity such as walking down the corridor.

As a result, from the interviews, it was found that the questions related to the component autonomy provided interesting information. It has many interfaces with the concept self-management and self-management for rehabilitation. In addition, autonomy clearly shows how the older adults rehabilitate, what they think about the rehabilitation and what their driving forces are to recover.

Broadly, three important results have been gathered from the interviews with regard to autonomy: (1) almost all older adults experience less or no autonomy after a lower limb fracture, (2) Autonomy increases during rehabilitation for all older adults, however, each at their own pace, and (3) The degree of autonomy varies per older adult, it is individual to what degree autonomy is being taken and performed.

- (1) After the fracture, all older adults have relapses in autonomy making the older adult more dependent. This is reflected in the answers of almost each older adult, they experience a lesser degree of- or no autonomy. They often referred to the activities they knew and did before, but are not able to do several activities at the moment.

"Sometimes I think, what else can I do? Like the toilet, this afternoon I had to wait for so long. Then I wish I could do it myself." [Participant 9]

- (2) Only less than half of the older adults is taking up their autonomy (again) quite actively. The other older adults need to rebuild this degree of autonomy with help from others. Here the older adults refer to regaining trust in themselves and the environment.

"And now I can walk myself. I'm walking with a walker, but I cannot just get out of bed. Yes, I can get out of bed, but I have to put the blanket off. That is hard for me, the nurses should help me with that." [Participant 6]

- (3) When the autonomy decreases due to a lower limb fracture, it slowly increases again during the rehabilitation, but this process differs per older adult. For example, some older adults, who already stayed a while in the rehabilitation ward, showed less autonomy than some of the older adults who were just a week at the rehabilitation ward. So, it needs to be looked at individually how they take up their autonomy.

"Usually I sit here in my room. Mostly I'm watching television." [Participant 2]

"Yes of course, at first, but it's actually that... I'm no longer dependent. The nurses say it is about you and not about us, you can tell us what you want, and we are here if you need help." [Participant 8]

When we look at the degree of self-management for rehabilitation related to the rehabilitation program, the older adults did not show that much self-management for rehabilitation qualities regarding the different exercises that were offered by the physiotherapist. With the help of the physiotherapist the exercises could be carried out, but the exercises were barely pursued individually. The rehabilitation consists of half an hour physiotherapy and where necessary, with other disciplines. Typically, almost every older adult had limited knowledge of the different exercises offered. This limits the older adults to practice the exercises individually, outside the therapy. It happens that only a little initiative was taken to fulfil the exercises or, for example, make a walk down the corridor. Some findings for this are:

- (1) The nursing staff was sometimes too busy in the eyes of some older adults. As a result, the older adults who needed help or a little bit support, could not actually walk with the walker if they intended to do. The autonomy is shifting to the nursing staff, possibly due to fear and insecurity of the older adults.

“Yes, but when the nurse is there I will go for a walk.” [Participant 4]

“It is okay now, but I would like them to walk with me more often. Yes, it’s very nice, but they put me in the wheelchair a lot.” [Participant 5]

- (2) It seems that it is difficult for the older adults to set goals related to their recovery. As mentioned, they do not immediately know what the content is of the different exercises. Sometimes the older adults take the situation as it is and totally rely on the nursing staff.

“Just what I’ve always done.” [Participant 5]

“Yes, I think it is important but I’m already 86. I think it is what it is, and it is good now.” [Participant 2]

- (3) It is often physically not feasible to experience a certain degree of autonomy again. Some older adults were wheelchair bound for a certain period, which means that they were more dependent on the nursing staff for a longer period.

“Then I had to sit for 6 weeks. I had to use a wheelchair the whole time.” [Participant 6]

- (4) Some older adults simply do not know how to pick up an exercise or instructions. It is no longer achievable to process all new information properly.

“In therapy, they decide what to do. Yes, because I do not know either.” [Participant 6]

The interaction between the components of self-management for rehabilitation

After the interviews have been conducted, it appears that all components (knowledge, skills, motivation, competence, autonomy, and relatedness) are related to each other. The interviews were taken to look at the degree of self-management for rehabilitation in older adults. To look more in-depth into the connection between the different components and the degree of self-management for rehabilitation a model has been developed that explains clearly what is needed to experience and perform self-management for rehabilitation. Figure 2 give a model of the components and their relationships. They will be explained from left to right (1-4).

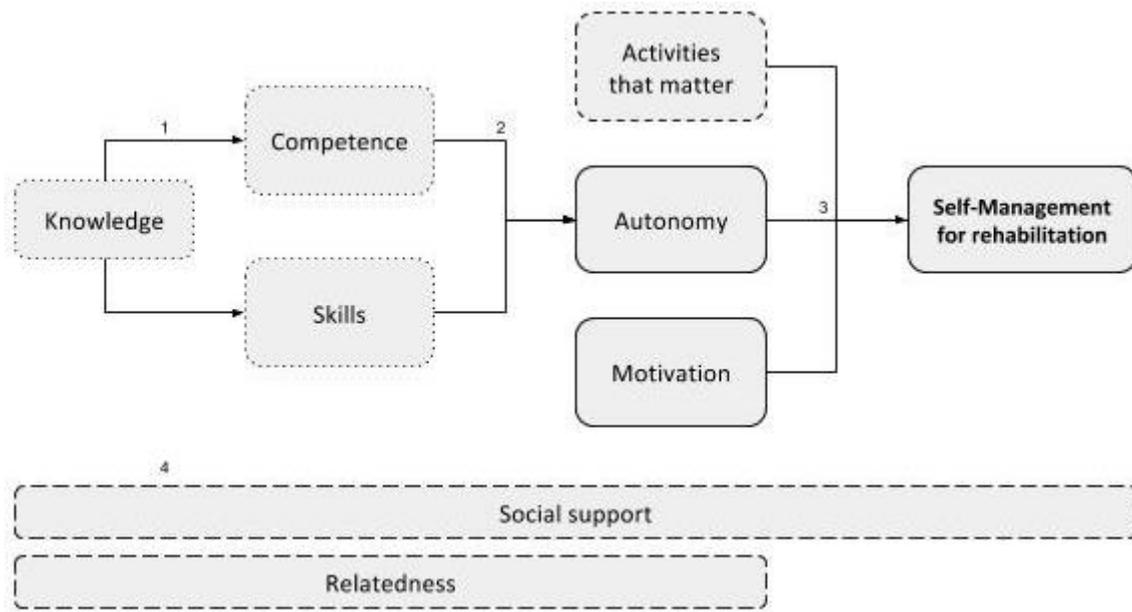


Figure 2: The relationship/interaction between the different components of Self-management for rehabilitation

- 1 Based on the analysis of the data of the interviews, a relation has been found in the first three components: knowledge, competence and skills. When there is lack of knowledge, the older adults will not be able to obtain a degree of competence or skills. The component knowledge was mainly lacking in the older adults. The level of knowledge affects the level of skills and competence. When the older adult had insufficient or no knowledge about the rehabilitation after a lower limb fracture, it was difficult for the older adults to actually perform an exercise in the context of rehabilitation. They do not know enough about their fracture and what rehabilitation can do for them. Their knowledge no longer reaches so far and now it is difficult to include and to understand new information correctly. Without the component knowledge, it is not possible to achieve that certain level of skills and/or competence. If the knowledge is present, it is possible that the components skills and/or competence are lacking. The older adults have a certain fear after they fell and broke something of their lower limb. They are very careful now, despite the fact that they use a wheelchair or a walker. As a result, they are inhibited in taking self-management regarding their rehabilitation process. In addition, the cognitive abilities gradually deteriorate. This could include for example aspects of memory, executive functions, reasoning and multitasking. Those functions are necessary for everyday activities and experiencing and performing self-management. So, the knowledge can be present but if the skills and/or competence are missing, the older adult will not be able to perform self-management for rehabilitation. In this group of older adults, it appears that mostly all three components are lacking. Which will affect the degree of performing and experiencing self-management.

- 2 Once the knowledge, competence and skills are present, the older adults are able to experience a certain degree of autonomy or be fully autonomous. Which means that the older adult is independent (from the healthcare professionals) and can decide for themselves. One can think of co-deciding and directing the healthcare professionals, but it can also include certain behaviour to be able to do something yourself. For example: the older adult uses a wheelchair in the beginning of the rehabilitation process. The older adult is now (more) depending on the healthcare professionals. However, the older adult could be autonomous by making decisions together with the healthcare professionals. The latter will help the older adult to fulfil different requests. The older adult who uses a walker is often more independent and able to be more autonomous. They can perform for example more activities by themselves, making them more independent.
- 3 Some degree of autonomy is needed to experience or perform self-management for rehabilitation, but there must be some motivation present in the older adults. The components motivation and autonomy come together at this point and those two together make it possible to experience or perform self-management for rehabilitation. The presence of only one component is not enough. Another component comes together with autonomy and motivation at this point. This variable is not included as a component of self-management for rehabilitation, but it has been found that this component is quite important for the older adult: an activity that matters. The older adults indicate that they have reached a certain age and that they do not expect much more from life, it is good at it is. There is no need for (too much) new information or (too much) new activities. It is therefore important that the rehabilitation is in line with the activities that the older adults are familiar with. For example, household chores or grocery shopping. The activity should matter, it should meet the needs of the older adult. The older adult will pursue the valuable things in life. So, when the activity matters, the older adult will be able to experience or perform (more) self-management.
- 4 The two other components, which have not been mentioned yet, are social support and relatedness. The first component, social support affects all the components. It has been found that the older adults highly value the help of their partners, children and other closest ones. Those social contacts can help them with the missing components. For example: when there is a lack of knowledge, social support can help in expanding their knowledge. The same goes for the other components. The older adults are able to experience self-management for rehabilitation without really owning it with the help of their social support. The last component, relatedness, applies almost the same. However, this component is more related to the care professionals. The care professionals can also play a huge role in supporting the components, yet when it comes to experiencing (the component) self-management for rehabilitation they will leave that to the older adult's self. The care professionals will offer a helping hand to lead them, but the control of self-management for rehabilitation will be fully given to the older adult.

4.4. Findings from the expert-meeting

With the help of the expert meeting, some points have been discussed which are important for the support of self-management for rehabilitation by technology. The results of the interviews were discussed during the expert meeting. The results of the interviews were processed in working document and in the design for lost habits. With the help of this design, the experts could systematically search for potential ideas for a technology that supports self-management for rehabilitation in the older adults during the rehabilitation period. Firstly, requirements came up on supporting self-management for rehabilitation in the older adults. In addition, some ideas came up about how a form of technology should look, when it supports self-management for rehabilitation.

4.4.1. Requirements

With help of the model that visualizes the interaction between the different components, it appears that missing/lacking components can be supported by technology. So, the requirements will be based on this information. The most important requirements that emerged will be briefly appointed and explained. Which means, the requirements that are mainly focused on enhancing the components: knowledge, skills and competence. Nevertheless, the requirements will also match with the older adult and their rehabilitation process in general. When they support other missing components, they will also be mentioned.

Requirements based on supporting the missing components

Knowledge	The technology should cover the knowledge gap of the older adults. It should provide the right information at the right time. The cognitive skills of the older adults are mostly insufficient. The technology should act as an extension of the older adult's cognition. It could give, for example, reminders when the physiotherapy takes place.
Competence	The technology should give the older adult more confidence in his or her own abilities. It should provide positive self-esteem through coaching, for example. It should give older adults the feeling that they can act safely. Confidence can also be more supported by the caregivers. Most caregivers coach the older adults. However, it would be better to create an unambiguous process in the coaching aspect. It is necessary to provide the caregivers some support and training in this. By the coaching aspect, older adults will get the feeling that they can rely on them.
Skills	The technology should be able to set more personal goals. From admission to a nursing home, goals will be set. Those goals are related to ADLs (activities of daily living) such as feeding ourselves, dressing etc. It would be more interesting when those general goals will be more specific and divided in parts, rather than one 'big' goal. This will make the therapy more personal. Making it more personal is important for this target group. This because each individual is different and there is high between-patient variability in feeling of the cognitive and physical skills.

Requirements in general for the rehabilitation process

Create a level of competition among the older adults, this at the level that suits the older adult. By creating competition, older adults may potentially stimulate each other. Perhaps the exercises will also be performed longer. For example, by playing a game that will give points for some exercises; you do not want to score less, or you would not lose that last game, so you will continue till you win that last game. Exchange of knowledge, skills, and competence can take place during this process.

Create the feeling that the older adult is useful. He or she must be able to contribute to the activities and help other residents. This can be done by, for example, doing tasks together. It is important to link the activities with the interests, such as handcraft. The day-care must be made useful. Through cooperation, exchange of knowledge, skills, and competence can take place during this process.

Requirements related to the technology

The technology should start the interaction, because the older adults mostly do not start an activity. The self-management for rehabilitation in older adults is low, the care professionals mostly decide what they should do and at what time. The older adults are fine with this phenomenon. Little initiative is taken by the older adults, this really has to be stimulated. Therefore, it is important that the technology starts; it will support the older adult to react on this and actually start the activity.

The technology should respond to the individual, it should approach the older adult personally. It is important to call the older adults by their first or last name. By making it more personal, the older adult will feel more appealing and will anticipate on that.

In addition to the goals that will be set, the recovery of the older adult should be mapped. This will also make it clearer to the older adult. By creating this insight, they can contribute more actively to the rehabilitation process. Progress will be shown and in addition, it becomes clear which aspect(s) requires more attention.

It should be kept as simple as possible. The older adult is familiar with a television and so with the remote control. But when you add some new gadgets or functions to this, it will become too difficult for them. You can think of using a DVD. In addition, you should also think of the use of simple words and sentences.

The technology should give positive incentives, like motivational messages. Compliments can be given on how far they have walked that day. Compliments and coaching are important aspects.

The technology should be recognizable, such as a television. In this way, it is no longer abstract for the older adults. It is difficult, sometimes not even feasible, to learn how a new form of technology works. They will not recognize this, and it is difficult for them to process the information about something new.

4.4.2. Design ideas

During the expert-meeting, the first design ideas came up to actually support self-management for rehabilitation. It was an open discussion, in which everyone could point out their ideas about a technology that can support self-management for rehabilitation. The current possibilities regarding technology in healthcare have been considered. In this regard, we looked at how these existing forms of technology can support the missing components (knowledge, skills, and competence).

On the image⁵⁶ on the right is visible that a robot (Zora) does exercises with the older adults. Zora can for example communicate, dance, play games and do different exercises. Zora is doing the exercises and the older adults should follow. Performing this type of exercises, is well suited for the older adult who must rehabilitate from a lower limb fracture. Certainly because of the facts that: (1) older adults are most of their time sitting in the living room of the nursing home. Instead of sitting the whole day, they can perform different exercises



(2) It stimulates when the activities can be performed together, you can either provide a little more support or just trigger each other, (3) In the beginning it will take some time for the care professionals to explain everything to the older adults. When it is clear for the older adults what they have to do, the older adults can do the exercises (more) independently (it should not replace the care professionals, it can be seen as an addition) and finally (4) the older adults are able to practice more than the half an hour of physical therapy per day that is offered.

How Zora can support self-management for rehabilitation

Zora can help on the missing components of self-management for rehabilitation. Knowledge can be supported by Zora, when it will act as a memory. It could provide reminders like, when they should perform a certain exercise. The skills will be enhanced by the exercises that Zora offers. When Zora approaches the older adults personally and offers personal exercises, the skills will improve. In addition, Zora creates more competence by giving confidence. This can be achieved by giving compliments, but also affirmative cues are important.

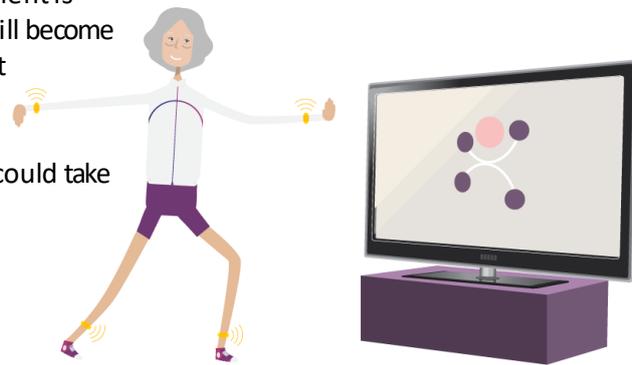
The image⁵⁷ on the right shows a robot, Paro a seal dog. Paro has different functions. It responds for example, to sound and touch by moving the tail and/or eyes. Paro is mainly used in home care facilities for older adults with dementia. It will therefore not directly affect the older adults who need rehabilitation after a lower limb fracture, but what if we convert this idea into a personal buddy? One can imagine that this buddy is always by their side during the stay in the nursing home. This buddy can give personal tips and feedback, but will also indicate when it is necessary to walk an extra round. It is actually an addition to the care professionals. This idea of a buddy, will give the older adults more independency.



How Paro can support self-management for rehabilitation

Paro can help on the missing components of self-management for rehabilitation. Knowledge can be supported when it will act as a memory. However, Paro, instead of Zora, will stay on your side all day long. The reminders can be given the whole day. The reminders are not specifically focused on physical therapy exercises. Paro can, for example, give a reminder when you should go to your therapy. Or a reminder that you did not practice/walked enough that day, it reminds you to go for a walk. Because Paro is a personal buddy, they can also help and coach them personally. This allows to increase the skills. In addition, Paro creates more competence by giving confidence. This can be achieved by giving compliments, but also affirmative cues are important. This can be given throughout the day, because this buddy is with you all day instead of being present only during physical therapy.

On the right, some images^{58 59} are shown when we think of a chip that should support self-management for rehabilitation. The idea is to place a chip in the older adults' clothes. When the older adult moves around the nursing home, several devices will respond to the movement. For example, a television screen, visible on the image below. At the time the older adult walks nearby the television screen, their physiotherapist will appear on it. The physiotherapist will approach the older adult personally and will mention that already 1000 steps have been taken. By complimenting, encouraging or making clear that more movement is needed, the aim will be that the older adults will become more active. This kind of technology will start the interaction, making it easier for the older adults to perform a certain activity. The other image on the left shows how the older adult could take up their exercises by using a television screen.



How a chip can support self-management for rehabilitation

By placing a chip in the older adults' clothes, the missing components of self-management for rehabilitation can be supported. Knowledge can be supported by the fact that this television screen can be used as a knowledge transfer, to overcome the knowledge gap. But it should act as an extension of the patient's cognition. This can be done by complementing their knowledge. Their care professionals do know the older adults and can give the information that this person is missing and needs to rehabilitate. Reminders can also be used, when an older adult passes a television screen, a reminder can pop up that they should walk at least 1000 steps that day. It could also be valuable to show a schedule on the screen when they need to do something, like when their half an hour physical therapy takes place. The skills will increase by using a personal approach, the older adults are called by their (last) name. This system responds to individual differences, it gives compliments as well as affirmative clues where necessary. Additionally, it can give tips, or it coaches the older adults in how to handle certain exercises or assignments. The chip will create more competence by giving confidence. This sense of confidence can be created by seeing their own physical therapist. This gives them the feeling of getting the support they need and the feeling that they can rely on their physiotherapist.

5 Discussion

The aim of this study was firstly to get a better understanding of the perception of older adults, with a lower limb fracture, regarding self-management for rehabilitation. Hardly any studies have been conducted looking at the degree of self-management for rehabilitation in older adults with a lower limb fracture. There are a few studies that considered the degree of self-management in the elderly population related to rehabilitation, but present studies mostly consider self-management related to the chronic ill population such as diabetes and COPD. Secondly, after looking at the degree of self-management for rehabilitation in older adults, some requirements came up for the development and implementation of a technology.

The degree of self-management for rehabilitation

This study introduced the concept of self-management for rehabilitation. This concept consists of several components: Knowledge, Skills, Motivation, Competence, Autonomy and Relatedness and in which two other components were added during this study: Social support and an Activity that matters. During the interviews, it has been found that older adults are not familiar with the concept of self-management for rehabilitation. The older adults in this study found it difficult to answer the questions. When the older adults were asked how they felt, they could tell a lot about this event. The older adults contribute great importance to the situation before the fall. It was found that the older adults were satisfied with the situation before admission to the nursing home. Almost all older adults could previously perform daily activities such as: household chores, doing groceries and some even volunteered. In this respect, we see that the degree of autonomy in the eyes of them was very high.

As a result of this research it has been found that some components are lacking in the older adult: knowledge, skills and competence. But to some extent, the component autonomy is also lacking. An important finding is that when an older adult falls and breaks something in their lower limb the autonomy relapses. They cannot walk (independently) anymore, their independency relapses too. The older adult put their trust in the care professionals. The older adults have less faith, are more insecure now, which makes the care professional very important to them. Only less than half of the older adults did take up their autonomy quite actively, the other older adults needed help from others to rebuild this degree of autonomy. In almost all older adults, an increased degree of autonomy was seen during the whole rehabilitation period. However, it is important to mention that the degree of autonomy varied enormously among the older adults. The older adults feel very related to the nursing staff and other professionals. Which is related to the component relatedness. As mentioned above, this is not odd because of their increased dependency after the fracture. Another aspect that appears to be important is the support from relatives, which strongly motivates them. This has led to the addition of an extra component: social support. This because the component relatedness refers more to the care professional. The decrease of autonomy was in line of expectations. However, the autonomy turned out to be much more lacking than previously expected. Just as the degree to which the older adults rely on the care professionals. An event such as falling therefore has a greater impact than previously expected. It turns out that physical performance and sense of autonomy are related. Yet, the phenomenon in this present study can be explained by the fact that autonomy has both a physical and a psychological dimension. In which the physical dimension refers to freedom of mobility and low levels of physical restrictions, while the psychological dimension refers to control over one environment and ability to control and make choices about one life.⁶⁰ You therefore see that autonomy also consists of a physical dimension and so are related.

Another important finding in this research is that not being able of experiencing and performing self-management for rehabilitation is not directly related to lack of autonomy. The model in figure 2 makes this clear, all components are related. It has been found that the components knowledge, skills and competence are also lacking in the older adults. Their knowledge is very limited about the rehabilitation process, there is a between-patient variability in cognitive and physical skills and the level of confidence has decreased significantly after falling. This can be explained by age-related losses e.g. cognitive problems or other health problems. All the older adults are intrinsically highly motivated to go back to their home situation. This even though different components are lacking. That the components knowledge, skills and competence would be that important, was not expected prior to this study. It is known that older adults have age related losses in cognitive and physical skills.⁶¹ However, it was surprising that knowledge, skills and competence are that much important in experiencing and performing self-management for rehabilitation.

The consistency between the components and self-management for rehabilitation

Based on the interviews, it appears that all components (knowledge, skills, motivation, competence, autonomy, and relatedness) are related to each other. A model of self-management for rehabilitation (figure 2) has been developed which explains what is needed to experience and perform self-management for rehabilitation. Two other components have been added to this model, which turned out to be very important; social support and an activity that matters.

During the study, a relation has been found between the various components: (1) the three components knowledge, competence and skills. We can conclude that when there is a lack of knowledge that the older adult will not be able to obtain a degree of competence or skills. It is possible that the knowledge is present, but the skills and/or competence are lacking. This could be explained by the fact that the older adult could be afraid of falling again or by deteriorating of their cognitive abilities. (2) the previously mentioned three components and the component autonomy. When those three components are missing it is hard to experience a certain degree of autonomy or be autonomous. Where autonomy means being independent and that the older adult can decide for themselves mainly about their rehabilitation process. (3) Autonomy and motivation comes together at this point, in which both are needed for experiencing or performing self-management for rehabilitation. Another (new) variable comes together at this point: an activity that matters. The rehabilitation should be in line with the activities that the older adults are familiar with. It should meet the needs of the older adults, they will pursue valuable things. (4) Social support and relatedness. Both are able to affect the other (missing) components. However, the component relatedness is mainly related to the care professionals. The focus of the care professionals is that the older adults can perform self-management for rehabilitation. They will provide the least possible support in this regard and will not affect self-management for rehabilitation. For example, when there is lack of knowledge, social support and/or care professionals can support them in expanding their knowledge. Prior to this study, this kind of relationship between the components was not expected. Apparently, all components are related and influence each other in their own way. However, it was expected that the level of motivation would be very important, because there are already many theories developed to explain (health related) behaviour and how this can be motivated in a positive way. Now it appears that the older adults are very motivated. It is a more underlying problem in which has been found that knowledge, skills and competence are much more important than expected. Maybe not completely unexpected afterwards, the older adults are aged and deteriorate on the cognitive and physical aspects. This is also reflected in the literature. The cognitive aspect is very broad and it is often age-related how the cognitive functions will be affected.

Deterioration of the cognitive aspects will also affect the physical aspects. The overall picture seems to be one of cognitive decline, but there is enormous variability across individuals. There are some cognitive functions, discussed in the literature, most affected by age: attention, memory, perception and higher level of cognitive functions such as language processing and decision making.⁶² It is therefore explainable that the components knowledge, skills, and competence are lacking. The components have various interfaces with above mentioned cognitive functions. For example, attention and memory. The older adult is less able to remember certain exercises or to pay attention to them for a longer period of time. As a result, the skills for walking independent again will develop slowly and the older adult will stay insecure about the walking aspect for a longer period than is necessary. The decision-making aspect is also very important, one is already talking about the component autonomy here.

Supporting autonomy

The problem with this target group is not the motivational aspect, which you often see in chronically ill people. The degree of autonomy should also be improved, since it will be decisive to what extent the older adult can perform self-management for rehabilitation. As a result, from the interviews, it was found that the questions related to the component autonomy provided interesting information. It has many interfaces with the concept self-management and self-management for rehabilitation. In addition, autonomy clearly shows how the older adults rehabilitate, what they think about the rehabilitation and what their driving forces are to recover. The other components, when they are missing, will also be taken into account. Various studies measure the degree of autonomy of the older adults with help of different measuring instruments, whereas in this present research one looked at the (degree of) autonomy with the help of interviews. Research of Mercante et al.,⁶³ looks at changes in the level of autonomy of the older adults admitted to the hospital at the entrance and at discharge in relation to a rehabilitation program. The older adults were evaluated with among others the Barthel Index (BI). Results shows that older adults presented a better score of the BI at discharge and this figure was associated to the implementation of a rehabilitation treatment. Somme et al.,⁶⁴ looked at the changes in the functional autonomy of elderly patients after a stay in a medical intensive care unit (ICU), and the impact of post-ICU management in geriatric ward. The BI was also used in this research. It appeared that the autonomy recovers rapidly, but the degree of recovery depends on the patient's previous autonomy. In both studies the autonomy increased after a health-related event for which admission followed. In present research some older adults were able to experience more autonomy than others. However, in this present study, no increase in autonomy is actually measured. The information is gathered from the interviews. After the interviews were analysed it became clear that the autonomy immediately decreases after a fall, the older adults feel that they are more dependent. In almost all older adults, an increased degree of autonomy was seen during the whole rehabilitation period. However, the degree of autonomy varied among the older adults.

The older adults have half an hour physiotherapy every day. The older adults are recovering, and they are more capable of carrying out different activities independently. The older adults have also mentioned this in the interviews, but they do not experience this as an increase in their autonomy while this is indeed the case. Several measuring instruments are already being used in the nursing homes in the rehabilitation ward(s), including the BI. However, these measuring instruments are currently not used to actually measure the degree of autonomy or to put the degree of autonomy into words. Early specific intervention to improve the autonomy of the older adults seems an attractive solution. The measuring instruments should be used from the beginning, to measure the degree of autonomy. In the long run one can show progress in the degree of autonomy. One can anticipate on the aspects that not score well. The health care professionals can work together with the older adults. By involving the older adult, more insight will be created into the concept of autonomy.

Research of Pardessus et al.,⁶⁵ suggests early home visit during hospitalization of older adults at risk for falling. This to better satisfy the real needs of the older adult and better preserve the patient's long term- autonomy. The older adults are offered future prospects by involving them in the process. The older adults would like to go back home again, and now they get help from the healthcare professionals. The older adults can work toward more independency, with eventually being able to go home again.

Design ideas to support self-management for rehabilitation

As a result of the interviews it became clear that the older adult will probably not be able to start using technology by themselves. So, first of all it is very important that the technology starts the interaction. The older adults are intrinsically highly motivated to go back to their home situation again. They will rely on the health professionals, and they will probably adopt and start using technologies when the health professionals recommend or use the technology with them. Older adults do not use technology that much and certainly did not use new, modern forms of technology because they are not familiar with this.⁶⁶ The older adult usually uses a phone, radio and a television. They are usually not familiar with any other form of technology. The expectation was therefore that they did not need to use a (new) form of technology in their rehabilitation process. However, the older adults were open for the idea of using technology. It was very important for them to go back to their own familiar environment. The research by Mitzner et al.,⁶⁷ also shows this phenomenon. In that research they looked at the use of and attitudes towards technology in context of older adults' home, work and healthcare. It may be a slightly different context, where this present research looks at the older adult who (temporarily) needs rehabilitation in a nursing home, but it is about the same age group. The older adult in this present research also lived independently and did everything themselves before admission to nursing home for rehabilitation. Mitzner's study shows that the older adults had more positive than negative attitudes towards the technologies they used, which contradict the stereotype that older adults are afraid or unwilling to use technology. Mitzner's study shows that the older adult used a lot of different technology items, especially in their homes. While in this present study the older adults had relatively little knowledge of technology and they also made little use of it. Research of Melenhorst et al.,⁶⁸ shows older adults' benefit-driven approach to new communication technology, which again contradict the common belief that barriers such as usability problems determine whether older people use technology. The form of technology that is discussed in this research is about e-mail experience. It seems that benefit perception is decisive in older adults' choice for innovation.

The most important finding in this research has been that the technology must provide the components the older adults is lacking. The older adult experiences mainly a lack of the components: knowledge, competence and/or skills. As a result, they cannot experience or perform self-management for rehabilitation. It is therefore important that the type of technology supports those missing components. For the component *knowledge* it is important that the technology should act as an extension of the older adults' cognition, because the cognitive skills of the older adults are often insufficient. So, it should provide information at the right time, so the older adults can anticipate on that information. This could include, for example that the technology should act as a memory and coaches the older adult when performing a complex task. It could give reminders when the physiotherapy takes place, or it can coach the older adult in doing their exercises regularly. There is a knowledge deficit that exercising ensures to achieve the old situation again. For *competence* the technology should create a sense of safety for the older adult. It should give the older adult more confidence in his or her own abilities. The nursing staff and relatives are most of the time involved in this process, but now the technology should act like the nursing staff and relatives are doing and give the older adult the feeling that they can rely on it. For example, a virtual presentation of the person(s), the older adults can rely on.

This virtual presentation from, for example, their own physiotherapist, can use affirmative cues. When we look at the *skills* we must consider the high between-patient variability in feeling of competence, the cognitive and physical skills. It is therefore important that the technology is personalized. The older adult should be called by their first or last name. It is also important that the technology is able of setting goals for the older adult, personal goals related to ADLs such as self-care. Prior to this study, the expectation was that the older adult cognitive skills should be limited. In addition, the expectation was also that the older adult would not be that much motivated in their rehabilitation process. However, it seems that the older adult is very motivated because he/she wants to go home again. It turned out that it was difficult to take up activities because other components were lacking or were missing: knowledge, competence and/or skills. Some studies confirm the expectation that the older adults' motivation is limited. It is often mentioned that the motivation in older adults decreases. This mostly because they become more selective in what they find important in life. Research of Löckenhoff et al.,⁶⁹ shows evidence that the older adults' life goals and motivations become more focussed on maximising meaning and positive emotions. They are less concerned with delayed future payoffs, such as improving health. Research of Freund⁷⁰ on the contrary, looked at the age-differential motivational consequences of optimization versus compensation in younger and older adults. A part of this research looked at whether or not younger adults were more motivated to aspire growth and gains (i.e., optimization), and if older adults were more motivated to preserve what they already have (i.e., compensation). The results of this research show that the older adults were more persistent in the compensation than in the optimization condition. When we compare this with this present research, there are similarities. The older adult in this present research is indeed motivated. The older adult wants to go home again, back to what they already have.

Conclusion

To answer the main research question: *What typifies a technology that supports self-management in older adults, who temporarily need rehabilitation in a nursing home after a lower limb fracture?* First the literature has been consulted. It turned out that there was no proper English translation of “eigen regie”. Various components emerged to map the level of self-management for rehabilitation. The following components played a major role: knowledge, skills, motivation, competence, autonomy and relatedness. In this study, a model has been developed to provide insight into the relationships and interaction of the various components. Two other components are added during this study: social support and an activity that matters. The component social support leads to extra motivation, but it can also provide the components that the individual himself no longer has. It also seems that the older adults should perform activities that matters, together with their motivation and their autonomy this lead to a certain extent of performing and experiencing self-management. This study shows that the autonomy in the older adult immediately relapses when he or she falls and leads to a lower limb fracture. The older adult is no longer able to experience or perform self-management for rehabilitation. During the rehabilitation, the older adults are intrinsically highly motivated to go back to their home situation again, but they have low levels of autonomy, competence, knowledge and skills. The older adults in this research are already at age and this has probably affected their competence, skills and knowledge. Those components can be supported by the help of technology. The technology should act as extended self. This can be done when the technology: (1) overcomes the knowledge gap since the cognitive skills are often insufficient. (2) gives the older adult more confidence and the feeling that they can rely on it, like they could rely on nursing staff and their relatives and (3) when it is personalized, this because of the high between-patient variability in feeling of competence, the cognitive and physical skills. It would be great when the technology is a virtual representation of those who the older adults rely on during their rehabilitation and that the technology can be used in a way that they can speak to it and it coaches them as a natural person would do.

Reference list

1. Loog A, van Overbeek R. *Zelfmanagement Bij Ouderen*. Utrecht; 2007. <http://www.vilans.nl/docs/producten/Zelfmanagement.pdf>. Accessed March 27, 2017.
2. Centraal Bureau voor de Statistiek DH. CBS StatLine - Prognose bevolking; kerncijfers 2011-2060. <http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=81411ned&D1=2-3,5-6&D2=0-4,9,14,19,29,39,44&VW=T>. Published 2011. Accessed March 3, 2017.
3. Keene GS, Parker MJ, Pryor GA. Mortality and morbidity after hip fractures. *BMJ*. 1993;307(6914):1248-1250. <http://www.ncbi.nlm.nih.gov/pubmed/8166806>. Accessed March 3, 2017.
4. Centraal Bureau voor de Statistiek DH. CBS StatLine - Ziekenhuisopnamen; geslacht, leeftijden diagnose-indeling VTV. <http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=71859NED&D1=4&D2=0&D3=0%2C15-21&D4=157&D5=I&HDR=T%2CG1&STB=G2%2CG3%2CG4&CHARTTYPE=1&VW=T>. Published 2014. Accessed March 3, 2017.
5. Cheng SY, Levy AR, Lefaivre KA, Guy P, Kuramoto L, Sobolev B. Geographic trends in incidence of hip fractures: a comprehensive literature review. *Osteoporos Int*. 2011;22(10):2575-2586. doi:10.1007/s00198-011-1596-z.
6. Folbert E, Smit R, Van Der Velde D, Regtuijt M, Klaren H, Hegeman H. Multidisciplinair zorgpad voor oudere patiënten met een heupfractuur: resultaten van implementatie in het Centrum voor Geriatrische Traumatologie, Almelo. *NED Tijdschr Geneeskd*. 2011;155. <https://www.zgt.nl/media/6097/multidisciplinair-zorgpad-voor-oudere-patienten-met.pdf>. Accessed March 22, 2017.
7. de Rooij SE, Govers A, Korevaar JC, Abu-Hanna A, Levi M, de Jonge E. Short-term and long-term mortality in very elderly patients admitted to an intensive care unit. *Intensive Care Med*. 2006;32(7):1039-1044. doi:10.1007/s00134-006-0171-0.
8. Boyd CM, Landefeld CS, Counsell SR, et al. Recovery of activities of daily living in older adults after hospitalization for acute medical illness. *J Am Geriatr Soc*. 2008;56(12):2171-2179. doi:10.1111/j.1532-5415.2008.02023.x.
9. Folbert EC, Hegeman JH, Veur JVD, De haas RJ, Broersma B, van der Velde D. Kortdurende geriatrisch revalidatie. Resultaten na behandeling van een heupfractuur. *Tijdschr voor Ouderengeneeskd*. 2012. <http://www.verenso.nl/assets/Uploads/TvO-Covers/Inhoud-TvO/TvO-6-2012/Folbert.pdf>. Accessed March 9, 2017.
10. Grigoryan K V, Javedan H, Rudolph JL. Orthogeriatric care models and outcomes in hip fracture patients: a systematic review and meta-analysis. *J Orthop Trauma*. 2014;28(3):e49-55. doi:10.1097/BOT.0b013e3182a5a045.
11. Kammerlander C, Roth T, Friedman SM, et al. Ortho-geriatric service—a literature review comparing different models. *Osteoporos Int*. 2010;21:637-646. doi:10.1007/s00198-010-1396-x.
12. Kinsman L, Rotter T, James E, Snow P, Willis J. What is a clinical pathway? Development of a definition to inform the debate. *BMC Med*. 2010;8:31. doi:10.1186/1741-7015-8-31.
13. Matthews D. What is a clinical pathway? *J Am Coll Dent*. 2005;72(4):32-36. <http://www.ncbi.nlm.nih.gov/pubmed/16737063>. Accessed March 21, 2017.
14. Aard en omvang geriatrische revalidatie anno 2009/2010. Eindrapport. 2010.

- [http://www.tangram.info/afbeeldingen/Rapporten/Aard en omvang 2010 eindversie 1 juli.pdf](http://www.tangram.info/afbeeldingen/Rapporten/Aard%20en%20omvang%202010%20eindversie%201%20juli.pdf). Accessed March 9, 2017.
15. Verenso. Behandelkaders Geriatrische Revalidatie. 2010. www.verenso.nl. Accessed March 9, 2017.
 16. Yu CH, Parsons JA, Mamdani M, et al. A web-based intervention to support self-management of patients with type 2 diabetes mellitus: effect on self-efficacy, self-care and diabetes distress. *BMC Med Inform Decis Mak*. 2014;14(1):117. doi:10.1186/s12911-014-0117-3.
 17. Boston Working Group on Improving Health Care Outcomes Through Geriatric Rehabilitation. *Med Care*. 1997;35(6 Suppl):JS4-20. <http://www.ncbi.nlm.nih.gov/pubmed/9191710>. Accessed March 16, 2017.
 18. Bachmann S, Finger C, Huss A, Egger M, Stuck AE, Clough-Gorr KM. Inpatient rehabilitation specifically designed for geriatric patients: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2010;340(apr20 2):c1718-c1718. doi:10.1136/bmj.c1718.
 19. Halbert J, Crotty M, Whitehead C, et al. Multi-disciplinary rehabilitation after hip fracture is associated with improved outcome: a systematic review. The Hip Fracture Rehabilitation Trial Collaborative Group. *J Rehabil Med*. 2007;39(39):507-512. doi:10.2340/16501977-0102.
 20. Everink IHJ, van Haastregt JCM, Kempen GJM, Dielis LMJ, Maessen JMC, Schols JMGA. Uitdagingen in de geriatrische revalidatiezorg: de ontwikkeling van een zorgpad. *Tijdschr Gerontol Geriatr*. 2015;46(2):104-112. doi:10.1007/s12439-015-0125-5.
 21. Folbert EC, Smit RS, van der Velde D, Regtuijt EM, Klaren M, Hegeman JH. Geriatric Fracture Center : A Multidisciplinary Treatment Approach for Older Patients With a Hip Fracture Improved Quality of Clinical Care and Short - Term Treatment Outcomes. doi:10.1177/2151458512444288.
 22. Folbert EC, Hegeman JH, Vermeer & M, Regtuijt EM, Van Der Velde D, Int O. Improved 1-year mortality in elderly patients with a hip fracture following integrated orthogeriatric treatment. *Osteoporos Int*. doi:10.1007/s00198-016-3711-7.
 23. University of Twente. Awarded PIHC Projects 2016, PIHC Vouchers 2016. https://www.utwente.nl/en/organization/news-agenda/special/2016/pioneers-in-healthcare/projects_archief/projects2016/. Published 2016. Accessed March 28, 2017.
 24. Doekhie KD, de Veer AJE, Rademakers JDDJM, Schellevis FG, Francke AL. *Nivel Overzichtstudies -Ouderen van de Toekomst: Verschillen in de Wensen En Mogelijkheden Voor Wonen, Welzijn En Zorg*. Utrecht: Nivel; 2014. <https://www.nivel.nl/sites/default/files/bestanden/Overzichtstudie-ouderen-van-de-toekomst.pdf>. Accessed March 15, 2017.
 25. Huisman DM, Deeg, Prof dr. D, Claassens C. Ervaren regie bij Nederlandse ouderen en de samenhang ervan met zorggebruik, demografische factoren en persoonlijkheid. 2014. <http://www.lasa-vu.nl/nieuws/documents/vws-rapport-2013-regie-ouderen.pdf>. Accessed March 15, 2017.
 26. Brody BL, Roch-Levecq A-C, Thomas RG, Kaplan RM, Brown SI. Self-management of Age-related Macular Degeneration at the 6-Month Follow-up. *Arch Ophthalmol*. 2005;123(1):46. doi:10.1001/archoph.123.1.46.
 27. Koch T, Jenkin P, Kralik D. Chronic illness self-management : locating the "self ." 2004.
 28. Heijmans M, Waverijn G, Van Houtum L. *Zelfmanagement, Wat Betekent Het Voor de Patiënt?*

- Utrecht; 2014.
https://www.nivel.nl/sites/default/files/bestanden/zelfmanagement_wat_betekent_het_voor_het_patient.pdf. Accessed March 27, 2017.
29. Ryan RM, Patrick H, Deci EL, Williams GC. Facilitating health behaviour change and its maintenance : Interventions based on Self- Determination Theory On the front lines : Improving prostate cancer decision making and quality of life An interview with Professor Stephen Lepore Self-ratings of heal. *Heal Psychol*. 2008;10(1):2-5.
http://www.ehps.net/ehp/issues/2008/v10iss1_March2008/EHP_March_2008_All.pdf.
 30. Ryan R, Deci E. Self-determination theory and the facilitation of intrinsic motivation. *Am Psychol*. 2000;55(1):68-78. doi:10.1037/0003-066X.55.1.68.
 31. Deci EL, Ryan RM. Self-determination theory in health care and its relations to motivational interviewing: a few comments. *Int J Behav Nutr Phys Act*. 2012;9(1):24. doi:10.1186/1479-5868-9-24.
 32. Deci EL, Ryan RM. The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychol Inq*. 2000;11(4):227-268.
doi:10.1207/S15327965PLI1104_01.
 33. Lorig KR, Ritter PL, Laurent DD, Plant K. Internet-Based Chronic Disease Self-Management. *Med Care*. 2006;44(11):964-971. doi:10.1097/01.mlr.0000233678.80203.c1.
 34. W Battersby M, Ask A, M Reece M, J Markwick M, P Collins J. The Partners in Health scale: The development and psychometric properties of a generic assessment scale for chronic condition self-management. *Aust J Prim Health*. 2003;9(3):41. doi:10.1071/PY03022.
 35. Angelmar R, Berman PC. Patient empowerment and efficient health outcomes. 2007.
https://med.over.net/javne_datoteke/novice/datoteke/10483-Report_3.pdf. Accessed March 27, 2017.
 36. Sherwin S, Winsby M. A relational perspective on autonomy for older adults residing in nursing homes. *Heal Expect*. 2011;14(2):182-190. doi:10.1111/j.1369-7625.2010.00638.x.
 37. Proot IM, Abu-Saad HH, de Esch-Janssen WP, Crebolder HF, ter Meulen RH. Patient autonomy during rehabilitation: the experiences of stroke patients in nursing homes. *Int J Nurs Stud*. 2000;37(JULY):267-276. doi:10.1016/S0020-7489(00)00008-0.
 38. Hackett G, Betz NE. A self-efficacy approach to the career development of women. *J Vocat Behav*. 1981;18(3):326-339. doi:10.1016/0001-8791(81)90019-1.
 39. Usher EL, Pajares F. Sources of Self-Efficacy in School: Critical Review of the Literature and Future Directions. *Rev Educ Res*. 2008;78(4):751-796. doi:10.3102/0034654308321456.
 40. Heo S, Lennie TA, Pressler SJ, Dunbar SB, Chung ML, Moser DK. Factors associated with perceived control and the relationship to quality of life in patients with heart failure. *Eur J Cardiovasc Nurs*. 2015;14(2):137-144. doi:10.1177/1474515113519931.
 41. Rodin J, Schooler C, Warner Schaie K. Control by any other name: Definitions, concepts, and processes. In: *Self Directedness: Cause and Effects Throughout the Life Course*. ; 1990:1-17.
 42. Alpay L, Boog P van der, Dumaij A. An empowerment-based approach to developing innovative e-health tools for self-management.
<http://dx.doi.org/101177/1460458211420089>. 2011. doi:10.1177/1460458211420089.
 43. Eysenbach G. What is e-health? *J Med Internet Res*. 2001;3(2):E20. doi:10.2196/jmir.3.2.e20.

44. van Gemert-Pijnen JEW, Peters O, Ossebaard HC. *Improving eHealth*. Den Haag: Eleven International Publishing; 2013.
45. Peeters J, Wiegers T, Bie J De, Friele R. *Overzichtstudies - Technologie in de Zorg Thuis - Nog Een Wereld Te Winnen!*; 2013. doi:10.1163/2352-0248_edn_a4278000.
46. Peek STM, Wouters EJM, van Hoof J, Luijkx KG, Boeije HR, Vrijhoef HJM. Factors influencing acceptance of technology for aging in place: A systematic review. *Int J Med Inform*. 2014;83(4):235-248. doi:10.1016/j.ijmedinf.2014.01.004.
47. Peek STM, Luijkx KG, Rijnaard MD, et al. Older Adults' Reasons for Using Technology while Aging in Place. *Gerontology*. 2016;62(2):226-237. doi:10.1159/000430949.
48. Peek STM, Wouters EJ, Luijkx KG, Vrijhoef HJ. What it Takes to Successfully Implement Technology for Aging in Place: Focus Groups With Stakeholders. *J Med Internet Res*. 2016;18(5):e98. doi:10.2196/jmir.5253.
49. Lim CSC. Designing inclusive ICT products for older users: taking into account the technology generation effect. *J Eng Des*. 2010;21(2):189-206. doi:10.1080/09544820903317001.
50. Arning K, Ziefle M. Understanding age differences in PDA acceptance and performance. *Comput Human Behav*. 2007;23(6):2904-2927. doi:10.1016/j.chb.2006.06.005.
51. Chen K, Chan AHS. A review of technology acceptance by older adults. *Gerontechnology*. 2011;10(1):1-12. doi:10.4017/gt.2011.10.01.006.00.
52. Britten N. Qualitative Research Qualitative interviews in medical research. 311:251-253.
53. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77-101. doi:10.1191/1478088706qp063oa.
54. Pope C, Ziebland S, Mays N, Mays N. Analysing qualitative data. 2000;320(January):5-7.
55. Schotman H. Lost Habits : and the acceptance of product service systems. September 2017. doi:10.3990/1.9789036543675.
56. RobotLAB. Educational Robots that are smart and useful. <http://www.robotlab.com/>. Accessed September 20, 2017.
57. Paro | Robot | Robots.NU. <http://www.robots.nu/paro/>. Accessed September 20, 2017.
58. Active@Home | Active@Home. <http://www.active-at-home.com/>. Accessed September 20, 2017.
59. Flinterdunne RFID chip veroorzaakt oerknal bij wasserijbranche voor particulier tot zorg | Ferm RFID. <http://www.fermrfd.nl/flinterdunne-rfid-chip-veroorzaakt-oerknal-bij-wasserijbranche-voor-particulier-tot-zorg>. Accessed September 20, 2017.
60. Rantakokko M, Portegijs E, Viljanen A, Iwarsson S, Kauppinen M, Rantanen T. Perceived environmental barriers to outdoor mobility and changes in sense of autonomy in participation outdoors among older people: a prospective two-year cohort study. *Aging Ment Health*. 2017;21(8):805-809. doi:10.1080/13607863.2016.1159281.
61. Tymula A, Rosenberg Belmaker LA, Ruderman L, Glimcher PW, Levy I. Like cognitive function, decision making across the life span shows profound age-related changes. *Proc Natl Acad Sci U S A*. 2013;110(42):17143-17148. doi:10.1073/pnas.1309909110.
62. Glisky EL. *Changes in Cognitive Function in Human Aging*. CRC Press/Taylor & Francis; 2007. <http://www.ncbi.nlm.nih.gov/pubmed/21204355>. Accessed January 5, 2018.

63. Mercante O, Gagliardi C, Spazzafumo L, et al. Loss of autonomy of hospitalized elderly patients: does hospitalization increase disability? *Eur J Phys Rehabil Med*. 2014;50(6):703-708. <http://www.ncbi.nlm.nih.gov/pubmed/24858036>. Accessed December 28, 2017.
64. Somme D, Andrieux N, Guérot E, et al. Loss of autonomy among elderly patients after a stay in a medical intensive care unit (ICU): A randomized study of the benefit of transfer to a geriatric ward. *Arch Gerontol Geriatr*. 2010;50(3):e36-e40. doi:10.1016/j.archger.2009.05.001.
65. Pardessus V, Puisieux F, Di Pompeo C, Gaudefroy C, Thevenon A, Dewailly P. Benefits of home visits for falls and autonomy in the elderly: A randomized trial study. *Am J Phys Med Rehabil*. 2002;81(4):247-252. doi:10.1097/00002060-200204000-00002.
66. Hickman JM, Rogers WA, Fisk AD. Training Older Adults To Use New Technology. *Journals Gerontol Ser B*. 2007;62(Special_Issue_1):77-84. doi:10.1093/geronb/62.special_issue_1.77.
67. Mitzner TL, Boron JB, Fausset CB, et al. Older Adults Talk Technology: Technology Usage and Attitudes. *Comput Human Behav*. 2010;26(6):1710-1721. doi:10.1016/j.chb.2010.06.020.
68. Melenhorst A-S, Rogers WA, Bouwhuis DG. Older adults' motivated choice for technological innovation: Evidence for benefit-driven selectivity. *Psychol Aging*. 2006;21(1):190-195. doi:10.1037/0882-7974.21.1.190.
69. Lockenhoff CE, Carstensen LL. Socioemotional Selectivity Theory, Aging, and Health: The Increasingly Delicate Balance Between Regulating Emotions and Making Tough Choices. *J Pers*. 2004;72(6):1395-1424. doi:10.1111/j.1467-6494.2004.00301.x.
70. Freund AM. Age-differential motivational consequences of optimization versus compensation focus in younger and older adults. *Psychol Aging*. 2006;21(2):240-252. doi:10.1037/0882-7974.21.2.240.

Appendices

1 Topiclist

Topics	Subtopics	Voorbeeldvragen
Profiel van patiënt voor heupfractuur	<ul style="list-style-type: none">- Oorzaak heupfractuur- Woonsituatie voor heupfractuur- Mate van activiteit voor heupfractuur	<ul style="list-style-type: none">- Hoe is het gekomen dat u uw heup heeft gebroken?- Hoe zag uw woonsituatie eruit?- Woont u nog samen?- Was u destijds altijd erg actief?- Wat voor activiteiten deed u zoal?
Ervaren revalidatie	<ul style="list-style-type: none">- Kennis, inzicht in revalidatie per dag- Perceptie eigen rol in revalidatieproces	<ul style="list-style-type: none">- Ik heb vernomen dat de dag vaak begint met de verzorging, u wordt geholpen met wassen en aankleden en wat u hierbij zelf kunt doen doet u nog zelf, klopt dat?- Vervolgens gaat u ontbijten en in de loop van de dag, dat kan 's ochtends of 's middags zijn, vindt er nog therapie plaats klopt dat?- Wordt uw dag dan voornamelijk ingedeeld door de verzorging?- Kunt u zelf ook bepalen wanneer u wat wilt gaan doen?- Wat vindt u hiervan?- Zou u hier meer/minder invloed op willen hebben?- Vindt u het belangrijk om mee te mogen beslissen over hoe uw behandeling eruitziet?- Waarom wel/niet?
Ervaren revalidatie t.a.v. fysiotherapie	<ul style="list-style-type: none">- Kennis, inzicht in therapie/oefeningen door fysiotherapeut- Perceptie eigen rol in toepassen van oefeningen	<ul style="list-style-type: none">- Hoe ziet een therapie er bij de fysiotherapeut uit?- Hoe vaak moet u oefenen met de fysiotherapeut?- Is dat voldoende denkt u?- Is het dezelfde fysiotherapeut die u helpt?

		<ul style="list-style-type: none"> - Welke oefeningen voert u dan uit? - Heeft u het idee dat de oefeningen helpen bij uw herstel? Ziet u zelf al vooruitgang? - Zijn deze oefeningen moeilijk voor u? - Voert u zelf ook oefeningen uit buiten de therapie om? - Waarom wel/niet?
Mening over en ervaring met oefentherapieën die aan worden geboden binnen het verpleeghuis ter revalidatie	<ul style="list-style-type: none"> - Inzicht therapie - Inzicht eigen rol t.a.v. therapieën (hoe wordt dit beleefd, wat is de motivatie) - Inzicht in resultaten van revalidatie - Inzicht in hoe doelen te bereiken 	<ul style="list-style-type: none"> - Als u zelf een dag hier mag indelen, zou u het dan anders doen? - Zou u meer therapie willen/minder? - Waarom zou u dit wel/niet veranderen? - Als iets anders kan, wilt u hier wat over zeggen? - Als het anders kan, durft u hier wat over te zeggen? - Heeft u het gevoel dat u hier afhankelijk of afhankelijker bent van de verzorging? <ul style="list-style-type: none"> - dat is moeilijk te veranderen in de huidige situatie, maar wat zou helpen om u minder afhankelijk te voelen? - probeert u ook zoveel mogelijk zelf te doen?
(Gewenste) uitkomst revalidatie	<ul style="list-style-type: none"> - Inzicht, kennis in eigen kunnen en bijbehorende uitkomstmaat - Inzicht, kennis in eigen rol om uitkomst te bereiken - Inzicht, kennis om hierbij hulp te vragen/nodig te hebben. 	<ul style="list-style-type: none"> - Heeft u ook een doel voor ogen, wat u graag weer zou willen kunnen na de revalidatie periode? - Wat wilt u precies weer kunnen als hier weg kan? - Is dat haalbaar denkt u? - Waarom wel/niet? - Hoe wil u dit doel bereiken? - Heeft u hierbij hulp nodig van eventuele verzorging/familie of kunt u dit ook alleen? - Wat voor hulp denkt u hierbij nodig te hebben om uw doel te bereiken?

Benodigde/Gewenste ondersteuning	<ul style="list-style-type: none"> - Ervaring met technologische ondersteuning - Mening over technologische ondersteuning 	<ul style="list-style-type: none"> - Gebruikt u zelf iets van technologie? Een iPad/computer/mobiele telefoon? - Maakt u bijvoorbeeld wel gebruik van pinnen in plaats van contant betalen? - Zo ja, vindt u het gebruik van technologie een meerwaarde hebben? Kunt u nog zonder? - 'inleiding silverfit' - Wat vindt u van deze vorm van revalidatie? - Is dit iets wat u zou kunnen? - Is dit iets wat u zou willen? - Denkt u dat technologie u zou kunnen helpen bij uw revalidatieproces? - Zo ja, waarom denkt u dit? - Zo nee, waarom denkt u niet? - Zou u dit motiveren om meer te oefenen?
Algemeen		Heeft u nog vragen naar aanleiding van de onderwerpen die we besproken hebben?

2 Characteristics of the Older adults

The characteristics of the older adults are based on information gathered from the interviews. During the interviews, the older adults were unconsciously observed. Those characteristics that came forward are written down in the table below for a complete picture of the older adults.

Participant	Age	Type of fracture	Cognition	Physical Activity	Characteristics (observational)
1 ♀	91	Hip fracture Participant fell, she does not know how it happened	No marked cognitive impairments. However, during the interview, some cognitive impairments were perceptible.	Participant 1 can walk again with a walker.	An older adult who previously could do almost everything herself, even cycled too. Now able to walk short distances with a walker. She has no further expectations about the walking aspects, and is glad she can still walk with a walker. Participant could reasonably answer my questions, but also had some trouble with 'difficult' questions. This led to unclear answers or no answers. She mostly passed on to another subject/topic. She would leave the rehabilitation department the next day. She is eligible for sheltered housing.
2 ♀	86	Proximal Femur fracture Participant fell in the shower	No explicit marked cognitive impairments. However, after the interview nursing staff, indicated that this older adult will need psychogeriatric care in a nursing home after rehabilitation.	Participant 2 uses a wheelchair. Is able to stand on both legs, but this will be practiced with the help of physiotherapists during the therapy.	Participant 2 was active before admission to the rehabilitation ward. She uses crutches while walking and was helped by home care. She knows that she will stay in this nursing home after the rehabilitation period, thinks it is fine. She does not have any expectations related to the walking aspects. She was somewhat surly, gave short answers like yes and/or no

Participants	Age	Type of fracture	Cognition	Physical Activity	Characteristics
3 ♀	88	Transverse Proximal Femur fracture Participant fell off the bike. The hip is bruised and is not operated	No marked cognitive impairments. Much interaction during the interview, participant understood the questions. Some information was given twice, she repeats herself.	Participant 3 was very active before she fell, did for example her own groceries and used a bike. Now she walks with a walker. Despite the pain in her hip, she remains active. She regularly goes for a walk by herself.	Participant 3 was previously very self-employed. During the rehabilitation, she practices for walking up and down the stairs. She would like to go home again and walking the stairs is a requirement. She walks regularly with her walker to get in shape again. She was the only older adult who used a tablet. She used to read the news, checked the weather and occasionally played a game.
4 ♀	89	Colum fracture Participant fell in the bedroom	No marked cognitive impairments. Could answer the questions well. Ms. Was very aware of details and It took time until she came to the core of her reply.	Participant 4 was active before she has fallen. She has home care for a couple of years now and walked at home with a walker. She now walks again with a walker, but she only wants to walk with nursing staff and/or physiotherapists. Walking is still very exhausting.	Participant 4 was able to live at home with the help of home care. During the interview, she knew a lot of details about when she fell, on which day and what time etc. Before she actually answered a question, there was sometimes a long story in advance. She would like to go home again, if she recovers completely. It was difficult for her to judge if this was going to happen. Her attitude was a little bit passive.
5 ♀	79	Trochanteric Femur fracture Participant fell in the kitchen	Nursing staff assume that Ms. could have some difficulties answering the questions of the interview related to her cognitive status (no marked cognitive impairments) However, she understood and could answer the questions	Participant 5 was active before she fell. Now she walks with a walker and also uses a corset for her back. She walks short distances, but is afraid to fall again. She thinks it would be nice if the staff could walk more often with her.	Participant lived by herself at home without any help. After the rehabilitation, she goes to a sheltered house. She was initially suspicious about the interview, she did not want any problems. She would like to go home again and do the things she used to do.

Participants	Age	Type of fracture	Cognition	Physical Activity	Characteristics
6 ♀	86	Pelvicfracture Participant fell on the balcony.	No marked cognitive impairments. In general, she understood the questions. She told a lot of stories during the interview which were not related to the questions, for example stories about her daughter and where she lived before.	Participant 6 was active before she fell, but these were mainly indoor activities like cleaning. She could not walk for 8 weeks, because of her fracture. She has been able to walk again for two weeks. She now walks independently with a walker	Participant 6 lived in a sheltered house, with the help of home care. Nevertheless, she was still very independent. She told a lot that was not related to the questions. Because you did not experience her stories, it was sometimes difficult to understand. It does matter for her who helped her out from the nursing staff if she asks something.
7 ♂	87	Periprostheticfracture Participant fell in the toilet	No marked cognitive impairments. Could answer my questions well, gave thoughtful answers.	Participant 7 lives with his wife, not sure how active he was, but he could walk by himself without any tools. Now he walks with a walker, but not that much.	Participant 7 lives with his wife in a normal house. There was no help from home care needed. He was somewhat reserved, but gave thoughtful answers. He would like to go home and wants to function as well as possible. The day of the interview he went home with an occupational therapist to see if the house needs to be adjusted when he goes home. He does not tell the staff directly what he wants and needs, he is very respectful.
8 ♀	80	Pelvicfracture Participant fell in the kitchen	No marked cognitive impairments. Could answer my questions very well, gave thoughtful answers.	Participant 8 was previously very active and could walk on her own. Now she uses a wheelchair, because she can't stand up for too long. A walker gives at this point not enough support. Nevertheless, she practices a lot and tries to do everything by herself.	Participant 8 is a very independent woman. Her husband is all day with her, and helps her when it is needed and possible. She is very active, she also does a lot of volunteer work with her husband. She does not ask for a lot of help, but it is needed when she uses the toilet, goes to bed etc. because she cannot stand up for too long. She has a sharp tongue and clearly indicates when she does not like something.

Participants	Age	Type of fracture	Cognition	Physical Activity	Characteristics
9 ♀	85	Periprosthetic fracture Participant fell outside	No cognitive impairments. She could answer my questions. She was a little bit deaf, so sometimes she did not understand me.	Participant 9 uses a walker in her home situation and was quite active, did the groceries by herself. Now she uses a wheelchair because she is not able to stand up by herself with the help of a walker. She practices this at the physical therapy and she drives herself with her wheelchair.	Participant 9 lived on her own in a sheltered house with the help of home care. Did also voluntary work. Ms. would like to go home again, but does not ask for help a lot. It seems that she is somewhat ignorant about what the possibilities are for her and what she can ask from the nursing staff/physical therapists.