Acceptance of telerehabilitation in chronic pain:

the patients' perspective

Karlijn Cranen

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THE PATIENTS' PERSPECTIVE

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Contents

1

Introduction

Anna Belt is 43 years old and suffering from chronic pain complaints. Today she visited a nearby rehabilitation centre and received a personalized telerehabilitation treatment set. At home Anna logs on to her personalized exercise schedule, calibrates her wearable sensors and a gaming console and starts her first exercise session. The next day a video conferencing call with her personal therapist is scheduled to discuss her exercise plan for the coming week.

While the treatment described above may for some seem far-fetched, the reality is that some of these elements are already being explored in the field of exercise-based telerehabilitation. With the increased access to mobile devices, wearable sensors, and the development of virtual exercise environments, such treatment possibilities are emerging at a rapid speed. These innovative telerehabilitation treatments are considered a potential breakthrough in the treatment of chronic diseases, since they may contribute to increased quality of care and increased access and convenience of care [1, 2]. The management of chronic diseases, which is currently mainly coordinated in primary care, is expected to gradually shift to alternate sites of care such as the home, as telerehabilitation allows patients to receive treatment within their own social environment [3]. By helping patients to better self-manage their disease with the support of technology, it is expected that their demands on healthcare services will be reduced and

that, as a consequence, high healthcare costs associated with chronic pain [4, 5] may be reduced.

The development of effective telerehabilitation treatments, however, is far from trivial. Despite the great potential of telerehabilitation, the intended benefits will only be realised when these treatments are accepted as fully fledged alternatives for conventional care and are subsequently used by the patient. In addition, as patients' views on whether the treatment is relevant, meaningful and likely to be successful are linked with their compliance, it is important to develop treatments that meet patients' underlying value systems [6–8]. This means that, an understanding of the reasons behind patients' acceptance or refusal of telerehabilitation is important. What telerehabilitation characteristics are valued the most by patients? And to what extent do patients' experiences with telerehabilitation affect acceptance?

This thesis focuses on the exploration of patients' acceptance in the context of exercise-based telerehabilitation for chronic pain. Five studies, viewing patients' acceptance from different angles, will identify the drivers and barriers related to patients' acceptance and provide insights into the factors enabling telerehabilitation success. In this chapter we will first introduce the reader to the main concepts that play a role in this thesis and provide a background of the setting in which the research was performed. Once the contextual framework is in place, we will then elaborate on the aims of this thesis and the way patient acceptance was conceptualized. To conclude, an outline of the rest of this thesis is presented.

Chronic pain

Chronic pain is defined as pain that persists beyond normal tissue healing time and lasts for more than 3 months [9]. It is estimated that it affects approximately 19% of the adult population in Europe [10]. Due to an ageing society, it is expected that the prevalence of chronic pain will rise, as chronic pain prevalence is greater in older adults [11, 12]. Chronic pain impacts quality of life [13], often interferes with family responsibilities [10], and sleep [14], and it is linked with an increased risk of depression [15]. In addition to the physical and emotional burden that chronic pain brings, it accounts for considerable direct health care costs, including costs related to tests, medication, and treatment, as well as indirect costs such as lost income and reduced work productivity [16]. In European countries, pain is estimated to cost economies between 3% and 10% of gross domestic products [14], resulting in an estimate of at least 140 billion euros per year [17].

Physical training and exercise have been proven beneficial for chronic pain patients as they reduce pain and disability [18, 19] and therefore play an important role in

current (multidisciplinary) pain rehabilitation programs. Although conventional rehabilitation programs are effective, poor adherence and high relapse rates have been shown to compromise the effectiveness of these programs [20–23] and as such lead to increased costs [1]. Because of the complexity and consequently high costs of treatment of chronic pain, there has been a growing interest in other possible deliveries of interventions, like telerehabilitation.

Telerehabilitation

Telerehabilitation refers to the delivery of rehabilitation services via information and telecommunication technologies. In recent years the use of telerehabilitation, providing remote delivery of rehabilitative services through Internet and communication technology, has been steadily increasing [24]. Telerehabilitation offers several advantages over conventional care as patients are offered readily available care at the time of need, which substantially facilitates the care delivery process and, in turn, can lead to better patient health outcomes, well-being and quality of life [25]. Furthermore, through telerehabilitation, contextual factors from the environment can be incorporated into the rehabilitation intervention, and by doing so, translation of the acquired skills into the patients' environment can be facilitated [2, 26]. Telerehabilitation also has the potential to foster patient self-management [27]. For example, performance can be monitored and feedback can be provided on progress without the real-time involvement of a therapist, which can empower patients to take an active role in their own rehabilitation [28].

The focus of this thesis lies on exercise-based telerehabilitation. While telerehabilitation initiatives have been steadily increasing in number and have become more sophisticated in functionality [29], the use of exercise-based telerehabilitation in the treatment of chronic pain is an emerging field. Currently applied strategies, among others, are individually tailored exercise programs with videos and commonly include either real-time (video consultations) or asynchronous telerehabilitation mediums (email, or web forums) [30–32].

Patients' acceptance of telerehabilitation

As mentioned before, the benefits reaped from telerehabilitation depend largely on patients' acceptance and actual use of these treatments [33]. However, research shows high drop-out and non-usage rates, as well as great variation in how interventions are used in terms of frequency and duration [34].

An important factor contributing to facilitating treatment acceptance and use of telerehabilitation is the design of patient-centred treatment programs [2, 35, 36]. The

Institute of Medicine defines patient-centred care as "providing care that is respectful of, and responsive to, individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions" [37]. The concept of patient-centred care has received increased attention in recent years and is considered an important aim for health care improvement [37, 38]. The underlying assumption is that by designing programs that reflect patients' needs, values and preferences, the 'fit' between patients' needs and the technology will improve, ultimately contributing to patients' acceptance and use [6, 25].

Currently, patients' acceptance in the field of exercise-based telerehabilitation in chronic pain is sparsely documented [24, 25, 39]. As a consequence, little is known about the factors, such as patients' beliefs and preferences, which influence patients' acceptance. The exploration of factors that promote or hinder patients' acceptance of exercise-based telerehabilitation services in chronic pain is, therefore, a necessary first step toward the design of patient-centred treatments. Ultimately, the gap between what patients need and what is offered can be identified and treatment may be optimized [8].

Understanding patients' acceptance

Strikingly, the concept of 'acceptance' itself is not clearly defined in the literature [40]. Davis [41] has described acceptance as a user's decision about how and when they will use technology. Within the field of telerehabilitation, this definition is not altogether satisfactory, because it leaves open the question of whether this refers to either intention to use, actual use, or something else. This confusion is also present within the literature. Or and Karsh [25] show that acceptance is commonly considered as equivalent to behavioural intention to use, although end-user satisfaction is another interpretation of acceptance that occurs in practice. We will further elaborate on the definition of acceptance in this thesis in the section *Thesis aims and outline*, after we have introduced the conceptual frameworks that prevail in the literature and that offer an extensive knowledge base that is valuable for the understanding of patients' acceptance of telerehabilitation [42].

Technology acceptance models

Within the field of psychology and sociology, a number of influential models and theories have been developed to explain technology acceptance. Depending on the research domain, acceptance is either characterized as implementation success on an organizational level [43], or described as individual acceptance of technology. In this thesis we focus on the exploration of individual acceptance of technology. Within this line of

research, the Technology Acceptance Model (TAM) [44] has been widely studied and is regarded as a parsimonious model with high predicting power in explaining individual acceptance behaviour across various contexts [45–48]. According to TAM, users' attitudes and beliefs of perceived usefulness (PU) and perceived ease of use (PEU) are the key predictors of users' intention to use the system, which eventually drives actual use. PEU represents an individual's assessment of the effort necessary to operate a technology, and PU represents an individual's perception of the benefits that could likely be obtained from using the technology. Taylor and Todd [49] added two factors, subjective norm and perceived behavioural control to TAM, which led to the C-TAM-TPB model. One of the latest models explaining technology acceptance is the Unified Theory of Acceptance and Use of Technology (UTAUT) [42], which is based on TAM and seven other models. Thus, UTAUT integrates core elements of eight prominent models and theories of IT acceptance and use (for example the Theory of Reasoned Action, Technology Acceptance Model, Theory of Planned Behaviour), and was found to clearly outperform each of the individual, underlying models/theories in terms of explanatory power [42]. Since its formulation in the early 2000s, UTAUT has been applied to explain individuals' intentions to use (information) technologies in various contexts, including the context of telemedicine [50–52]. The general applicability of the UTAUT model as well as the reliability and validity of the model constructs have been demonstrated [53]. UTAUT suggests that, besides technology-related factors, societal factors and factors relating to the degree to which the patient feels in control, affect behaviour. In line with UTAUT, in our studies we hypothesized that patients' actual use is determined by patients' intentions to use telerehabilitation as well as by the degree to which patients perceive internal (such as a lack of skills and motivation) and external constraints (lack of space, resources) that influence the use of telerehabilitation. In its turn, patients' intentions to use telerehabilitation are determined by patients' perceptions of whether telerehabilitation will be of benefit (performance expectancy), perception of others' opinions on whether or not to use technology (social influence) and patients' perceptions of internal or external constraints.

In this thesis, the above mentioned intention-based models are used as a theoretically based starting point and adapted to the context of telerehabilitation. In this way, we extend the scarce base of research domains that has applied these models within the field of patients' acceptance of telerehabilitation [54, 55]. Furthermore, identification of certain patient groups which are either more or less likely to accept telerehabilitation in the treatment of chronic pain is also of importance to contribute to the understanding of patient acceptance and patient-centred design. In the treatment of chronic pain little is known about patient characteristics in relation to patients' acceptance. Yet,

identifying characteristics that are important in telerehabilitation acceptance, can inform developers about whether and how an intervention should be adapted to those specific subgroups of users.

Patients' acceptance: a process-based view

While being valid and parsimonious, technology acceptance models such as TAM and UTAUT, approach the concept of acceptance from a 'static' point of view and disregard the fact that technology acceptance may change over time [44, 56–58]. Literature suggests that repeated exposure to technology and experience with the target behaviour provides the user with a greater opportunity to consider various aspects of performing the desired behaviour [59]. Since patients commonly do not have prior experience with telerehabilitation services, we could therefore expect patients' beliefs and patients' acceptance to change over time as they gain experience with the service [60, 61]. Besides, patients' perceptions driving use of the telerehabilitation may not be the same perceptions that have led to initial acceptance [62]. Insight into these changes in pre- and post-use perceptions during use is therefore of significant importance as this can guide the development of both service design and education strategies thereby contributing to higher levels of patients' acceptance of telerehabilitation and ultimate use. Currently, within the field of telerehabilitation, patients' acceptance and determinants are commonly measured at one single point in time, either before or after patients have used the service [63, 64]. Consequently, our understanding of perceptions leading to telerehabilitation acceptance and how these might change over time is limited [62, 65, 66]. To contribute to addressing this knowledge gap, we have applied a process-based view of acceptance in which we monitor acceptance at multiple time instants. The way we view acceptance, i.e., as the result of a complex decision-making process, is very similar to the technology adoption process described by Rogers' Diffusion of Innovation Theory [67]. According to Rogers, the innovation decision process may be conceptualized as a temporal sequence of steps (stages) through which a person passes from initial knowledge of an innovation, to forming a favourable or unfavourable attitude toward it, to a decision to adopt or reject it, to putting the innovation to use, and to finally seeking reinforcement of the adoption decision made [67]. Adoption decisions can be reversed during the process, if for example an individual becomes dissatisfied with a technology. Figure 1.1 provides a schematic overview the research framework and the stages of acceptance that were derived from Rogers' Diffusion of Innovation Theory.

From a theoretical perspective, by applying a process-based view of acceptance and by investigating temporal changes of perceptions over time, these results represent an

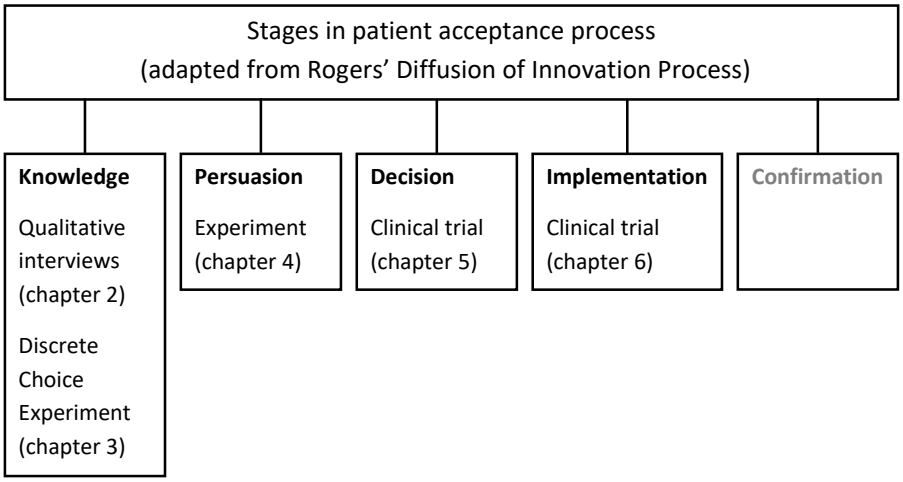

Figure 1.1: *Stages of acceptance.*

important first step toward a richer understanding patients' acceptance. From a practical perspective, knowing which factors are important for acceptance, enables system developers to employ more targeted design and educational strategies at different phases of the acceptance process.

Preferences value driven design

Alongside the fields of psychology and sociology, the domain of behavioural economics offers methodologies that can contribute to a better understanding of the drivers and barriers underlying patients' acceptance of telerehabilitation. One such method is a discrete choice experiment (DCE). A DCE is a preference elicitation methodology that is being increasingly used in health care research [68]. Preferences, which we define as the most desired choices among bound sets of alternatives, reflect the choices that individuals make in order to maximize their overall utility [69]. Patients use preference evaluation prior to their decision-making process of whether to accept telerehabilitation at a certain point in time. A DCE offers respondents a series of choices between two or more treatment alternatives, described by a combination of treatment attributes, and choose their preferred treatment. Analysis of these choices allows for the estimation of the relative importance of treatment attributes. A DCE can assist in prioritizing health care resource allocation, as it provides a better understanding of the factors that are most important to patients and can be used to inform patient-centred

telerehabilitation design. In addition, the use of DCEs is especially valuable in the context of innovative treatments, for example chronic pain telerehabilitation treatment, as it allows for the estimation of patients' preferences for multiple treatment scenarios that do not yet exist.

Thesis aims and outline

The goal of this thesis is to identify drivers and barriers related to patients' acceptance of exercise-based telerehabilitation among chronic pain patients. By doing so, we aim to contribute to a better general understanding of patients' acceptance in telerehabilitation and eventually to improvements in telerehabilitation design. More specifically, we aim to acquire insights that can help to estimate the potential of novel telerehabilitation alternatives in the management of chronic pain, based on the patients' perspective.

In this thesis we provide a multi-faceted exploration of patients' acceptance of telerehabilitation using a mixed-method approach, employing the different methods and theoretical viewing points from the psycho-social and behavioural-economic domain summarized in the section *Understanding patients' acceptance*. This combined qualitative and quantitative work thus adds to the scarce body of mixed-methods research that is currently applied within the field of information system research [70, 71]. As mentioned previously, within the field of telerehabilitation there is no universally accepted definition of patient acceptance, which makes operationalisation of our aim far from trivial. In addition, we have described how the concept of acceptance may be susceptible to change as patients gain knowledge and experience with telerehabilitation. Consequently, we applied a process-based view of acceptance, investigating patients' acceptance with five studies measuring acceptance at different moments in time. The first two studies measured telerehabilitation acceptance of patients with limited knowledge of and no prior experience with telerehabilitation services; patients elaborated on hypothetical telerehabilitation scenarios. During the third study, patients were offered brief exposure to a telerehabilitation service, but were aware that the telerehabilitation service they were evaluating was a prospective telerehabilitation service, not currently offered in the chronic pain rehabilitation treatment. In the last two studies a group of patients was subjected to a telerehabilitation service that was actually implemented and used during their chronic pain rehabilitation program.The fourth study focused on patients' decisions to engage in telerehabilitation treatment. The fifth study explored changes in patients' pre- and post-use perceptions and in what way these perceptions were related to patients' actual use of telerehabilitation.

As a consequence of both the process-based view and mixed-method approach that was used in this thesis, patients' acceptance was operationalised in the following ways:

1. patients' intentions to use telerehabilitation (chapter 2, 3 and 4)
2. patients' decisions to use telerehabilitation (chapter 5)
3. patients' actual use of telerehabilitation (chapter 6)

For the reader's convenience each study is briefly summarized below.

Chapter 2

An exploration of chronic pain patients' perceptions of home telerehabilitation services

This chapter describes a qualitative exploration of patients' perceptions regarding prospective telerehabilitation services and the factors that facilitate or impede patients' intentions to use these services. Using semi-structured interviews, patients reflected on the pros and cons of various scenarios of prospective telerehabilitation services. The study targets patients' acceptance in the very first stage.

Chapter 3

Towards patient-centred telerehabilitation design: understanding chronic pain patients' preferences of prospective telerehabilitation treatments using a discrete choice experiment

A Discrete Choice Experiment (DCE) can assist in prioritizing health care resource allocation, as it provides a better understanding of the factors that are most important to patients and can be used to inform patient-centred telerehabilitation design. In addition, the use of DCEs is especially valuable in the context of innovative treatments, for example, chronic pain telerehabilitation treatment, as it allows for the estimation of patients' preferences for multiple treatment scenarios that do not yet exist. Chapter 3 determines what treatment attributes are most important to chronic pain patients and identifies which telerehabilitation scenario chronic pain patients are most likely to accept as an alternative to conventional rehabilitation.

Chapter 4

Change of patients' perceptions of telemedicine after brief use

Patients' decisions to opt for telerehabilitation treatment and their underlying perceptions might be influenced by knowledge and experience. The aim of this study was to investigate the influence of brief experience on patients' perceptions of telerehabilitation.

Chapter 5

To accept or refuse: exploring the factors related to patients' decisions to participate in a telerehabilitation program using the UTAUT framework

An exercise-based telerehabilitation program was designed and implemented as a partial replacement of an outpatient multidisciplinary group rehabilitation program. The aim of this exploratory study was to examine chronic pain patients' decisions to accept or refuse participation in this telerehabilitation program, using the UTAUT as a theoretically supported starting point. Acceptance was operationalised as patients' choice of whether or not to use the telerehabilitation service during treatment.

Chapter 6

Do patients' perceptions of a telerehabilitation service change after use and what is the relationship with actual use?

Insight into patients' changing perceptions of a telerehabilitation service could guide efforts to prevent for possible treatment attrition. Therefore, the aim of this study was to gain insight in how patients' perceptions of telerehabilitation change over time by measuring patients' pre- and post- use perceptions of a telerehabilitation service and by investigating how these perceptions related to patients' actual use of telerehabilitation.

Chapter 7

General discussion

In the final chapter of this thesis, we will first summarize the findings of the five studies. We will then further reflect on the different factors that relate to patients' acceptance of telerehabilitation and discuss the implications for future research and the development of telerehabilitation in the treatment for chronic pain.

References

1. Enthoven P, Skargren E and Oberg B. Clinical course in patients seeking primary care for back or neck pain: a prospective 5-year follow-up of outcome and health care consumption with subgroup analysis. *Spine*, 2004; **29:** 2458–2465.
DOI: 10.1097/01.brs.0000143025.84471.79.

2. Cooper K, Smith BH and Hancock E. Patient-centredness in physiotherapy from the perspective of the chronic low back pain patient. *Physiotherapy*, 2008; **94:** 244–252.
DOI: 10.1016/j.physio.2007.10.006.

3. Temkin AJ, Ulicny GR and Vesmarovich SH. Telerehab. A perspective of the way technology is going to change the future of patient treatment. *Rehab Management*, 1996; **9:** 28–30.
PMID: 10166562.

4. Lahad A, Malter AD, Berg AO and Deyo RA. The effectiveness of four interventions for the prevention of low back pain. *The Journal of the American Medical Association*, 1994; **272:** 1286–1291.
DOI: 10.1001/jama.1994.03520160070046.

5. Blyth FM, March LM, Brnabic AJ and Cousins MJ. Chronic pain and frequent use of health care. *Pain*, 2004; **111:** 51–58.
DOI: 10.1016/j.pain.2004.05.020.

6. Kotarba JA and Seidel JV. Managing the problem pain patient: compliance or social control? *Social Science & Medicine*, 1984; **19:** 1393–1400.
DOI: 10.1016/0277-9536(84)90029-7.

7. Donovan JL and Blake DR. Patient non-compliance: deviance or reasoned decision-making? *Social Science & Medicine*, 1992; **45:** 507–513.
DOI: 10.1016/0277-9536(92)90206-6.

8. Slade SC, Patel S, Underwood M and Keating JL. What are patient beliefs and perceptions about exercise for non-specific chronic low back pain? A systematic review of qualitative studies. *The Clinical Journal of Pain*, 2014; **30:** 995–1005.
DOI: 10.1097/AJP.0000000000000044.

9. Merskey H and Bogduk N. Classification of chronic pain. 2nd ed. Seattle: IASP Press, 1994.

10. Breivik H, Collett B, Ventafridda V, Cohen R and Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 2006; **10:** 287–333.
DOI: 10.1016/j.ejpain.2005.06.009.

11. Langley PC. The prevalence, correlates and treatment of pain in the European Union. *Current Medical Research and Opinion*, 2011; **27:** 463–480.
DOI: 10.1185/03007995.2010.542136.

12. Smith M, Davis MA, Stano M and Whedon JM. Aging baby boomers and the rising cost of chronic back pain: secular trend analysis of longitudinal medical expenditures panel survey data for years 2000 to 2007. *Journal of Manipulative and Physiological Therapeutics*, 2013; **26:** 2–11.
DOI: 10.1016/j.jmpt.2012.12.001.

13. O'Brien T and Breivik H. The impact of chronic pain–European patients' perspective over 12 months. *Scandinavian Journal of Pain*, 2012; **3:** 23–29.
DOI: 10.1016/j.sjpain.2011.11.004.

14. Breivik H, Eisenberg E and O'Brien T. The individual and societal burden of chronic pain in Europe: the case for strategic prioritisation and action to improve knowledge and availability of appropriate care. *BMC Public Health*, 2013; **13:** 2–14.
DOI: 10.1186/1471-2458-13-1229.

15. Elliott TE, Renier CM and Palcher JA. Chronic pain, depression, and quality of life: correlations and predictive value of the SF-36. *Pain Medicine*, 2003; **4:** 331–339.
DOI: 10.1111/j.1526-4637.2003.03040.x.

16. Lambeek LC, Tulder MW van, Swinkels I, Koppes LLJ, Anema JR and Mechelen W van. The trend in total cost of back pain in the Netherlands in the period 2002 to 2007. *Spine*, 2011; **36:** 1050–1058.
DOI: 10.1097/BRS.0b013e3181e70488.

17. Rycroft CE, Hirst M, Dunlop WC, Pirk O, Mullins D and Akehurst R. The suitability of end point designs for health technology assessment in chronic pain studies. *Value in Health*, 2015; **18:** 987–993.
DOI: 10.1016/j.jval.2015.07.001.

18. Fordyce W, McMahon R, Rainwater G et al. Pain complaint-exercise performance relationship in chronic pain. *Pain*, 1981; **10:** 311–321.
DOI: 10.1016/0304-3959(81)90091-9.

19. Tulder M van, Malmivaara A, Esmail R and Koes B. Exercise therapy for low back pain: a systematic review within the framework of the Cochrane Collaboration Back Review Group. *Spine*, 2000; **25:** 2784–2796.
DOI: 10.1097/00007632-200011010-00011.

20. Turk DC and Rudy TE. Neglected topics in the treatment of chronic pain patients-relapse, noncompliance, and adherence enhancement. *Pain*, 1991; **44:** 5–28.
DOI: 10.1016/0304-3959(91)90142-K.

21. Hayden JA, Tulder MW van, Malmivaara A and Koes BW. Exercise therapy for treatment non-specific low back pain (review). *Cochrane Database Systematic Reviews*, 2005**:** CD000335.
DOI: 10.1002/14651858.CD000335.pub2.

22. Jordan JL, Holden MA, Mason EE and Foster NE. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Systematic Reviews*, 2010**:** CD005956.
DOI: 10.1002/14651858.CD005956.pub2.

23. Morley S. Relapse prevention: still neglected after all these years. *Pain*, 2008; **134:** 239–240.
DOI: 10.1016/j.pain.2007.12.004.

24. Kairy D, Tousignant M, Leclerc N, Côté A and Levasseur M. The patient's perspective of in-home telerehabilitation physiotherapy services following total knee arthroplasty. *International Journal of Environmental Research and Public Health*, 2013; **10:** 3998–4011.
DOI: 10.3390/ijerph10093998.

25. Or CKL and Karsh B. A systematic review of patient acceptance of consumer health information technology. *Journal of the American Medical Informatics Association*, 2009; **16:** 550–560.
DOI: 10.1197/jamia.M2888.

26. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP and Gonder-Frederick LA. A behaviour change model for internet interventions. *Annals of Behavioral Medicine*, 2009; **38:** 18–27.
DOI: 10.1007/s12160-009-9133-4.

27. Finkelstein J, Lapshin O, Heather C, Cha E and Provance PG. Home-based physical telerehabilitation in patients with multiple sclerosis: A pilot study. *Journal of Rehabilitation Research and Development*, 2008; **45:** 1361–1373.
DOI: 10.1682/JRRD.2008.01.0001.

28. Brennan DM, Mawson S and Brownsell S. Telerehabilitation: enabling the remote delivery of healthcare, rehabilitation, and self management. In: *Studies in Health Technolology and Informatics*. Ed. by Gaggioli A, Keshner EA, Weiss PL and Riva G. 2009**:** 231–248.
DOI: 10.3233/978-1-60750-018-6-231.

29. Kairy D, Lehoux P, Vincent C and Visintin M. A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. *Disability and Rehabilitation*, 2009; **31:** 427–447.
DOI: 10.1080/09638280802062553.

30. Dunphy E, Hamilton FL, Spasić I and Button K. Acceptability of a digital health intervention alongside physiotherapy to support patients following anterior cruciate ligament reconstruction. *BMC Musculoskeletal Disorders*, 2017; **18:** 471.
DOI: 10.1186/s12891-017-1846-0.

31. Wan ES, Kantorowski A, Homsy D et al. Promoting physical activity in COPD: Insights from a randomized trial of a web-based intervention and pedometer use. *Respiratory Medicine*, 2017; **130:** 102–110.
DOI: 10.1016/j.rmed.2017.07.057.

32. Cottrell MA, Galea OA, O'Leary SP, Hill AJ and Russell TG. Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: A systematic review and meta-analysis. *Clinical Rehabilitation*, 2017; **31:** 625–638.
DOI: 10.1177/0269215516645148.

33. Holden RJ and Karsh BT. The technology acceptance model: its past and its future in health care. *Journal of Biomedical Informatics*, 2010; **43:** 159–172.
DOI: 10.1016/j.jbi.2009.07.002.

34. Bossen D, Veenhof C, Dekker J and Bakker D de. The usability and preliminary effectiveness of a web-based physical activity intervention in patients with knee and/ or hip osteoarthritis. *BMC Medical Informatics and Decision Making*, 2013; **13:** 61.
DOI: 10.1186/1472-6947-13-61.

35. Epstein RM, Fiscella K, Lesser CS and Stange KC. Why the nation needs a policy push on patient-centered health care. *Health Affairs*, 2010; **29:** 1489–1495.
DOI: 10.1377/hlthaff.2009.0888.

36. Roumie CL, Greevy R, Wallston KA et al. Patient centered primary care is associated with patient hypertension medication adherence. *Journal of Behavioral Medicine*, 2011; **34:** 244–253.
DOI: 10.1007/s10865-010-9304-6.

37. Institute of Medicine (Committee on Quality of Health Care in America). Crossing the quality chasm: a new health system for the 21st century. Washington (DC): National Academies Press (US), 2001.
PMID: 25057539.

38. Greene SM, Tuzzio L and Cherkin D. A framework for making patient-centered care front and center. *The Permanente Journal*, 2012; **16:** 49–53.
DOI: doi.org/10.7812/TPP/12-025.

39. Adamse C, Dekker-Van Weering MG, van Etten-Jamaludin FS and Stuiver MM. The effectiveness of exercise-based telemedicine on pain, physical activity and quality of life in the treatment of chronic pain: a systematic review. *Journal of Telemedicine and Telecare*, 2017.
DOI: 10.1177/1357633X17716576.

40. Straub D and Burton-Jones A. Veni, Vidi, Vici: Breaking the TAM Logjam. *Journal of the Association for Information Systems*, 2007; **8**. URL: http://aisel.aisnet.org/jais/vol8/iss4/14.

41. Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 1989; **13:** 319–340.
DOI: 10.2307/249008.

42. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478.
DOI: 10.2307/30036540.

43. Leonard-Barton D and Deschamps I. Managerial Influence in the Implementation of New Technology. *Management Science*, 1988; **34:** 1252–1265.
DOI: 10.1287/mnsc.34.10.1252.

44. Davis FD, Bagozzi RP and Warshaw PR. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 1989; **35:** 982–1003.
DOI: 10.1287/mnsc.35.8.982.

45. Mathieson K. Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior. *Information Systems Researc*, 1991; **3:** 173–191.
DOI: 10.1287/isre.2.3.173.

46. Adams DA, Nelson RR and Todd PA. Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication. *MIS Quarterly*, 1992; **16**.
DOI: 10.2307/249577.

47. Chin WW and Todd PA. On the Use, Usefulness, and Ease of Use of Structural Equation Modeling in MIS Research: A Note of Caution. *MIS Quarterly*, 1995; **19:** 237–246.
DOI: 10.2307/249690.

48. Segars AH and Grover V. Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. *MIS Quarterly*, 1993; **17:** 517–525.
DOI: 10.2307/249590.

49. Taylor S and Todd PA. Understanding information technology usage: A test of competing models. *Information Systems Research*, 1995; **6:** 144–176.
DOI: 10.1287/isre.6.2.144.

50. Cimperman M, Makovec Brenčič M and Trkman P. Analyzing older users' home telehealth services acceptance behavior-applying an Extended UTAUT model. *International Journal of Medical Informatics*, 2016; **90:** 22–31.
DOI: 10.1016/j.ijmedinf.2016.03.002.

51. Kohnke A, Cole M and Bush R. Incorporating UTAUT predictors for understanding home care patients' and clinician's acceptance of healthcare telemedicine equipment. *Journal of technology management & innovation*, 2014; **9**.
DOI: 10.4067/S0718-27242014000200003.

52. Hoque R and Sorwar G. Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model. *International Journal of Medical Informatics*, 2017; **101:** 75–84.
DOI: 10.1016/j.ijmedinf.2017.02.002.

53. Venkatesh V, Thong JYL and Xu X. Unified Theory of Acceptance and Use of Technology: A Synthesis and the Road Ahead. *Journal of the Association for Information Systems*, 2016; **17:** 328–376.
DOI: 10.17705/1jais.00428.

54. Or CK, Karsh BT, Severtson DJ, Burke LJ, Brown RL and Brennan PF. Factors affecting home care patients' acceptance of a web-based interactive self-management technology. *Journal of the American Medical Informatics Association*, 2011; **18:** 51–59.
DOI: 10.1136/jamia.2010.007336.

55. Gammon D, Johannessen LK, Sørensen T, Wynn R and Whitten P. An Overview and Analysis of Theories Employed in Telemedicine Studies: A Field in Search of an Identity. *Methods of Information in Medicine*, 2008; **47:** 260–269.
PMID: 18473093.

56. Liao C, Palvia P and Chen J-L. Information technology adoption behavior life cycle: toward a Technology ContinuanceTheory. *International Journal of Information Management*, 2009; **29:** 309–320.
DOI: 10.1016/j.ijinfomgt.2009.03.004.

57. Yousafzai SY, Foxall GR and Palliste JG. Technology acceptance: a meta-analysis of the TAM: Part 2. *Journal of Modelling in Management*, 2007; **2:** 281–304.
DOI: 10.1108/17465660710834462.

58. Zheng K, Padman R, Johnson MP and Diamond HS. Evaluation of Healthcare IT Applications: The User Acceptance Perspective. In: *Advanced Computational Intelligence Paradigms in Healthcare-2. Studies in Computational Intelligence*. Ed. by Vaidya S, Jain LC and Yoshida H. Berlin, Heidelberg: Springer, 2007.
DOI: 10.1007/978-3-540-72375-2_4.

59. Petty RE and Cacioppo JT. The Elaboration Likelihood Model of persuasion. In: *Advances in experimental social psychology*. Ed. by Berkowitz L. New York: Academic Press, 2007**:** 123–205.

60. Hanson D, Calhoun J and Smith D. Changes in provider attitudes toward telemedicine. *Telemedicine Journal and e-Health*, 2009; **15:** 39–43.
DOI: 10.1089/tmj.2008.0052.

61. Demiris G, Speedie SM and Finkelstein S. Change of patients' perceptions of TeleHomeCare. *Telemedicine Journal and e-Health*, 2001; **10:** 122–128.
DOI: 10.1089/153056201316970948.

62. Bhattacherjee A and Premkumar G. Understanding changes in belief and attitude toward information technology usage: a theoretical model and longitudinal test. *MIS Quarterly*, 2004; **28:** 229–254.
DOI: 10.2307/25148634.

63. Palazzo C, Klinger E, Dorner V et al. Barriers to home-based exercise program adherence with chronic low back pain: Patient expectations regarding new technologies. *Annals of physical and rehabilitation medicine*, 2016; **59:** 107–113.
DOI: 10.1016/j.rehab.2016.01.009.

64. Currie M, Philip LJ and Roberts A. Attitudes towards the use and acceptance of eHealth technologies: a case study of older adults living with chronic pain and implications for rural healthcare. *BMC Health Services Research*, 2015; **15:** 162.
DOI: 10.1186/s12913-015-0825-0.

65. Karahanna E, Straub DW and Chervany NL. Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, 1999; **23:** 183–213.
DOI: 10.2307/249751.

66. Peek ST, Wouters EJ, Hoof J van, Luijkx KG, Boeije HR and Vrijhoef HJ. Factors influencing acceptance of technology for aging in place: a systematic review. *International Journal of Medical Informatics*, 2014; **83:** 235–248.
DOI: 10.1016/j.ijmedinf.2014.01.004.

67. Rogers EM. Diffusion of Innovations. 3rd ed. New York: The Free Press, 1983.

68. Bridges JF, Kinter ET, Kidane L, Heinzen RR and McCormick C. Things are looking up since we started listening to patients: recent trends in the application of conjoint analysis in health. *The Patient*, 2008; **1:** 273–282.
DOI: 10.2165/1312067-200801040-00009.

69. McFadden D. Econometric models for probabilistic choice among products. *The Journal of Business*, 1980; **53:** S13–S29.
DOI: 10.1086/296093.

70. Lee AS and Hubona GS. A Scientific Basis for Rigor in Information Systems Research. *MIS Quarterly*, 2009; **33:** 237–262.
DOI: 10.2307/20650291.

71. Mingers J. Combining IS Research Methods: Towards a Pluralist Methodology. *Information Systems Research*, 2001; **12:** 240–259.
DOI: 10.1287/isre.12.3.240.9709.

2

An exploration of chronic pain patients' perceptions of home telerehabilitation services

An earlier version of this chapter has been published as:

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Abstract

Objectives To explore patients' perceptions regarding prospective telerehabilitation services and the factors that facilitate or impede patients' intentions to use these services.

Design Using semi-structured interviews, patients reflected on the pros and cons of various scenarios of prospective telerehabilitation services. Patients' arguments were first arranged according to the Unified Theory of Acceptance and Use of Technology (UTAUT). Next, using inductive analysis, the data for each UTAUT component were analysed and arranged into subthemes.

Setting and participants Twenty-five chronic pain patients were selected from a rehabilitation centre in the Netherlands.

Results Overall, participants considered telerehabilitation helpful as a complementary or follow-up treatment, rather than an autonomous treatment. Arguments mainly related to the UTAUT constructs of performance expectancy and facilitating conditions. Patients valued the benefits such as reduced transportation barriers, flexible exercise hours and the possibility to better integrate skills into daily life. However, many patients feared a loss of treatment motivation and expressed concerns about both reduced fellow sufferer contact and reduced face-to-face therapist contact. Few arguments related to social norms and effort expectancy.

Conclusions The effect of telerehabilitation on healthcare strongly depends on patients' willingness to use. Our study showed that chronic pain patients valued the benefits of telerehabilitation but hesitate to use it as an autonomous treatment. Therefore, future initiatives should maintain conventional care to some degree and focus on patients' attitudes as well. Either by giving information to increase patients' confidence in telerehabilitation or by addressing reported drawbacks into the future design of these services. Further quantitative studies are needed to explore patients' intentions to use telerehabilitation.

Introduction

Chronic pain is a common condition that occurs in at least 19% of adult Europeans, and varies from moderate to severe intensity [1]. As well as having personal consequences, chronic pain puts pressure on society as it affects direct healthcare costs as well as indirect costs such as social compensation, pensions and a loss of productivity [2–4].

At present, it is acknowledged that physical exercises should be part of chronic pain treatment. Therapeutic exercises prove beneficial for chronic pain patients as they reduce pain and disability [5–9]. Despite the benefits, adherence to the exercise programs is often suboptimal. Dropout rates have ranged from 10 to 36% and many patients' exercise adherence levels decline even further once they have completed their programme [10]. Geographical and transportation barriers, socio- economic factors and financial constraints might be important determinants of this non-adherence [11]. Therefore, it is important to look for alternative models of health service delivery that could better meet patients' preferences and, in so doing, enhance exercise treatment compliance.

Home-based telerehabilitation, providing care at home via communication technologies [12], is one such alternative model. Telerehabilitation is supposed to have several advantages over conventional care as patients have the opportunity to rehabilitate within their own social environment [13], can avoid transportation issues [14], are able to personally adjust exercise hours [15–17] and are encouraged to manage their disease themselves.

Results from empirical effect studies coincide with the idea that telerehabilitation services are beneficial to patients. Brattberg et al. [18] used the internet to provide video-films for the rehabilitation of people on long-term sick leave due to chronic pain and/or burnout. Over half of the experimental group reported an increased work capacity, compared with thirteen percent in the control group. In addition, Buhrman et al. [19] showed in their controlled trial that an internet based cognitive behavioural intervention with telephone support for chronic back pain patients leads to significant improvements in health.

Despite this, within the field of chronic pain and telerehabilitation, no attention has been given to the patients' perspective on telerehabilitation services. As patients' judgements whether the treatment is relevant, meaningful and likely to be successful are linked with their compliance [20, 21] it is important to develop interventions that meet patients' underlying value systems. Therefore, the aim of this study is to explore chronic pain patients' perceptions of prospective home telerehabilitation services

and understanding the factors seen as important from their perspective by means of qualitative interviews.

Method

Setting and sampling

A convenience sample of 25 chronic pain patients was selected from a rehabilitation centre. The following inclusion criteria were applied:

i Patients were receiving or had received physical therapy,
ii patients had sufficient communication skills and a basic knowledge of the Dutch language, and
iii only adults were asked to participate.

The sample included maximum variation, including a balance of men and women, older and younger participants, and patients with and without experience with the conventional rehabilitation program. Interviews took place at the research facilities near the rehabilitation centre. Participants unable to visit the research department were visited at home. Written and verbal consent to participate was obtained from all participants.

Semi-structured interviews

Interviews were conducted by KC (communication scientist) and ESB (psychologist), lasted between 30 and 90 min, and were guided by a semi-structured interview guide. The guide explored the perceived advantages and disadvantages of potential exercise-based telerehabilitation services with a focus on cognitive behavioural treatment and patients' intention to use these services. Although areas for exploration were defined, the semi-structured interview allowed for flexibility and deeper examination of issues arising.

To facilitate the interview process patients first discussed the pros and cons of their past and current treatments. Patients were then shown cards, providing a brief description and picture of four home-based treatments, including three prospective telerehabilitation treatments. The scenarios did not represent full and realistic treatments, but each depicted a different functionality of telerehabilitation. The rationale behind this was that this would help patients to gradually become familiar with the broad concept of telerehabilitation. In addition, the scenarios represented telerehabilitation as a total replacement of clinic-based care.

The first and final consultation would take place at the clinic, giving patients face-to-face contact with their therapist. This 'extreme' proposition was expected to trigger

patients' perceptions of telerehabilitation and to help them to elaborate on the pros and cons. The functionalities presented were:

i. a home-based treatment with home visits by a therapist,
ii. a home-based treatment by means of web camera therapist consultations,
iii. a sensor-based treatment that made use of a system with incorporated sensors generating feedback about a patient's movements during exercising, and
iv. a home-based treatment through the use of a web-based tailored exercise program with video instruction files.

At the end of each interview patients filled out a short personal characteristics questionnaire.

Analysis

Interviews were audio recorded and transcribed verbatim with participants' permission. First, two coders (KC and ESB) separately read all transcripts to familiarize themselves with the data. Data were then arranged according to a thematic framework based on the Unified Theory of Acceptance and Use of Technology (UTAUT). We used this as it has been proven a robust and parsimonious framework to understand the drivers of user's intentions to accept ICT [22]. According to UTAUT, performance expectancy, effort expectancy, social influence and facilitating conditions are the key predictors of ICT acceptance.

Next, the data for each UTAUT component were analysed and arranged into subthemes using an inductive process, meaning that patterns, themes and categories arise from the data [23]. Differences were discussed and resolved during discussion meetings. The credibility of the analysis was aided by ongoing discussion with two additional reviewers CHCD (health promotion scientist) and LMAB (health scientist), both having experience with qualitative analysis. To ensure confidentiality, we removed all identifying information from the quotes.

Results

Sample characteristics

Table 2.1 outlines the characteristics of the research sample which consisted of 25 chronic pain patients of whom thirteen were female patients. Participants ranged in age from 22 to 77 years, with a mean of 40 years. A total of five participants had a high level of formal education, six an intermediate level and fourteen a lower level. Seven participants were single; the remaining eighteen were married or cohabiting. Thirteen patients were unemployed.

Table 2.1: *Characteristics of the research sample.*

Demographics	
Gender	*n*
Female	13
Male	12
Age	years
Mean (SD)	39.8 (14.1)
Range	22 – 77
Marital status	*n*
Single	7
Married/cohabiting	18
Employment	*n*
Employed	12
Unemployed	13
Education	*n*
Low	14
Middle	6
High	5

Interview results

There was much similarity in the characteristics that participants associated with prospective telerehabilitation services, although they differed in the value they attached to these characteristics. The results are structured according to the following constructs, all derived from the Unified Theory of Acceptance and Use of Technology (UTAUT) [22]:

I. Performance expectancy
II. Effort expectancy
III. Social influence
IV. Facilitating conditions
V. Intention to use

An overview of all themes and subthemes is provided in Figure 2.1. The majority of the patients looked at telerehabilitation in the light of performance expectancy and facilitating conditions. Fewer subthemes emerged regarding the constructs of social influence and effort expectancy.

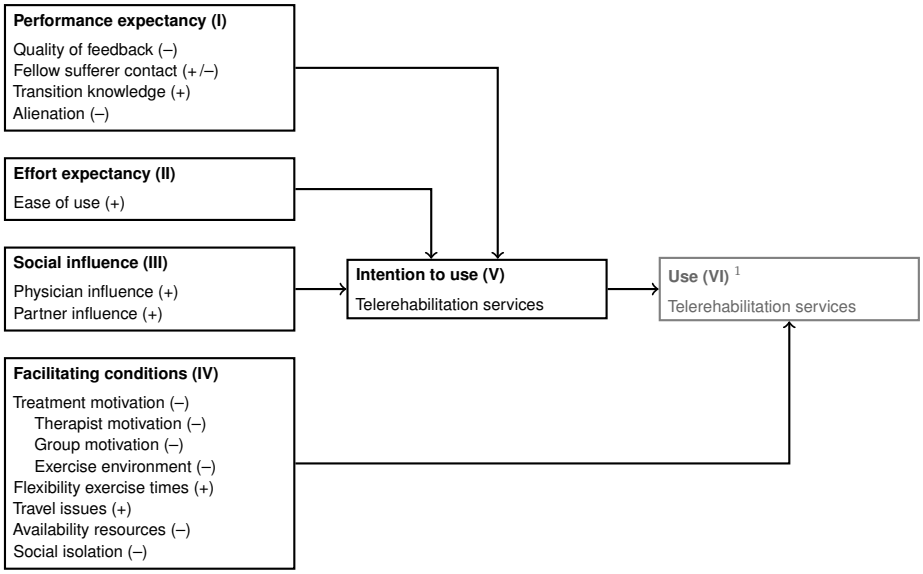

Figure 2.1: *Revealed themes, using the UTAUT as organising structure, relating to patients' perceptions of prospective home telerehabilitation services (the – and + signs indicate whether these perceptions were negative or positive).*
[1] *The UTAUT construct 'use' was not explored during this research.*

Performance expectancy (I)

Performance expectancy relates to the degree that a patient believes the use of telerehabilitation would improve his or her health outcome. With regard to all home-based telerehabilitation scenarios presented, patients perceived the benefit of learning skills outside the clinic. However, a majority of the patients also expressed worries concerning the quality of feedback, the possibility of fellow sufferer contact and the feeling of alienation.

Quality of feedback First, all of the patients were concerned with the quality of feedback provided regarding their movement when exercising at home without their therapist physically present. For all scenarios presented, the majority stressed the importance of receiving feedback from a therapist during each exercise session. Patients felt insecure about their own exercise abilities and were afraid something would go wrong in absence of the face-to-face supervision of a therapist. With respect to the web camera scenario a patient mentioned:

> *Then you're at home with a video screen and he explains something to you... what if you don't do it right and you can't correct yourself, then what?*
>
> *(female participant, 23)*

Generally, patients expected their therapist to touch them during therapy:

> *A physiotherapist just tries to explain to you accurately which muscles you have to tense and also lets you feel it. Via the Internet that is impossible.*
>
> *(female participant, 59)*

However, feedback by means of touching and feeling did not seem equally important to everyone:

> *I mean, the therapist doesn't always have to touch you of course.*
>
> *(male participant, 37)*

In addition, some patients indicated that their need for physical contact diminished during their treatment as they became more familiar with their exercises. These patients had less concerns about the quality of feedback provided at a distance, as with the web camera consultation scenario; however, their perceptions of the sensor feedback scenario differed greatly. One half of the sample doubted the prospective sensor system could provide correct feedback about their exercise performances. The other half was positive about the sensor system. They thought it could provide even more accurate feedback than a therapist. Nevertheless, most of them still preferred face-to-face contact to discuss the feedback. Concerning the web-based exercise scenario, patients were enthusiastic about the video files used for exercise instructions, but stressed the need for feedback from their therapist during their exercise sessions.

Fellow sufferer contact Some patients perceived all the telerehabilitation scenarios disadvantageous with respect to fellow sufferer contact, as none of the scenarios offered fellow sufferer contact. They considered this contact important for the provision of emotional support during the rehabilitation process:

> *Because... with a physiotherapist you can open up your heart, but he doesn't know what you feel, how you feel. And then at home you can, as in my case, tell your mother and your sister, but they don't really get it.*
>
> *(female participant, 23)*

In addition, contact with fellow sufferers gave patients the opportunity to share advice and to learn from each other by watching and copying during exercise:

> *You learn from each other... you can give each other a bit of advice.*
>
> *(female participant, 55)*

One male patient (participant, 23) suggested that contact with fellow sufferers could be preserved within telerehabilitation by organizing chat sessions with other patients or by developing a forum. Not every patient, however, appreciated fellow sufferer

contact. These patients perceived all telerehabilitation scenarios to be beneficial, with respect to the lack of fellow-sufferer contact, as they felt they had plenty of problems of their own and had no need to hear other patients' problems:

> *All of these people moaning. Some people complain about it a lot, don't they?*
>
> *(female participant, 54)*

Transition knowledge The majority of the patients perceived the advantage of acquiring the exercise skills at home, outside the rehabilitation setting. For them, all telerehabilitation scenarios would make it easier to integrate exercise as a routine into their daily life. Patients expected this to enhance the effectiveness of their treatment.

Alienation In addition, the majority of the patients commented on the effects of home-based telerehabilitation on the patient-therapist relationship. Patients thought the limited face-to-face contact with their therapist would limit emotional bonding and subsequently treatment results. They considered pain rehabilitation as both a physical and emotional process. As a consequence, it was important for them to talk to their therapist in person and to share their feelings. Although web camera consultation would enable communication with their therapist, most patients expressed a feeling of alienation when they imagined themselves communicating remotely:

> *It's just so... detached.* *(female participant, 26)*

Some felt that when communicating via web camera, the therapist might fail to notice emotions as well as new complaints about pain. In addition, others felt it would be more difficult to share feelings with someone by means of a web camera than with in vivo contact. In general, telerehabilitation was associated with an impersonal approach:

> *I feel that with [the webcam scenario]... you are a bit like a number.*
>
> *(female participant, 26)*

Some patients, however, acknowledged their feelings about alienation could be the result of their unfamiliarity with remote communication systems:

> *Perhaps it takes time getting used to it.* *(male participant, 23)*

Patients who did not feel the need for an emotional bond with their physiotherapist, pointed out that video communication could work well.

Effort Expectancy (II)

Alongside the construct of performance expectancy, patients reflected on themes relating to the UTAUT construct of effort expectancy. This construct is defined as the degree

of ease that a patient associates with the use of telerehabilitation. With regard to all telerehabilitation scenarios, most patients expected that the software or equipment would be easy to use or would be designed to be user friendly.

For both the web camera consultation and web-based exercise scenario, operating the video communication system and the use of internet was considered easy by most patients. Some of them had already experienced this form of communication. One patient expressed reservations about the use of a web camera:

> *Well, I think that the camera brings about a lot of clumsiness.*
>
> *(male participant, 27)*

With regard to the sensor based scenario, the majority of participants thought that the use of the sensors would not be problematic. One patient mentioned she did not want to spend time learning how to work with technology:

> *[...] because I don't have that much understanding [of technology], I will have to learn it all first. If I have to spend my time on it then I have better things to do regarding my treatment.* *(female participant, 59)*

Social influence (III)

In this study, social influence, the third UTAUT construct, is defined as: patients' perceptions whether people that are important to them think that they should choose a certain treatment. These norms are influenced by peers such as family, friends and partners on the one hand, and by professionals on the other hand. For all home based scenarios, participants stated that it would be pleasant for them if their social environment held a positive attitude toward the treatment but that this would not be a deciding factor. In addition, some participants associated the clinic with professionalism. As a result, they would rely on the advice of the rehabilitation clinic and their therapist:

> *There is so much knowledge around. You [the rehabilitation clinic] will know better what works best.* *(female participant, 59)*

Facilitating conditions (IV)

Patients reflected on themes relating to the facilitating conditions construct of the UTAUT, which embodies three different constructs of perceived behavioural control, facilitating conditions and compatibility. These constructs capture the user's perceptions of their ability to perform the behaviour and measure the degree to which the treatment fits with the user's existing values, previous experiences and current needs [22].

Patients, who did not consider themselves very self-disciplined in particular, reflected on the construct of perceived behavioural control. For all telerehabilitation scenarios, they expected telerehabilitation to negatively affect their treatment compliance because of reduced motivational stimulus resulting from remote therapist and fellow sufferer contact and training in the home environment. In addition to the perceived internal barrier of motivation, some patients reflected on external barriers (facilitating conditions) as they found resources were lacking, such as exercise space and telerehabilitation equipment. Finally, a majority of the patients perceived benefits such as reduced travel times and flexibility of exercise times, both relating to the compatibility construct. These patients thought telerehabilitation would be more compatible with their needs and way of life, compared to conventional care. On the other hand, some patients reflected negatively on the compatibility construct as they thought telerehabilitation would lead to social isolation.

Treatment motivation The majority of the patients felt that all telerehabilitation scenarios would negatively affect their treatment motivation. Patients reflected on three sources from which they derived motivational stimuli, namely their therapist, fellow sufferers and their exercise environment.

Therapist motivation Some patients considered their therapist as the one who could motivate them at times when they had difficulties with exercising. These participants often stressed the importance of supervision by their therapist:

> *Well, in my case there must always be someone around, because I feel like... I can't do it... you know... then I quit.* *(male participant, 23)*

Therefore, some patients considered both the web-based exercise and the sensor-based scenario motivating as their efforts were tracked. With regard to the web-based exercise scenario, patients commented on the fact that the system required them to log on to a personal account. While this seemed to motivate some, others pointed out the possibility of fooling the system:

> *And that he [the therapist] can see, based on your login and your exercises, how often and when you exercise, and things like that. I find that... very risky as I could think: "I'm not in the mood for performing exercises but I'll just log in so [the therapist] will think that I've done them anyway."*
>
> *(female participant, 23)*

There was also a group of patients who thought it was their job to motivate themselves:

> *It is me I am doing this therapy for, not the physiotherapist.*
>
> *(male participant, 44)*

This group did not foresee any problems in training individually with distant supervision.

Group motivation Furthermore, patients who did not consider themselves as self-disciplined in particular, found it motivating to train in groups. For these patients it was important to be motivated by others:

> *[. . .] you stir each other up a little and you don't want to be inferior to one another.* *(female participant, 23)*

They thought that all home based exercise scenarios would be less motivational than group training at a clinic. Nonetheless, some participants preferred treatment in the home setting because they considered the group process to be inhibiting. One female participant (47) thought she would express feelings more openly during individual treatment. One male (23) expressed feeling shame when exercising in a group. He felt de-motivated by the fact that he, a younger person surrounded by older people, was so disabled.

Exercise environment Patients highlighted the fact that all scenarios presented would have an impact on their motivation to exercise. Most patients felt more hesitation to cancel an appointment at the clinic, than to decide to skip exercise at home in the case of telerehabilitation:

> *[. . .] I mean, I have to sit at home and exercise a little bit, this may be easy, but. . . but it's also the going out, that you go somewhere and that you have an appointment, and then you must do it.* *(female participant, 41)*

In addition, some patients considered the house a more distracting environment:

> *Someone might just ring the doorbell. People can call.* *(female participant, 36)*

Some patients stressed they wanted to keep their home environment separate from their treatment environment:

> *Well, and then you go [to the clinic]. You forget about work. You do have to follow therapy and everything. . . It affects my state of mind. You are completely out of your home environment.* *(male participant, 44)*

Though some patients favoured a separation of their home and rehabilitation environment, there were patients who preferred a home-based treatment because they found the home environment more private and comfortable.

Availability of resources All participants mentioned the necessity of resources for the use of home telerehabilitation programs. Some patients reported a lack of exercise space, lack of exercise equipment or the absence of a personal computer and internet connection. However, the majority of the patients reported exercise space would be available to them and expected that the technical resources and equipment would be provided by the rehabilitation clinic.

Flexibility exercise times Participants perceived flexibility as the main advantage of the telerehabilitation scenarios. Telerehabilitation was expected to be more compatible with daily life:

> *No longer hurried, I have to go [to the clinic]. You can fit your treatment into your own rhythm.* *(female participant, 47)*

Patients liked the idea of being able to perform their exercises early in the morning or late in the evening, before and after work as they were not reliant on their clinic's or therapist's availability. This perceived advantage applied most particularly to the web-based and sensor based telerehabilitation scenario. One patient (male, 28) even proposed the possibility of exercising at work. Although most people thought of flexibility as an advantage, a minority still preferred exercising at fixed times. They thought that otherwise they would fail to give priority to exercising or would just forget to exercise.

Travel issues Some participants stressed the physical and mental exhaustion of travelling to the clinic:

> *Well, at the time [of treatment] I had a lot of trouble with driving. Especially when it's somewhat busier then it's hard. Then you are already tired by the time you arrive...* *(male participant, 28)*

Others experienced physical pain during the journey from their homes to the clinic:

> *Every bump I take hurts.* *(female participant, 23)*

In addition, patients who relied on others to get to the clinic felt they were being a burden to their care givers. Participants with a job or other commitments in particular, perceived the advantages of reduced travel time and reduced travel expenses with respect to the telerehabilitation scenarios.

Social isolation Some patients considered social isolation as a consequence of home based exercise treatment. Going to the clinic was considered as an opportunity to get out of the house:

> *Yes, then you're sitting at home... for me that plays a role, you know, because if I don't take precautions, as I am not studying and don't have a job, then I will be at home all day long.* *(male participant, 27)*

In addition, the clinic-based treatment offered them the opportunity of meeting other people.

Intention to use (V)

Finally, we asked patients about their intentions to use any of the potential telerehabilitation services presented to them. With respect to all telerehabilitation scenarios patients were willing to use the technologies described. However, they attached great value to therapist face-to-face contact and would rather not use these technologies as replacement of clinic-based care. Instead they preferred to use these technologies during follow-up care or as additional care to complement their regular care at the clinic.

Discussion

The central aim of this study was to explore chronic pain patients' perceptions of prospective telerehabilitation services and to determine the factors important to them. Patients perceived telerehabilitation to have certain benefits over conventional care. However, at present none of the participants would consider telerehabilitation as an autonomous treatment as they expressed concerns relating to UTAUT construct of performance expectancy. For instance, patients highly valued face-to-face contact with their therapist as they considered being touched by a professional essential for effective feedback and exercise instructions. This was especially important during the first phases of treatment and diminished for some when they became more confident with exercising. A study of Escolar-Reina et al. [24] confirms the importance of adequate feedback and instructions to reduce pain patients' insecurity when exercising at home.

Some participants were willing to accept less physical presence later on in their treatment, if feedback about their movements was provided by means of a sensor based system. Half of the participants, however, remained sceptical about the quality of feedback that such a system would provide. This scepticism is probably the result of a lack of exposure to telerehabilitation technologies [25] and the fact that patients still consider physiotherapy as a predominantly 'hands on' practice. Secondly, face-to-face contact with a therapist was considered important for receiving emotional support during treatment. This coincides with the role psychological behavioural mechanisms play in chronic pain [26]. Patients expressed concerns that remote communication would lead to a feeling of alienation. This concern could be the effect of unfamiliarity

with working with remote communication systems [27]. In addition, some patients expressed dependence on the physical presence of their therapist to motivate them to finish their exercise regimen. These patients were concerned that telerehabilitation treatment could result in a loss of motivation and therefore be less effective. This dependence on medical professionals is documented in earlier research about chronic low back pain [28, 29]. A smaller number of patients indicated they did not feel the need to be motivated by others.

In addition to face-to-face therapist contact, fellow-sufferer contact arose as an important theme, grouped under the construct of performance expectancy. This fellow-sufferer contact was considered particularly important for emotional support and for exchange of illness related information. This finding fits with previous studies on the importance of support groups [30–32].

In addition, most patients made use of the group to motivate themselves to work harder and to adhere to their exercise regimen. This is explained by the social comparison theory of Festinger [33]. This theory states that individuals, especially in western cultures, have the desire to evaluate their performance in comparison with others who are similar to them and draw motivation from this as they feel pressure to improve their abilities accordingly [34].

Patients valuing fellow sufferer contact expressed concerns that telerehabilitation would reduce fellow sufferer contact and their motivation to exercise. Although one patient pointed out the possibility of virtual support groups, most patients stressed the importance of the physical presence of one another. Further research is needed to investigate if virtual group support could replace the need for the physical presence of fellow sufferers. Some patients on the other hand, felt that group exercise was inhibiting. This effect is also found in bladder patients [35] and in chronic low back patients who expressed feelings of embarrassment when training in a group [36]. For these patients, telerehabilitation treatment would address their desire to exercise privately. Patients also valued individual treatment as they felt their individual needs would not be addressed during group exercises.

Besides the UTAUT construct of performance expectancy, most of the subthemes arose under the construct facilitating conditions. Among them was flexibility which the participants regarded as the most important advantage of home based telerehabilitation. Patients stated they could exercise whenever they liked and avoid travelling to the clinic during working hours. In addition, the home environment was preferred by some as it offered privacy and a relaxing environment. Some patients considered training in the home environment beneficial as exercise skills would be acquired at

home and could be implemented in daily life. These findings are confirmed by other studies [37, 38].

Nonetheless, for most participants the flexibility of time and location was inferior to the advantages of the conventional treatment. Although travelling to the clinic could be exhausting and time-consuming, some patients found it a good way 'to get out of the house' and meet other people. This finding accords with other research [39]. As half of our research sample was unemployed, this could be a possible explanation for their need for social contacts. In addition, some patients stated they wanted to keep their home environment separate from their treatment environment and would therefore accept the travel time. A review regarding home based rehabilitation elucidates this possible intrusion caused by home based care as it brings clinical care to the 'safe haven' of the home environment [40].

In addition, patients thought that the atmosphere in the clinic kept them more focused than they would be in their home environment. For them, training in the home environment would result in a loss of motivation to exercise. This is explained by Hale et al. [38] who state that within the home environment there is the need for internal motivation, while in the clinical setting, the motivation for therapy may come from the setting itself.

Finally, some patients stressed that it would be difficult to engage in telerehabilitation as their homes were not suited to becoming exercise areas due to a lack of space. These results are in concordance with a study by Stephenson and Wiles [41].

These results make it clear that the UTAUT constructs perceived usefulness and facilitating conditions offer a good starting point in structuring and understanding patients' perceptions of prospective telerehabilitation services. In relation to the UTAUT constructs social norm and ease of use, fewer themes arose. Those that did were of less concern according to the interviewed patients. Few patients commented on the way their peers would react to telerehabilitation and if so, they commented that their peers would support them during their treatment. In addition, most of the patients did not expect to have problems when using the software or equipment needed for telerehabilitation. This is in concordance with earlier literature. Taylor and Todd [42] point out that, users without prior experience are more likely to view the use of technology in terms of perceived usefulness.

Limitations

The sample size of this study is small, which limits the ability to generalize these findings. However, the use of maximum variation allowed for a wide range of perceptions regarding prospective telerehabilitation services. Future quantitative studies

are needed to further explore patients' perceptions of these services and to investigate whether patterns in the patients' characteristics might explain their perceptions regarding telerehabilitation.

In addition, we intentionally used scenarios that each depicted a different functionality of telerehabilitation, thereby representing telerehabilitation as a total replacement of clinic-based care. Although this method has provided insight into patients' perceptions about the pros and cons of telerehabilitation, future studies should investigate patients' perceptions with regard to more realistic scenario's by, for example, exploring patients' perceptions of telerehabilitation as a partial replacement of clinic-based care and by presenting scenarios that combine different modalities of telerehabilitation (e.g. a web-based exercise program with sensor monitoring).

Furthermore, patients who participated in this study had no prior experience with telerehabilitation services. As limited telerehabilitation services exist at this point in time, patients' perceptions regarding telerehabilitation are solely based on their expectations. However, all participants were familiar with physiotherapy treatment; twelve participants already experienced the clinic-based rehabilitation program. Therefore, they were able to elaborate on the pros and cons of conventional versus prospective telerehabilitation services. Further research should investigate the role of prior experience with telerehabilitation on patients' perceptions regarding these services.

Conclusions

A central aim of this study was to explore chronic pain patients' perceptions towards future telerehabilitation services and to determine the factors important to them. The main findings reveal that patients valued the benefits of telerehabilitation and considered telerehabilitation especially helpful as a complement or follow up to conventional treatment. However, none of them would consider telerehabilitation as an autonomous treatment as they as they felt that the perceived benefits do not override their perceived barriers regarding the use of telerehabilitation. These barriers included doubts about the effectiveness of telerehabilitation because of diminished face-to-face therapist contact, fellow sufferer contact and feelings of alienation. In addition, patients mentioned the internal barrier of motivation, stressing that telerehabilitation would result in a loss of motivational stimuli eventually leading to lower treatment compliance. Future research should investigate whether these perceived barriers are the result of unfamiliarity with telerehabilitation services and could therefore be overcome by giving more information to increase patients' confidence in these services and eliminate misunderstandings about it. In addition, research should focus on careful selection of appropriate target groups and on the adaptation and design of

technologies to overcome reported drawbacks.

Our research also shows that the Unified Theory of Acceptance and Use of Technology (UTAUT) [22] is a useful organising structure in which to study patients' willingness to use prospective telerehabilitation applications and has made the UTAUT constructs more context-specific for telerehabilitation. Future quantitative studies are needed to further explore patients' intention to use prospective telerehabilitation services.

References

1. Breivik H, Collett B, Ventafridda V, Cohen R and Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 2006; **10:** 287–333.
   DOI: 10.1016/j.ejpain.2005.06.009.
2. Lahad A, Malter AD, Berg AO and Deyo RA. The effectiveness of four interventions for the prevention of low back pain. *The Journal of the American Medical Association*, 1994; **272:** 1286–1291.
   DOI: 10.1001/jama.1994.03520160070046.
3. Jensen MP, Nielson WR, Turner JA, Romano JM and Hill ML. Changes in readiness to self-manage pain are associated with improvement in multidisciplinary pain treatment and pain coping. *Pain*, 2004; **111:** 84–95.
   DOI: 10.1016/j.pain.2004.06.003.
4. Blyth FM, March LM, Brnabic AJ and Cousins MJ. Chronic pain and frequent use of health care. *Pain*, 2004; **111:** 51–58.
   DOI: 10.1016/j.pain.2004.05.020.
5. Rainville J, Hartigan C, Martinez E, Limke J, Jouve C and Finno M. Exercise as a treatment for chronic low back pain. *The Spine Journal*, 2004; **4:** 106–115.
   DOI: 10.1016/S1529-9430(03)00174-8.
6. Fordyce W, McMahon R, Rainwater G et al. Pain complaint-exercise performance relationship in chronic pain. *Pain*, 1981; **10:** 311–321.
   DOI: 10.1016/0304-3959(81)90091-9.
7. Tulder MW van, Koes BW and Bouter LM. Conservative treatment of acute and chronic nonspecific low back pain. A systematic review of randomized controlled trials of the most common interventions. *Spine*, 1997; **22:** 2128–2156.
   DOI: 10.1097/00007632-199709150-00012.
8. Tulder MW van, Malmivaara A, Esmail R and Koes BW. Exercise therapy for low back pain. *Cochrane Database of Systematic Reviews (Online)*, 2000**:** CD000335.
   DOI: 10.1002/14651858.CD000335.

9. Ostelo RW, Tulder MW van, Vlaeyen JW, Linton SJ, Morley SJ and Assendelft WJ. Behavioural treatment for chronic low-back pain. *Cochrane Database of Systematic Reviews (Online)*, 2005**:** CD002014.
DOI: 10.1002/14651858.CD002014.pub2.

10. Blanchard CM, Courneya KS, Rodgers WM et al. Is the theory of planned behavior a useful framework for understanding exercise adherence during phase II cardiac rehabilitation? *Journal of Cardiopulmonary Rehabilitation*, 2003; **23:** 29–39.
DOI: 10.1097/00008483-200301000-00007.

11. Rimmer JH, Wang E and Smith D. Barriers associated with exercise and community access for individuals with stroke. *Journal of Rehabilitation Research & Development*, 2008; **45:** 315–322.
DOI: 10.1682/JRRD.2007.02.0042.

12. Rosen MJ. Telerehabilitation. *NeuroRehabilitation*, 1999; **12:** 11–26.

13. Temkin AJ, Ulicny GR and Vesmarovich SH. Telerehab. A perspective of the way technology is going to change the future of patient treatment. *Rehab Management*, 1996; **9:** 28–30.
PMID: 10166562.

14. Agrell H, Dahlberg S and Jerant AF. Patients' Perceptions Regarding Home Telecare. *Telemedicine and e-Health*, 2000; **6:** 409–415.
DOI: 10.1089/15305620050503889.

15. Ruland CM and Moore SM. Eliciting exercise preferences in cardiac rehabilitation: initial evaluation of a new strategy. *Patient Education and Counseling*, 2000; **44:** 283–291.
DOI: 10.1016/S0738-3991(00)00189-0.

16. Baar JD van, Joosten H, Car J et al. Understanding reasons for asthma outpatient (non)-attendance and exploring the role of telephone and e-consulting in facilitating access to care: exploratory qualitative study. *Quality & Safety in Health Care*, 2006; **15:** 191–195.
DOI: 10.1136/qshc.2004.013342.

17. Jones M, Jolly K, Raftery J, Lip GY and Greenfield S. 'DNA' may not mean 'did not participate': a qualitative study of reasons for non-adherence at home- and centre-based cardiac rehabilitation. *Family Practice*, 2007; **24:** 343–357.
DOI: 10.1093/fampra/cmm021.

18. Brattberg G. Internet-based rehabilitation for individuals with chronic pain and burnout: a randomized trial. *International Journal of Rehabilitation Research*, 2006; **29:** 221–227.
DOI: 10.1097/01.mrr.0000210055.17291.f5.

19. Buhrman M, Faltenhag S, Strom L and Andersson G. Controlled trial of Internet-based treatment with telephone support for chronic back pain. *Pain*, 2004; **111:** 368–377.
DOI: 10.1016/j.pain.2004.07.021.

20. Kotarba JA and Seidel JV. Managing the problem pain patient: compliance or social control? *Social Science & Medicine*, 1984; **19:** 1393–1400.
DOI: 10.1016/0277-9536(84)90029-7.

21. Donovan JL and Blake DR. Patient non-compliance: deviance or reasoned decision-making? *Social Science & Medicine*, 1992; **45:** 507–513.
DOI: 10.1016/0277-9536(92)90206-6.

22. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478.
DOI: 10.2307/30036540.

23. Patton MQ. Qualitative Evaluation and Research Methods. London: Sage Publications Ltd, 1990.

24. Escolar-Reina P, Medina-Mirapeix F, Gascón-Cánovas JJ et al. How do care-provider and home exercise program characteristics affect patient adherence in chronic neck and back pain: a qualitative study. *BMC Health Services Research*, 2010; **10:** 1–8.
DOI: 10.1186/1472-6963-10-60.

25. Theodoros D and Russell T. Telerehabilitation: current perspectives. *Studies in Health Technology and Informatics*, 2008; **131:** 191–209.
PMID: 18431862.

26. Verhaak PF, Kerssens JJ, Dekker J, Sorbi MJ and Bensing JM. Prevalence of chronic benign pain disorder among adults: a review of the literature. *Pain*, 1998; **77:** 231–239.
DOI: 10.1016/S0304-3959(98)00117-1.

27. Harrison R, MacFarlane A, Murray E and Wallace P. Patients' perceptions of joint teleconsultations: a qualitative evaluation. *Health Expectations*, 2006; **9:** 81–90.
DOI: 10.1111/j.1369-7625.2006.00368.x.

28. Klaber Moffett JA and Richardson PH. The influence of the physiotherapist-patient relationship on pain and disability. *Physiotherapy Theory and Practice*, 1997; **13:** 89–96.
DOI: 10.2522/ptj.20090245.

29. Cook FM and Hassenkamp A-M. Active rehabilitation for chronic low back pain: The patients' perspective. *Physiotherapy*, 2000; **86:** 61–68.
DOI: 10.1016/S0031-9406(05)61207-2.

30. Ng P and Chan W. Group psychosocial program for enhancing psychological wellbeing of people with systemic lupus erythematosus. *Journal of Social Work in Disability and Rehabilitation*, 2007; **6:** 75–87.
DOI: 10.1300/J198v06n03_05.

31. Subramaniam V, Stewart MW and Smith JF. The development and impact of a chronic pain support group: A qualitative and quantitative study. *Journal of Pain and Symptom Management*, 1999; **17:** 376–783.
DOI: 10.1016/S0885-3924(99)00012-3.

32. Weis J. Support groups for cancer patients. *Supportive Care in Cancer*, 2003; **11:** 763–768.
DOI: 10.1007/s00520-003-0536-7.

33. Medina-Mirapeix F, Escolar-Reina P, Gascón-Cánovas JJ, Montilla-Herrador J and Collins SM. Personal characteristics influencing patients' adherence to home exercise during chronic pain: a qualitative study. *Journal of Rehabilitation Medicine*, 2009; **41:** 347–352.
DOI: 10.2340/16501977-0338.

34. Festinger L. A theory of social comparison processes. *Human Relations*, 1954; **7:** 117–140.
DOI: 10.1177/001872675400700202.

35. Wood JV. Theory and research concerning social comparisons of personal attributes. *Psychological Bulletin*, 1989; **106:** 231–248.
DOI: 10.1037/0033-2909.106.2.231.

36. Karvinen KH, Courneya KS, Venner P and North S. Exercise programming and counseling preferences in bladder cancer survivors: a population-based study. *Journal of Cancer Survivorship*, 2007; **1:** 27–34.
DOI: 10.1007/s11764-007-0010-5.

37. Cooper K, Smith BH and Hancock E. Patient-centredness in physiotherapy from the perspective of the chronic low back pain patient. *Physiotherapy*, 2008; **94:** 244–252.
DOI: 10.1016/j.physio.2007.10.006.

38. Hale L, Bennett D, Bentley M, Crawshaw A and Davis H. Stroke rehabilitation - Comparing hospital and home-based physiotherapy: the patient's perception. *New Zealand Journal of Physiotherapy*, 2003; **31:** 84–92.

39. Tamm M. What does a home mean and when does it cease to be a home? Home as a setting for rehabilitation and care. *Disability and Rehabilitation*, 1999; **21:** 49–55.
DOI: 10.1080/096382899297963.

40. Thomas C and Parry A. Research on users' views about stroke services: Towards an empowerment research paradigm or more of the same? *Physiotherapy*, 1996; **82:** 6–12.
DOI: 10.1016/S0031-9406(05)66991-X.

41. Stephenson S and Wiles R. Advantages and disadvantages of the home setting for therapy: views of patients and therapists. *British Journal of Occupational Therapy*, 2000; **63:** 59–64.
DOI: 10.1177/030802260006300203.

42. Taylor S and Todd P. Assessing IT usage: The role of prior experience. *MIS Quarterly*, 1995; **19:** 561–570.
DOI: 10.2307/249633.

3

Towards patient-centred telerehabilitation design: understanding chronic pain patients' preferences for web-based exercise telerehabilitation using a discrete choice experiment

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Abstract

Background Patient-centred design, addressing patients' preferences and needs, is considered an important aim for improving healthcare systems. At present, within the field of pain rehabilitation, patients' preferences regarding telerehabilitation remain scarcely explored and little is known about the optimal combination between human and electronic contact from the patients' perspective. In addition, limited evidence is available about the best way to explore patients' preferences. Therefore, the assessment of patients' preferences regarding telemedicine is an important step towards the design of effective patient-centred care.

Objective To identify which telerehabilitation treatment options patients with chronic pain are most likely to accept as alternatives to conventional rehabilitation and to assess which treatment attributes are most important to them.

Methods A discrete choice experiment with fifteen choice tasks, combining six telerehabilitation treatment characteristics, was designed. Each choice task consisted of two hypothetical treatment scenarios and an opt-out scenario. Relative attribute importance was estimated using a bivariate probit regression analysis. One hundred and thirty surveys were received, of which 104 usable questionnaires, resulting in 1547 observations, were included in analysis.

Results Physician communication mode, the use of monitoring and feedback technology (FMT) and exercise location were key drivers of patients' treatment preferences ($p<0.001$). Patients were willing to accept less frequent physician consulting offered mainly through video communication, provided that they were offered FMT, some face-to-face consulting and could exercise outside their home environment at flexible exercise hours. Home-based telerehabilitation scenarios with minimal physician supervision were the least preferred. A reduction in healthcare premiums would make these telerehabilitation scenarios as attractive as conventional clinic-based rehabilitation.

Conclusions 'Intermediate' telerehabilitation treatments, offering FMT, some face-to-face consulting and a gym-based exercise location, should be pursued as promising alternatives to conventional chronic pain rehabilitation. Further research is necessary to explore whether strategies other than healthcare premium reductions could also increase the value of home telerehabilitation treatment.

Introduction

Chronic pain and treatment

Chronic pain is considered a major public health problem. Breivik et al [1] explored the prevalence of chronic pain in 15 European countries and Israel and found that 19% ($n = 8815$) of their study sample suffered from chronic pain varying from moderate to severe intensity. Due to an ageing society, it is expected that the prevalence of chronic pain may rise even higher, as chronic pain prevalence is greater in older adults [2, 3]. Chronic pain often interferes with family and home responsibilities, recreational activities [1], and sleep [4], and it is linked with an increased risk of depression [5]. In addition to the physical and emotional burden chronic pain brings, it accounts for considerable direct health care costs, including costs related to tests, medication, and treatment, as well as indirect costs such as lost income and reduced work productivity [6]. In European countries, pain is estimated to cost economies between 3% and 10% of gross domestic products [4], resulting in an estimate of at least € 140 billion [7].

Physical training has been proven to decrease pain and improve function [8–10] and therefore plays an important role in current (multidisciplinary) pain rehabilitation programs. The majority of these programs are clinic-based and supervised [11]. Although conventional rehabilitation programs are effective, poor adherence and high relapse have been shown to compromise the effectiveness of these programs [11–14] and as such lead to increased costs [15].

Patient-centred design

An important factor in facilitating treatment adherence is the design of patient-centred treatment programs [16–18]. The Institute of Medicine defines patient-centred care as "providing care that is respectful of, and responsive to, individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions" [19]. The concept of patient-centred care has received increased attention in recent years and is considered an important aim for health care system improvement [19, 20].

Clinical guidelines for the management of chronic pain follow up on this patient-centred approach and recommend that patient preferences should be considered and that treatment programs should be individualized [21]. The underlying assumption is that by designing programs that address patients' preferences and beliefs, treatment adherence will improve [22]. In addition, there is evidence that patient preferences affect treatment outcome. A systematic review found an increase in the effectiveness of the treatment among participants in musculoskeletal medicine trials, who were randomized to their preferred treatment compared with those who were indifferent to the treatment allocation [23]. In addition, patients' preferences should be respected on

the basis of moral grounds alone regardless of their relationship to the health outcomes [24].

The assessment of chronic pain patients' preferences is, therefore, a necessary first step toward the design of patient-centred pain rehabilitation programs that help better meet patients' needs. The gap between what patients prefer and what is offered can be identified, and treatment may be optimized [22].

One method to estimate patients' preferences is the use of a discrete choice experiment (DCE). A DCE is a preference elicitation methodology that is being increasingly used in health care research [25, 26]. Respondents are offered a series of choices between two or more treatment alternatives, described by a combination of treatment attributes, and choose their preferred treatment. Analysis of these choices allows for the estimation of the relative importance of treatment attributes. A DCE can assist in prioritizing health care resource allocation, as it provides a better understanding of the factors that are most important to patients and can be used to inform patient-centred telerehabilitation design. In addition, the use of DCEs is especially valuable in the context of innovative treatments, for example, chronic pain telerehabilitation treatment, as it allows for the estimation of patients' preferences for multiple treatment scenarios that do not yet exist.

Telerehabilitation

In recent years, the use of telerehabilitation, providing remote delivery of rehabilitative services through Internet and communication technology, has been steadily increasing [27]. Systematic reviews have demonstrated that telerehabilitation has small but significant effects on pain experience and reduction in functional disability [28–30]. A review by Kairy et al [27] concluded that telerehabilitation can lead to clinical outcomes that are similar to those of traditional rehabilitation programs. Telerehabilitation is considered a promising alternative strategy next to conventional clinic-based rehabilitation programs, as it can facilitate access and adherence to health interventions [31]. Since pain rehabilitation involves changes in often long-lasting personal behaviour and lifestyle, it is important that patients are able to use the acquired skills outside of the rehabilitation clinic. However, as most rehabilitation programs are supervised and provided in clinics, they may not be conducive to fostering maintenance or compliance in patients' natural environments [11]. Telerehabilitation, offering care in the patients' environment, can be a better fit with the patient's lifestyle, and by doing so, translation of the acquired skills into the patients' environment will become easier [16, 32]. Furthermore, telerehabilitation has the potential to foster patient self-management [33]. For example, performance can be monitored and feedback can be provided on progress

without the real-time involvement of a therapist, which perhaps will empower patients to take an active role in their own rehabilitation [34]. Self-management is especially encouraged in patients with a long-term condition such as chronic pain and has been shown to improve patient outcomes [35]. International clinical practice guidelines endorse the promotion of self-management behaviour, including physical activity, for chronic pain patients as an important component of care [21, 36]. In a systematic review, Liddle et al [37] found that educating chronic pain patients about appropriate exercise and function activity to promote active self-management is effective.

At present, within the field of pain rehabilitation, patients' preferences of telerehabilitation remain scarcely explored and little is known about the optimal combination between human and electronic contact from the patients' perspective. In addition, limited evidence is available about the best way to explore patients' preferences. To our knowledge, this is the first study in the field of telemedicine that uses a DCE to explore what patients want as well as explore their priorities. As telerehabilitation represents a fundamental change from conventional treatment programs, it is vital to understand patients' preferences, and DCEs may prove to be invaluable, as the market potential of different prospective telerehabilitation services can be simulated.

Therefore, this study aims to identify chronic pain patients' preferences for telerehabilitation services using a DCE. The primary objective is to determine what treatment attributes are most important to chronic pain patients and identify which telerehabilitation scenario chronic pain patients are most likely to accept as an alternative to conventional rehabilitation. Conventional rehabilitation was described as physical activity through supervised group exercise at the clinic. The telerehabilitation scenarios that were explored varied at different levels, allowing exploration of the potential benefit of telerehabilitation. Jansen-Kosterink [38] states that the potential value of telemedicine services depends on the technology used, the clinical purpose it serves, and how the telemedicine service is implemented in daily clinic practice (service configuration). To that end, the scenarios explored different types of technology used for different clinical purposes (e.g., monitoring or coaching) and also explored different methods of service configuration (e.g., clinic-based care or home-based treatment). The scenarios represented a continuum of health care services ranging from clinic- based rehabilitation to home-based telerehabilitation with a focus on patient self-management. Furthermore, a willingness to accept (WTA) was estimated to explore whether patients were willing to trade health care premium reduction for more resource-efficient telerehabilitation treatments. To our knowledge, this is the first study in the field of telerehabilitation to assess patients' preferences with a DCE.

Methods

Study design

Implemented as part of a larger survey that explored patients' attitudes toward telerehabilitation, patients' preferences for hypothetical telemedicine treatments were elicited using a self-administered discrete choice survey. The discrete choice experiment followed the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) checklist [39] on patient-preference methods. The following steps were taken: (1) identification of the key treatment attributes and assignment of levels to the attributes; (2) design of the experiment and determination of hypothetical treatment scenarios using various combinations of attributes and levels; (3) choosing an elicitation format and obtaining choice data in patients; and (4) analysis of the choice data. These steps are described in the following section.

Identification of key attributes of telemedicine treatment and assignment of levels

Qualitative interviews with 10 chronic pain patients (6 females, mean age 41.0 years, with pain complaints lasting longer than 6 months) and an expert focus group with 6 professionals (4 rehabilitation therapists, 1 nurse practitioner, and 1 rehabilitation doctor) were used to select the following attributes (Table 3.1) for inclusion in the survey: (1) treatment mode and location, (2) physician contact mode, (3) physician contact frequency, (4) feedback and monitoring technology, (5) program flexibility, and (6) health care premium reduction. The health care premium reduction attribute was used to estimate a 'willingness to accept' value. This value represented a reduction in health care premiums and was used to explore whether patients were willing to trade more expensive conventional rehabilitation services for premium reductions.

Using the 6 attributes, a pilot questionnaire was developed and tested on 15 patients (11 females, mean age 42.5 years, with pain complaints lasting longer than 6 months) attending treatment in the rehabilitation clinic. In the pilot, data were collected on the time taken to complete the questionnaire and the patients' understanding of the questionnaire. Only minor adaptations were made after the pilot tests, in particular regarding the wording of the attributes.

Survey format and scenario development

Patients were offered 15 choice sets consisting of two telemedicine treatment scenarios and one opt-out scenario. They were asked to choose their preferred scenario. The scenarios comprised short statements based on the treatment attributes described earlier. Figure 3.1 represents a questionnaire example. The choice questions were designed

Table 3.1: *Treatment attributes and levels used to construct the rehabilitation scenarios.*

Attributes	Levels
Treatment mode and location	You exercise in a group at the gym You exercise individually at the gym You exercise individually at home You exercise in a virtual group at home
Physician contact mode	All physician contact takes place at the clinic face-to-face One quarter of your physician contact through web camera Three-quarters of your physician contact through web camera All your physician contact takes place through web camera
Physician contact frequency	Every exercise session you will have physician consulting Once per 2 exercise sessions you will have physician consulting Once per 3 exercise sessions you will have physician consulting Once per 4 exercise sessions you will have physician consulting
Feedback and monitoring technology	Use of technology-feedback and monitoring of your exercises No technology-feedback and monitoring of your exercises
Program flexibility	Fixed exercise times Flexible exercise times
Health care premium reduction	No discount € 50 discount € 150 discount € 450 discount

to mimic the 'real' choices, and as such, the opt-out option was included to ensure that the patients were not forced to make a choice between treatments when they might choose neither in practice. The attributes and levels in this study (4 attributes with 4 levels and 2 attributes with 2 levels) resulted in a total of 1024 hypothetical

treatment scenarios. For practical reasons, not all of these could be presented to each respondent. Hence, we employed a commonly used D-optimal experimental design algorithm, which reduced the number of choice sets to the smallest number of choice sets required to generate statistically efficient preference estimates for the treatment attributes included. This resulted in a so-called fractional factorial design, using three versions of the questionnaire, which explored 45 choice sets in total. The resulting questionnaire design was orthogonal and balanced in terms of the number of times each level of an attribute was seen in a scenario. Subjects were randomly assigned to a questionnaire version. Sawtooth software (Sawtooth Software Inc.) was used to design the choice tasks. Prior to choosing between treatment scenarios, all attribute levels were described to the patients.

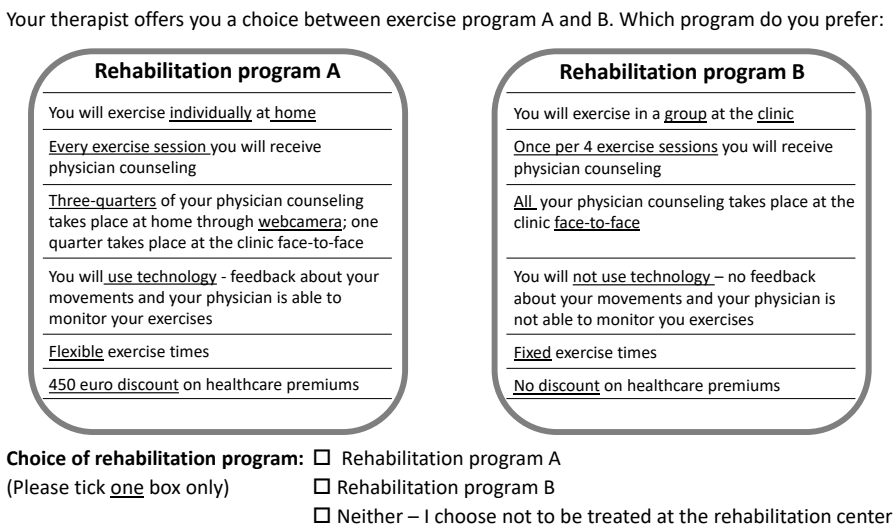

Figure 3.1: *Questionnaire example.*

Survey administration

Patients in this study were recruited from a waiting list of a rehabilitation centre. These patients were waiting to enrol in a group-based supervised exercise program, which was part of the multidisciplinary pain rehabilitation program. In total, 300 questionnaires were administered per mail. Questionnaires were sent to patients' home along with their invitation for a physician-led interview at the clinic. They were asked to return the completed questionnaire during the interview. Subjects were included if they were 18 years or older. Respondents did not receive incentives.

Consistency tests

In addition to the 15 choice sets, three fixed choice sets that were not included in analysis were presented to test patients' response consistency and assess the internal validity of the stated-preference data. Validity was tested in two ways. The first was to include a choice set that presented a dominant scenario to assess whether patients chose the treatment scenario with the best treatment attributes. In this choice set, all treatment attributes of both scenarios were kept the same, except for WTA. Second, two choice sets were included that presented identical scenarios in reversed-order scenarios ('mirror set'). Patients who were inconsistent on both of these validity checks were excluded from the analysis.

Model estimation

The choice between the two alternative scenarios and the status quo can be seen as two choices simultaneously: first, the patient chooses between the status quo and telemedicine treatment, and second, the patient chooses between alternatives A and B. These two choices may depend on each other; that is, depending on the levels of the telemedicine treatment, the preference between status quo and telemedicine may change. We only observe the choice between the two telemedicine treatments when the status quo is not chosen; consequently, we will have complete observations of the first choice but a selected (censored) sample for the second choice. These types of data can be analysed with a bivariate probit model with sample selection [40]. Patients' utility for a telemedicine scenario is specified as linear in treatment attributes, and the utility of no treatment is an alternative- specific constant. Categorical test attributes were effects coded, and WTA was treated as a continuous variable. Accordingly, two functions were used (Textbox 3.1).

The $V_{\text{treatment}}$ β parameters represent relative importance weights, where larger values suggest more preferred attributes. Patient-specific characteristics are constant for any pair of treatment alternatives and cancel out the utility differences unless they are interacted with the uptake parameter. Therefore, patient characteristics were interacted with $D_{\text{no-treatment}}$, which represents a dummy variable indicating that the respondents chose the 'non-option.' The parameters indicate the effect of patients' characteristics on telemedicine treatment uptake. The error terms $\epsilon_{\text{treatment}}$ and $\epsilon_{\text{no-treatment}}$ represent the part of the utility that is unobservable, and these error terms may be correlated with correlation ρ. The following patient characteristics were included in the final regression model: gender, age, education, Internet experience, and work hours.

The relative importance of the treatment attributes is represented by the coefficient estimates of the bivariate probit model. With these estimates, uptake of hypothetical

TextBox 3.1: *Functions.*

$$
\begin{aligned}
V_{\text{treatment}} = & \\
& \beta_{\text{groupgym}} \times D_{\text{groupgym}} + \\
& + \beta_{\text{individualgym}} \times D_{\text{individualgym}} + \\
& + \beta_{\text{individualhome}} \times D_{\text{individualhome}} + \\
& + \beta_{\text{grouphome}} \times D_{\text{grouphome}} + \\
& + \beta_{100\%\text{web camera}} \times D_{100\%\text{web camera}} + \\
& + \beta_{75\%\text{web camera}} \times D_{75\%\text{web camera}} + \\
& + \beta_{25\%\text{web camera}} \times D_{25\%\text{web camera}} + \\
& + \beta_{\text{consultingeverysession}} \times D_{\text{consultingeverysession}} + \\
& + \beta_{\text{consultingper2sessions}} \times D_{\text{consultingper2sessions}} + \\
& + \beta_{\text{consultingper3sessions}} \times D_{\text{consultingper3sessions}} + \\
& + \beta_{\text{FeedbackMonitoringTechnology}} \times D_{\text{FeedbackMonitoringTechnology}} + \\
& + \beta_{\text{fixedsessions}} \times D_{\text{fixedsessions}} + \\
& + \beta_{\text{nodiscount}} \times D_{\text{nodiscount}} + \\
& + \beta_{5\%\text{discount}} \times D_{5\%\text{discount}} + \\
& + \beta_{15\%\text{discount}} \times D_{15\%\text{discount}} + \\
& + \epsilon_{\text{treatment}} \\
V_{\text{no-treatment}} = & \\
& (\beta_0 + \beta_{\text{male}} + \beta_{<45\text{ years}} + \beta_{\text{education}} + \\
& \qquad + \beta_{\text{workhours}} + \beta_{\text{internet}}) \times D_{\text{no-treatment}} + \epsilon_{\text{no-treatment}}
\end{aligned}
$$

telemedicine treatments can be predicted for different levels of incentives and other treatment attributes. For ease of presentation and interpretation, the model results were rescaled from 0 to 10 using a linear transformation of β coefficients from 0 (least desirable level) to 10 (most desirable level). Data were analysed with heckprob function in Stata 11.2 (Statacorp).

Scenario comparison of telerehabilitation treatment

As well as the individual treatment attributes, patients' preferences for five hypothetical telerehabilitation treatments were explored. These scenarios represented a continuum of health care settings ranging from clinic-based rehabilitation to home-based telerehabilitation with a focus on patient self-management and less physician involve-

ment. All five scenarios were considered realistic treatment scenarios from a clinical perspective. One scenario represented conventional clinic-based rehabilitation. The conventional treatment consists of a supervised group-based exercise program at the rehabilitation clinic. The exercise program is part of a multidisciplinary pain rehabilitation program. In every session, exercises are supervised face-to-face by a rehabilitation physician. This conventional scenario was used to determine how patients valued the five telerehabilitation scenarios relative to conventional care. This was estimated with a willingness to accept value that represented a health care premium reduction in euros.

Results

Overview

We received 130 surveys that resulted in a total of 1950 observations from choice sets, with 13 observations missing. Patients who failed to pass both the validity checks were excluded from the analysis, which resulted in 104 usable questionnaires and a total of 1547 observations. The 104 respondents were spread fairly evenly across the three versions, with 42, 31, and 31 patients for versions 1, 2, and 3, respectively.

Respondent demographics

The majority of the research sample (mean age 43.8 years, SD = 14.8) was female (66 out of 104) and had completed a middle-high education (51 out of 104 participants). The majority of the respondents were unemployed (69 out of 104 participants) at the time and had Internet access (97 out of 104 participants). Patients' mean visual analogue scale (VAS) pain score was 6.3 and pain complaints varied in the lower back, hip, knee, joint, and neck areas and lasted longer than 6 months (Table 3.2).

Relative importance of the treatment attributes

The results of this study indicate that physician contact mode, feedback and monitoring technology, health care premium reduction, physician contact frequency, exercise location, and program flexibility are all significant determinants of patients' treatment preference ($p < .001$). The sign and significance of the regression coefficients (Table 3.3) show that respondents preferred to have all physician counselling face-to-face. These face-to-face consultations were preferred over consultations that were offered either entirely or partly via remote video communication. Patients were relatively indifferent as to whether they had 25% or 75% of their consultation via video communication; however, having all consultations with video camera was the least preferred option. Furthermore, patients favoured the use of feedback and monitoring technology while exercising and preferred to exercise at a gym location. In addition, they

Table 3.2: *Respondent characteristics.*

Respondent characteristics (n=104)				
Gender	n	(%)		
Female	66	(63.4)		
Age (years)	mean	(SD)	max	min
	43.8	(14.8)	79	20
VAS pain score	mean	(SD)	max	min
	6.3	(1.7)	10	2.1
Education	n	(%)		
Low	6	(5.8)		
Middle	50	(48.1)		
High	48	(46.2)		
Employment	n	(%)		
Employed	35	(33.7)		
Internet	n	(%)		
Yes	97	(93.3)		

preferred physician contact every session and flexible exercise sessions and favoured the highest discount on their health care premium. Conversely, respondents preferred not to undergo treatment that involved video consulting and minimized physician contact, exercising individually in the home environment without feedback and monitoring technology at fixed time frames. The attribute levels are generally well ordered, except for the attribute 'consulting frequency.' Less frequent supervision (once per 4 exercise sessions) is preferred over more frequent supervision (once per 3 exercise sessions).

Table 3.3: *Coefficient estimates of the bivariate probit model (n=1547).*

Attribute level	β	(SE)	95% CI			p
Treatment mode and location						
Group at gym	.05	(0.05)	−0.04	to	0.14	.29
Virtual group at home	−.20	(0.04)	−0.28	to	−0.12	<.001
Individually at gym	.20	(0.04)	0.11	to	0.28	<.001
Individually at home	−.04	(0.05)	−0.14	to	0.05	.35
Consulting frequency						
Every exercise session	.13	(0.04)	0.05	to	0.21	.001
Once per 2 exercise sessions	.02	(0.04)	−0.06	to	0.09	.68
Once per 3 exercise sessions	−.13	(0.04)	−0.20	to	−0.05	.002
Once per 4 exercise sessions	−.02	(0.04)	−0.10	to	0.06	.60
Consulting mode						
100% Face-to-face consults	.31	(0.04)	0.22	to	0.39	<.001
25% Video consults	−.04	(0.05)	−0.13	to	0.04	.32
75% Video consults	−.06	(0.04)	−0.13	to	0.02	.17
100% Video consults	−.21	(0.04)	−0.29	to	−0.12	<.001
Feedback and monitoring technology						
Yes	.22	(0.02)	0.19	to	0.26	<.001
No	−.22	(0.02)	−0.26	to	−0.19	<.001
Flexibility exercise sessions						
Fixed	−.08	(0.02)	−0.12	to	−0.03	<.001
Flexible	.08	(0.02)	0.03	to	0.12	<.001
Health care premium reduction	.004	(0.001)	0.00	to	0.01	.001
Decision of treatment (no treatment=0)						
Constant	1.59	(0.15)	1.30	to	1.87	<.001
Gender	−.09	(0.10)	−0.29	to	0.12	.41
Age >45 years	−.20	(0.10)	−0.40	to	−0.01	.04
Secondary education	.10	(0.13)	−0.16	to	0.36	.43
Higher education	.13	(0.13)	−0.12	to	0.37	.31
Internet	.21	(0.20)	−0.18	to	0.59	.29
Work hours	−.34	(0.10)	−0.53	to	−0.15	.001

Figure 3.2 illustrates the relative importance of the attribute levels on a standardized scale, with preference weights scaled between 0 and 1. For the most important attribute (physician contact mode), the most preferred level (100% face-to-face counselling sessions) is assigned a preference weight of 1. All other attribute levels are scaled relative to the most important attribute. Physician contact mode, the presence of feedback and monitoring technology, and exercise location were the most important attributes. The utility of moving from 100% face-to-face contact to 100% video consulting exceeded that for any other change between attribute levels. The smallest utility difference was between 25% video consulting versus 75% video consulting and € 50 health care premium reduction and no health care premium reduction.

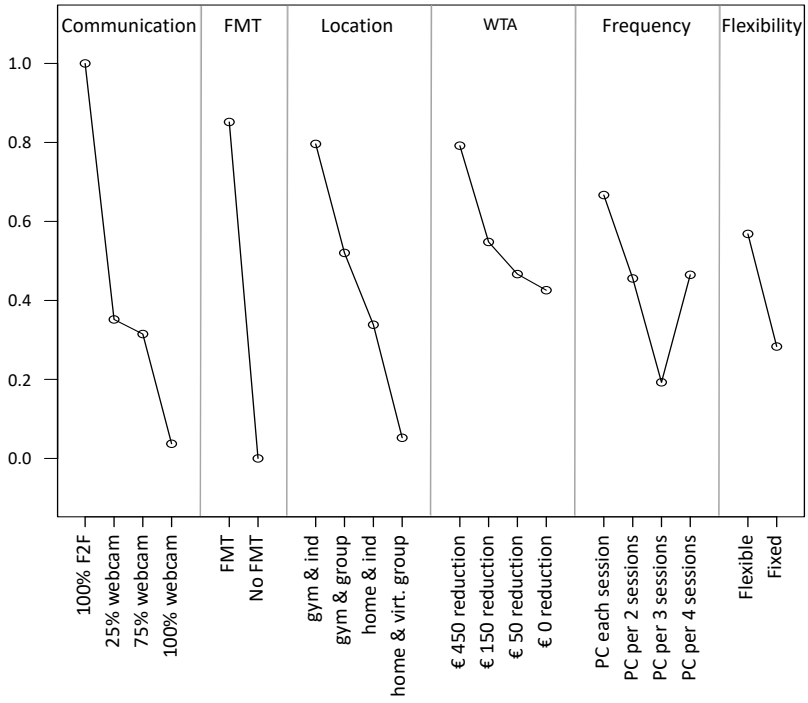

Figure 3.2: *Relative importance of the attribute levels on a standardized scale.*

Comparison of treatment scenarios

Using the results of the bivariate probit model, the choice probabilities of 5 hypothetical telerehabilitation scenarios were explored (Table 3.4). These could be arrayed on a continuum from clinic-based rehabilitation to home-based telerehabilitation with a focus on patient self-management and less physician involvement, with scenario B as

the most conventional scenario, E and F the least conventional, and C and D varying in between. Scenario A represented conventional clinic-based rehabilitation.

Table 3.4 shows that scenario C is preferred the most out of all treatment scenarios. This treatment scenario is considered an 'intermediate' scenario that falls between conventional and telemedicine care. Patients are offered a clinical exercise environment with feedback and monitoring technology; however, face-to-face consulting with a physician is limited. Remarkably, scenario C is also the only scenario that outweighs the utility of conventional care (A). This demonstrates the willingness of patients to accept both a reduction in consulting frequency and face-to-face consulting when remote feedback and monitoring technology is offered.

Patients' preferences for the five hypothetical telerehabilitation scenarios revealed that scenario F is the least preferred scenario. This scenario offers therapy at home with minimal physician supervision and requires a high level of patient self-management. Furthermore, the results demonstrated that conventional rehabilitation (A) is preferred over all home-based treatment scenarios varying in levels of monitoring and physician consulting (D-F). The model suggests that a reduction in health care premiums could raise the utility of these less preferred telerehabilitation treatments, which could increase future acceptance. For example, offering a reduction of€ 206.30 per year would make the least preferred scenario F equally attractive to conventional care. A smaller reduction (€ 70.70) is necessary to make scenario E equally attractive to conventional care.

Preferences for no treatment

No treatment was preferred over treatment A or B in 136 observations, corresponding to 34 individuals who chose the 'non-option.' Of these, 9 individuals did so on one occasion. One individual always chose the no treatment option. The parameter estimates for the patient characteristics age ($p = .04$) and work hours ($p = .001$) interacted with no treatment and were statistically significant. Older patients were more likely to choose the opt-out option than younger patients. Second, patients having a higher number of working hours were less likely to choose the opt-out option.

Table 3.4: *Utility of the different treatment scenarios A–F (n=1547).*

Treatment attributes	A	B	C	D	E	F
Location	Gym; group	Gym; group	Gym; individual	Home; individual	Home; virtual group	Home; virtual group
Communication	100% face-to-face	25% video	75% video	75% video	75% video	100% video
Frequency	Every session	Every session	1×4 sessions	Every session	1×4 sessions	1×4 sessions
Feedback and monitoring technology	No	No	Yes	No	Yes	No
Flexibility	Fixed	Fixed	Fixed	Flexible	Flexible	Flexible
Health care premium reduction	None	None	None	None	None	None
Utility (SD) [Heckman]	0.18 (0.08)	−0.17 (0.08)	0.27 (0.08)	−0.42 (0.09)	−0.13 (0.08)	−0.73 (0.08)
WTA[a] necessary to reach utility scenario A (€)	––	79.3	0	136.6	70.7	206.3

[a] WTA: willingness to accept

Discussion

Principal findings

Although telemedicine is assumed to be improving efficient allocation of resources, its actual success depends on the patients' acceptance and adherence. Therefore, future telemedicine services need to be designed with the patients' perspective in mind. This study explored chronic pain patients' preferences for telerehabilitation treatments using a discrete choice experiment and determined which future telerehabilitation design was preferred the most by chronic pain patients and which treatment attributes were most important to them. In addition, WTA was estimated to explore how patients valued telerehabilitation services relative to conventional rehabilitation and if they would be willing to trade health care premium discounts for more resource-efficient telerehabilitation treatments. Although DCEs are widely used in health care, this is the first study in the field of telerehabilitation estimating preferences for treatments to inform patient-centred treatment design.

Five hypothetical telerehabilitation scenarios were explored, which could be arrayed on a continuum from clinic-based rehabilitation to home-based telerehabilitation with a focus on patient self-management and minimal physician supervision. The most preferred treatment out of all five was an 'intermediate' scenario that falls between conventional clinic-based rehabilitation and a telerehabilitation program with a focus on self-management and with no frequent face-to-face supervision. Patients preferred treatment outside the home environment, with a combination of video consultation and face-to-face consulting and the use of feedback and monitoring technology. Patients' preference for an 'intermediate' scenario demonstrates patients' willingness to 'trade' between treatment attributes and underscores the potential of the use of remote feedback and monitoring technology in chronic pain telerehabilitation. Patients were willing to accept less frequent physician consulting offered mainly through video communication, provided that they were offered assistance through remote feedback and monitoring technology and could exercise outside their home environment during flexible exercise hours. A key finding is that this 'intermediate' scenario was preferred over conventional rehabilitation, which suggests that this scenario would make a feasible alternative to conventional care.

On the contrary, home-based telerehabilitation scenarios with minimal physician contact, provided entirely through video communication, and without the use of remote feedback and monitoring technology were preferred the least. This is an important finding, as a paradigm is emerging in which people with chronic disease are encouraged to take an active role in self-management and become actors in their own

health care [41, 42]. Offering remote feedback and monitoring technology as well as some physician face-to-face consulting would make home-based rehabilitation more attractive; however, it would not make these scenarios equally attractive to conventional rehabilitation. As such, to foster patient acceptance of home-based telerehabilitation with minimal physician supervision, other incentives are necessary to make these treatment scenarios more attractive.

WTA was estimated and demonstrated that chronic pain patients were willing to trade a reduction in health care premiums for less preferred treatment attributes, for example, less face-to-face physician consulting or a home-based treatment scenario. A reduction in health care premiums would make less preferred resource-efficient telerehabilitation scenarios with a focus on patient self-management equally attractive to conventional clinic-based rehabilitation. Ultimately, even a home-based telerehabilitation scenario with minimal physician consulting, the least preferred scenario out of all five, could become an acceptable alternative to conventional clinic-based care if health care premium reduction is offered. However, these results must be interpreted with caution. Further research is necessary to explore whether, next to health care premium reductions, other strategies such as the use of motivational tools (e.g., serious gaming) could increase the value of home-based telerehabilitation treatment.

In addition to the estimation of patients' preferences for the various telerehabilitation scenarios, the importance of the individual treatment attributes was estimated. While all attributes impacted patients' treatment preference, physician contact mode proved a key driver of preference for chronic pain rehabilitation with patients having a strong preference for some physician face-to-face contact. Treatment scenarios with partly remote physician video communication were preferred over scenarios that offered remote video communication only. The psychosocial nature of chronic pain treatment could be underlying this preference. In the treatment of chronic pain especially, the patient-physician communication plays an important role, as pain must be identified as a subjective phenomenon in the discussion [43] and both empathy and emotional support are considered essential [43, 44]. Although touch is not necessary to convey empathy and establish a therapeutic bond [45, 46] per se, a qualitative study in chronic pain patients established that some patients associated remote physician consultation with a loss of personal attention [47]. This same feeling of loss of personal attention was also found by Mair et al [48]. A physician's inability to perform a hands-on physical examination during a remote consultation is also a cause for concern to some patients [46–49], which could also explain patients' strong preference for physician face-to-face contact. Some patients consider face-to-face supervision an es-

sential means to provide effective feedback and instruction. Furthermore, supervision during exercise may reduce patients' insecurity and fear of exercising [50]. These findings indicate that integration of some face-to-face physician consultation is important to increase patient acceptance, which is consistent with other literature that found that attrition rates may be reduced by even minimal human contact [41]. A recent study of chronic pain patients suggests that web-based chronic pain management intervention may be the most effective for patients with mild or moderate chronic pain who have better overall psychological and physical health. Individuals with numerous comorbidities, or spinal, neuropathic, or fibromyalgia pain, may require face-to-face contact, as this could be necessary in achieving optimal outcomes in pain management [51].

The importance that chronic pain patients place on feedback during exercise is also reflected in the value that patients place on the use of monitoring and feedback technology, which proved nearly as important as face-to-face physician contact. Strikingly, although none of the research sample had prior experience with the telemedicine technology, a factor that is associated with increased acceptance [52, 53], the majority of our research sample preferred to use remote monitoring and feedback technology. Possibly, the use of the latest technology translates into 'quality of care,' as some patients expect that the use of remote monitoring and feedback could provide even more accurate feedback than a therapist [47]. These results suggest that the lack of experience with the technology does not impede the acceptance of telerehabilitation and that, on the contrary, the use of innovative technology can be used as a way to increase acceptance of home telerehabilitation.

Treatment location proved a third important attribute, with patients having a preference for exercising individually outside the home environment. Patients attached great value to exercise in a clinic-based setting, either individually or in a group, rather than exercising in the home environment. Apparently, the hypothesized benefits that home treatment could bring to patients, for example, reduced transportation issues and easier translation of acquired skills, do not outweigh the disadvantages perceived by our study sample. Previous research with chronic pain patients demonstrated that a clinical environment can offer a more motivating environment for the patient and it creates an opportunity to get out of the house and meet other patients [47]. In addition, feelings of intrusion could be underlying the preference to exercise outside the home, since telerehabilitation brings clinical care into the 'safe haven' of the home.

Limitations

With regard to the reliability of the discrete choice experiment, some limitations of the study must be emphasized. First, the results might be limited in terms of the extent to

which they could be generalized. Data were collected in a specific patient population, namely chronic pain patients waiting for their conventional rehabilitation to start. In addition, perceptions of patients who did not pass the consistency tests were disregarded. Little is known about how patients' preferences regarding telemedicine change during treatment; therefore, we do not know whether patients' possible insecurity at the start of their treatment had affected their telemedicine treatment preferences and whether this could explain why home-based telerehabilitation scenarios with a focus on self-management were preferred the least. Future studies should assess patients' preferences at different points of time during rehabilitation, since preferences are likely to change over time and telerehabilitation treatments may need to be adjusted to the altering needs of patients during treatment. We also chose to include a non-option. This created a more realistic choice experiment, but also meant that we were limited in the exploration of the effect of patient demographics on patients' preferences. Data revealed that both older patients and patients with a low education were more likely to choose the opt-out option. This could partially be attributed to the cognitive burden, for which discrete choice experiments have been criticized. In addition, we were not able to collect demographic information on non-responders to determine whether there were systematic differences between responders and non-responders. Future studies should further investigate the effect of patient demographics on treatment preference.

Conclusions

A central aim of this study was to assess which treatment attributes were most important to chronic pain patients and to explore which telerehabilitation treatment was the most preferred. Physician contact mode, the use of feedback and monitoring technology, and exercise location were key drivers of patients' treatment preferences. An 'intermediate' treatment scenario consisting of attributes associated with both conventional rehabilitation and telerehabilitation was the most preferred. This demonstrated that patients were willing to accept less frequent physician consultation offered mainly through video communication, provided that they were offered feedback and monitoring technology and some face-to-face consultation and could exercise outside their home environment at flexible exercise hours. As such, telerehabilitation treatments that incorporate these attributes should be pursued as promising alternatives to conventional rehabilitation. Home-based telerehabilitation treatments with minimal physician supervision were the least preferred. However, offering health care premium reductions could make these treatments as attractive as conventional clinic-based rehabilitation.

References

1. Breivik H, Collett B, Ventafridda V, Cohen R and Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 2006; **10:** 287–333.
   DOI: 10.1016/j.ejpain.2005.06.009.
2. Langley PC. The prevalence, correlates and treatment of pain in the European Union. *Current Medical Research and Opinion*, 2011; **27:** 463–480.
   DOI: 10.1185/03007995.2010.542136.
3. Smith M, Davis MA, Stano M and Whedon JM. Aging baby boomers and the rising cost of chronic back pain: secular trend analysis of longitudinal medical expenditures panel survey data for years 2000 to 2007. *Journal of Manipulative and Physiological Therapeutics*, 2013; **26:** 2–11.
   DOI: 10.1016/j.jmpt.2012.12.001.
4. Breivik H, Eisenberg E and O'Brien T. The individual and societal burden of chronic pain in Europe: the case for strategic prioritisation and action to improve knowledge and availability of appropriate care. *BMC Public Health*, 2013; **13:** 2–14.
   DOI: 10.1186/1471-2458-13-1229.
5. Elliott TE, Renier CM and Palcher JA. Chronic pain, depression, and quality of life: correlations and predictive value of the SF-36. *Pain Medicine*, 2003; **4:** 331–339.
   DOI: 10.1111/j.1526-4637.2003.03040.x.
6. Lambeek LC, Tulder MW van, Swinkels I, Koppes LLJ, Anema JR and Mechelen W van. The trend in total cost of back pain in the Netherlands in the period 2002 to 2007. *Spine*, 2011; **36:** 1050–1058.
   DOI: 10.1097/BRS.0b013e3181e70488.
7. Rycroft CE, Hirst M, Dunlop WC, Pirk O, Mullins D and Akehurst R. The suitability of end point designs for health technology assessment in chronic pain studies. *Value in Health*, 2015; **18:** 987–993.
   DOI: 10.1016/j.jval.2015.07.001.
8. Hayden JA, Tulder MW van, Malmivaara AV and Koes BW. Meta-analysis: exercise therapy for nonspecific low back pain. *Annals of Internal Medicine*, 2005; **142:** 765–775.
   DOI: 10.1002/14651858.CD000335.pub2.
9. Tulder M van, Malmivaara A, Esmail R and Koes B. Exercise therapy for low back pain: a systematic review within the framework of the Cochrane Collaboration Back Review Group. *Spine*, 2000; **25:** 2784–2796.
   DOI: 10.1097/00007632-200011010-00011.

10. Abenheim L, Rossignol M, Valat JP et al. The role of activity in the therapeutic management of back pain. *Spine*, 2000; **25:** 1S–33S.
PMID: 10707404.

11. Turk DC and Rudy TE. Neglected topics in the treatment of chronic pain patients-relapse, noncompliance, and adherence enhancement. *Pain*, 1991; **44:** 5–28.
DOI: 10.1016/0304-3959(91)90142-K.

12. Hayden JA, Tulder MW van, Malmivaara A and Koes BW. Exercise therapy for treatment non-specific low back pain (review). *Cochrane Database Systematic Reviews*, 2005**:** CD000335.
DOI: 10.1002/14651858.CD000335.pub2.

13. Jordan JL, Holden MA, Mason EE and Foster NE. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Systematic Reviews*, 2010**:** CD005956.
DOI: 10.1002/14651858.CD005956.pub2.

14. Morley S. Relapse prevention: still neglected after all these years. *Pain*, 2008; **134:** 239–240.
DOI: 10.1016/j.pain.2007.12.004.

15. Enthoven P, Skargren E and Oberg B. Clinical course in patients seeking primary care for back or neck pain: a prospective 5-year follow-up of outcome and health care consumption with subgroup analysis. *Spine*, 2004; **29:** 2458–2465.
DOI: 10.1097/01.brs.0000143025.84471.79.

16. Cooper K, Smith BH and Hancock E. Patient-centredness in physiotherapy from the perspective of the chronic low back pain patient. *Physiotherapy*, 2008; **94:** 244–252.
DOI: 10.1016/j.physio.2007.10.006.

17. Epstein RM, Fiscella K, Lesser CS and Stange KC. Why the nation needs a policy push on patient-centered health care. *Health Affairs*, 2010; **29:** 1489–1495.
DOI: 10.1377/hlthaff.2009.0888.

18. Roumie CL, Greevy R, Wallston KA et al. Patient centered primary care is associated with patient hypertension medication adherence. *Journal of Behavioral Medicine*, 2011; **34:** 244–253.
DOI: 10.1007/s10865-010-9304-6.

19. Institute of Medicine (Committee on Quality of Health Care in America). Crossing the quality chasm: a new health system for the 21st century. Washington (DC): National Academies Press (US), 2001.
PMID: 25057539.

20. Greene SM, Tuzzio L and Cherkin D. A framework for making patient-centered care front and center. *The Permanente Journal*, 2012; **16:** 49–53.
DOI: doi.org/10.7812/TPP/12-025.

21. Savigny P, Watson P and Underwood M. Early management of persistent non-specific low back pain: summary of NICE guidance. *BMJ*, 2009; **338:** b1805.
DOI: 10.1136/bmj.b1805.

22. Slade SC, Molloy E and Keating JL. People with chronic low back pain who have participated in exercise programs have preferences about exercise: a qualitative study. *Australian Journal of Physiotherapy*, 2009; **55:** 115–121.
DOI: 10.1016/S0004-9514(09)70041-8.

23. Preference Collaborative Review Group. Patients' preferences within randomised trials: systematic review and patient level meta-analysis. *BMJ*, 2008; **337:** a1864.
DOI: 10.1136/bmj.a1864.

24. Epstein RM and Street Jr RL. The values and value of patient-centered care. *Annals of Family Medicine*, 2011; **9:** 100–103.
DOI: 10.1370/afm.1239.

25. Ryan M. Discrete choice experiments in health care. *BMJ*, 2004; **328:** 360–361.
DOI: 10.1136/bmj.328.7436.360.

26. Bekker-Grob EW de, Ryan M and Gerard K. Discrete choice experiments in health economics: a review of the literature. *Health Economics*, 2012; **21:** 145–172.
DOI: 10.1002/hec.1697.

27. Kairy D, Lehoux P, Vincent C and Visintin M. A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. *Disability and Rehabilitation*, 2009; **31:** 427–447.
DOI: 10.1080/09638280802062553.

28. Bender JL, Radhakrishnan A, Diorio C, Englesakis M and Jadad AR. Can pain be managed through the Internet? A systematic review of randomized controlled trials. *Pain*, 2011; **152:** 1740–1750.
DOI: 10.1016/j.pain.2011.02.012.

29. Macea DD, Gajos K, Calil YAD and Fregni F. The efficacy of Web-based cognitive behavioral interventions for chronic pain: a systematic review and meta-analysis. *The Journal of Pain*, 2010; **11:** 917–929.
DOI: 10.1016/j.jpain.2010.06.005.

30. Ruehlman LS, Karoly P and Enders C. A randomized controlled evaluation of an online chronic pain self management program. *Pain*, 2012; **153:** 319–330.
DOI: 10.1016/j.pain.2011.10.025.

31. Amorim AB, Pappas E, Simic M et al. Integrating mobile health and physical activity to reduce the burden of chronic low back pain trial (IMPACT): a pilot trial protocol. *BMC Musculoskeletal Disorders*, 2016; **17:** 36.
DOI: 10.1186/s12891-015-0852-3.

32. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP and Gonder-Frederick LA. A behaviour change model for internet interventions. *Annals of Behavioral Medicine*, 2009; **38:** 18–27.
DOI: 10.1007/s12160-009-9133-4.

33. Finkelstein J, Lapshin O, Heather C, Cha E and Provance PG. Home-based physical telerehabilitation in patients with multiple sclerosis: A pilot study. *Journal of Rehabilitation Research and Development*, 2008; **45:** 1361–1373.
DOI: 10.1682/JRRD.2008.01.0001.

34. Brennan DM, Mawson S and Brownsell S. Telerehabilitation: enabling the remote delivery of healthcare, rehabilitation, and self management. In: *Studies in Health Technolology and Informatics*. Ed. by Gaggioli A, Keshner EA, Weiss PL and Riva G. 2009**:** 231–248.
DOI: 10.3233/978-1-60750-018-6-231.

35. Bodenheimer T, Lorig K, Holman H and Grumbach K. Patient self-management of chronic disease in primary care. *Journal of the American Medical Association*, 2002; **288:** 2469–2475.
DOI: 10.1001/jama.288.19.2469.

36. Delitto A, George SZ, Dillen LR van et al. Low back pain. *Journal of Orthopaedic & Sports Physical Therapy*, 2012; **42:** A1–57.
DOI: 10.2519/jospt.2012.0301.

37. Liddle SD, Gracey JH and Baxter GD. Advice for the management of low back pain: a systematic review of randomised controlled trials. *Manual Therapy*, 2007; **12:** 310–327.
DOI: 10.1016/j.math.2006.12.009.

38. Jansen-Kosterink SM. The added value of telemedicine service for physical rehabilitation. PhD thesis. University of Twente, 2003.
DOI: 10.3990/1.9789082319606.

39. Bridges JFP, Hauber AB, Marshall D et al. Conjoint analysis applications in health–a checklist: a report of the ISPOR Good Research Practices for Conjoint Analysis Task Force. *Value in Health*, 2011; **14:** 403–413.
DOI: 10.1016/j.jval.2010.11.013.

40. Greene WH. Econometric Analysis (5th edition). Pearson Education, 2003. URL: https://books.google.nl/books?id=njAcXDlR5U8C.

41. Rosser BA, Vowles KE, Keogh E, Eccleston E and Mountain GA. Technologically assisted behaviour change: A systematic review of studies of novel technologies for the management of chronic illness. *Journal of Telemedicine and Telecare*, 2009; **15:** 327–338. DOI: 10.1258/jtt.2009.090116.

42. Lorig KR, Sobel DS, Ritter PL, Laurent D and Hobbs M. Effect of a self-management program on patients with chronic disease. *Effective Clinical Practice*, 2001; **4:** 256–262. PMID: 11769298.

43. Matthias MS and Bair MJ. The patient-provider relationship in chronic pain management: where do we go from here? *Pain Medicine*, **11**.

44. Matthias MS, Miech EJ, Myers LJ, Sargent C and Bair MJ. An expanded view of self-management: patients' perceptions of education and support in an intervention for chronic musculoskeletal pain. *Pain Medicine*, 2012; **13:** 1018–1028. DOI: 10.1111/j.1526-4637.2012.01433.x.

45. Montague E, Chen P, Xu J, Chewning B and Barrett B. Nonverbal Interpersonal Interactions in Clinical Encounters and Patient Perceptions of Empathy. *Journal of Participatory Medicine*, 2013; **5:** e33.

46. Kairy D, Tousignant M, Leclerc N, Côté A and Levasseur M. The patient's perspective of in-home telerehabilitation physiotherapy services following total knee arthroplasty. *International Journal of Environmental Research and Public Health*, 2013; **10:** 3998–4011. DOI: 10.3390/ijerph10093998.

47. Cranen K, Drossaert CHC, Brinkman ES, Braakman-Jansen ALM, IJzerman MJ and Vollenbroek-Hutten MMR. An exploration of chronic pain patients' perceptions of home telerehabilitation. *Health Expectations*, 2012; **15:** 339–350. DOI: 10.1111/j.1369-7625.2011.00668.x.

48. Mair F, Whitten P, May C and Doolittle GC. Patients' perceptions of a telemedicine specialty clinic. *Journal of Telemedicine and Telecare*, 2000; **6:** 36–40. DOI: 10.1258/1357633001933925.

49. Agha Z, Schapira RM, Laud PW, McNutt G and Roter DL. Patient satisfaction with physician-patient communication during telemedicine. *Telemedicine and e-Health*, 2009; **15:** 830–839. DOI: 10.1089/tmj.2009.0030.

50. Escolar-Reina P, Medina-Mirapeix F, Gascón-Cánovas JJ et al. How do care-provider and home exercise program characteristics affect patient adherence in chronic neck and back pain: a qualitative study. *BMC Health Services Research*, 2010; **10:** 1–8. DOI: 10.1186/1472-6963-10-60.

51. Nevedal DC, Wang CMS, Oberleitner L, Schwartz S and Williams AM. Effects of an Individually Tailored Web-Based Chronic Pain Management Program on Pain Severity, Psychological Health, and Functioning. *Journal of Medical Internet Research*, 2013; **15:** e201. DOI: 10.2196/jmir.2296.

52. Or CKL and Karsh B. A systematic review of patient acceptance of consumer health information technology. *Journal of the American Medical Informatics Association*, 2009; **16:** 550–560. DOI: 10.1197/jamia.M2888.

53. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478. DOI: 10.2307/30036540.

4

Change of patients' perceptions of telemedicine after brief use

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Abstract

Objective This study aims to investigate whether patients' perceptions regarding a web-based telemedicine service, for instruction and monitoring of an exercise program, change after brief use.

Materials and methods Thirty patients were allocated, matched on gender and age, to a control group (10) or an experimental group (20). After basic training, the experimental group was given a 15 min opportunity to use a web-based telemedicine service. Patients' perceptions regarding the telemedicine service were measured using a questionnaire, based on the Technology Acceptance Model (TAM). This questionnaire was administered to both the control and experimental group before and after the experimental group's intervention. Both groups were compared with respect to any change in perceptions related to the web-based telemedicine service.

Results The experimental group showed a significantly greater change on the TAM constructs perceived usefulness [$F(1,27)=3.40$, $p=0.08$] and perceived ease of use [$F(1,27)=5.37$, $p=0.03$] than the control group, who showed no statistically significant change of perceptions. Patients within the experimental group became significantly more positive about the usefulness and ease-of-use of the web-based telemedicine program after a brief period of use.

Conclusions These findings show that brief use of a web-based telemedicine service has a significant positive effect on patients' perceptions of this service. Therefore, as patients do not have prior experience with innovative telemedicine services, offering patients a risk-free way to explore and experiment with the service can increase the development of accurate perceptions and user needs. Ultimately, this will increase patients' acceptance of telemedicine. Future studies should investigate the effect of continued usage on patients' perceptions of telemedicine.

Introduction

Chronic pain is a disorder that occurs in 19% of adult Europeans, with moderate to severe intensity [1]. It affects a person's ability to function, their mood, and social life. In addition to its effect on individuals, chronic pain has major social and economic consequences [2, 3]. Traditionally, pain rehabilitation programs involve clinic-based care. However, recent developments in information and communication technologies have fostered the development of telemedicine services. These services have several advantages over conventional care as they overcome geographic and transportation barriers [4] and offer the possibility of flexible exercise hours [5, 6]. In addition, with telemedicine services patients can learn coping skills within their own social environment and can therefore integrate these more easily within their daily lives.

Despite the great potential of telemedicine, only a few of the numerous initiatives are eventually implemented in daily healthcare [7]. User acceptance proves one important barrier to implementation [8]. By understanding the determinants of patient acceptance of telemedicine services it becomes clear which issues that impede acceptance should be addressed to improve acceptance and, consequently, uptake of telemedicine services in mainstream healthcare.

Within the field of telemedicine, the determinants of patient acceptance are commonly measured at one point in time before patients used the service. However, insight into whether use of telemedicine influences patients' perceptions is currently missing from the literature. Especially in the field of telemedicine services, we could expect these perceptions to change before and after use as patients commonly do not have prior experience with these innovative services. It is important to investigate the possible gap between patients' pre- and post-use perceptions of a telemedicine service, as its effect is twofold. First, a gap creates the risk of unintentionally missing out on potential patient-users who could benefit from a telemedicine service as they decide not to use the service based on their low expectations. Second, a gap brings the risk of dissatisfied users [9] who decide to withdraw from their telemedicine treatment, because their high hopes were not met.

Hence, reducing the gap between patients' pre- and post-use perceptions is important, as this could contribute to higher patient acceptance rates. This can be reached through targeted patient information programs to foster the creation of accurate perceptions of telemedicine. In addition, user-centred design contributes to minimizing the gap as it will result in services that better meets patients' needs and expectations.

Therefore, the aims of this study were to investigate whether patients' perceptions of a telemedicine service change after brief use and to provide indications of where efforts should be focused to maximize patient acceptance of future telemedicine services.

Methodology

Sample and procedure

The research population consisted of a convenience sample of 30 patients with a primary diagnosis of chronic pain and who had participated in exercise therapy during the past half year. Further, patients had to be proficient in Dutch to be able to complete the questionnaire. Patients who agreed to participate were allocated, matched on gender and age, to a control group (10) or an experimental group (20). After basic training, the experimental group was given a 15 min opportunity to use a web-based telemedicine service and explore its functionalities. The control group was not given this opportunity to gain experience with the service. Patients' perceptions regarding the telemedicine service were measured using a questionnaire. This questionnaire was administered to both the control and experimental groups before (pretest) and after (posttest) the experimental group's intervention. Prior to the measurement of patients' perceptions at the pretest, both the control and experimental groups received written and oral information about the web-based telemedicine service. Both groups were compared with respect to any change in perceptions related to the web-based telemedicine service.

Web-based telemedicine service

The telemedicine service in this study consisted of a tailored web-based exercise program (Figure 4.1), which gives patients access to a variety of online exercise instruction videos, which are selected by their therapist. An online agenda serves as both a motivation and reminder for patients to exercise and enables the therapist to monitor the duration and type of exercises a patient performed at home. By means of a web camera, patients are instructed to record specific exercises, which a therapist will remotely examine to monitor the quality of the preformed exercises. In addition, the patient has the choice of scheduling a video or phone consultation or to consult his therapist by e-mail.

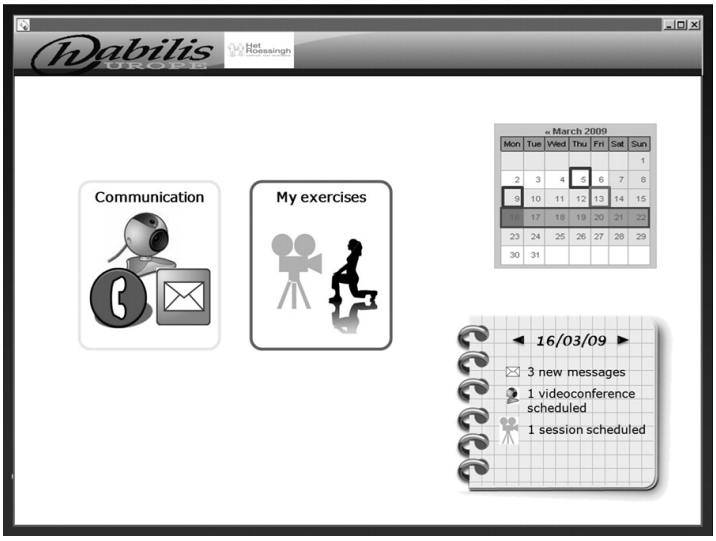

Figure 4.1: *Web-based telemedicine program.*

Questionnaire

To investigate whether brief use leads to altered perceptions of the web-based telemedicine service, a questionnaire measured patients' perceptions before (pretest) and after (posttest) they used the service (Figure 4.2).

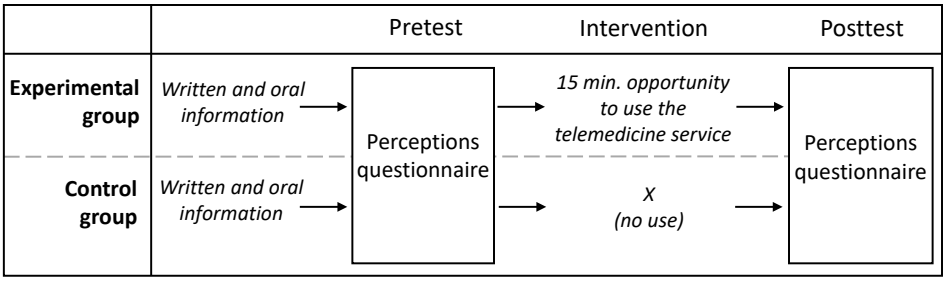

Figure 4.2: *Experimental study design.*

The questionnaire was based on the Technology Acceptance Model (TAM) [10], as this model has proven to be a robust and parsimonious framework to understand individual acceptance of information technology [11]. It measured patients' 'intention' to accept telemedicine and its three determinants [10]: (1) perceived usefulness, which reflects the degree to which telemedicine is perceived as providing benefits; (2) per-

ceived ease of use, which refers to the beliefs about the effort it will take to learn and use the technology; and (3) attitude, which measures an individual's affective response toward telemedicine. In sum, holding a positive affective response toward the technology and perceiving it to be both useful and easy to use will facilitate a patient's intention to accept technology.

Items used to operationalise the constructs were adopted from prior research [11, 12] and adapted to the context of telemedicine. All items were measured using a seven-point Likert scale. Further, respondents provided information about their demographic characteristics. In the present sample, the questionnaire constructs showed a high reliability (Chronbach's alphas varying from 0.77 to 0.93 for the different constructs) after the items that were worded in a negative manner received a reversed scoring (Table 4.1).

Statistical analysis

Analysis of covariance (ANCOVA) was applied to examine the difference between the experimental and control groups with respect to changes in the questionnaire pre- and posttest scores. For each questionnaire construct (perceived usefulness, ease of use, attitude, and intention), an ANCOVA was performed. Therefore, the posttest score was used as the dependent variable, and the pretest score was used as a covariate. Prior to each ANCOVA analysis, data were checked for normality and the homogeneity of the regression slopes for both the experimental and control groups was tested to evaluate whether this assumption for performing ANCOVA was met. In addition, a t-test was performed to check for the difference between scores of the experimental and control groups on the questionnaire pretest scores. All reported p-values are for two-sided tests. Because of the relatively small sample size of the experimental group, a liberal value of $p = 0.10$ was used as a cutoff point. Post hoc tests, using paired t-tests, were used to give insight into the changes within both the experimental and control groups between pre- and posttest scores.

In addition to the mean change, the number of relevant changes within both the experimental and control groups was investigated by means of frequency statistics. Therefore, the Δ of the questionnaire pretest and posttest scores was calculated for each construct. As there are no existing guidelines that define which magnitude of change on a seven-point Likert scale is clinically relevant, the Δ score of a patient's change between the questionnaire pre- and posttest scores was considered a relevant change when the Δ score exceeded the statistically relevant score of the 75^{th} percentile of the experimental or control group.

Table 4.1: *Questionnaire items and scientific justification per construct and their internal consistencies measured in the current research sample* ($n = 30$).

	Source
Perceived usefulness ($\alpha = 0.86$)	
PU1. Using the web-based exercise program will be of benefit to my treatment.	Taylor and Todd [12]
PU2. I think the use of the web-based exercise program would enhance the effectiveness of my treatment.	Davis [10]
PU3. I think the use of the web-based exercise program would make my treatment easier.	Davis [10]
PU4. I would find the web-based exercise program useful in the treatment of my complaints.	Davis [10]
Perceived ease of use ($\alpha = 0.82$)	
PEU1. It will be difficult to learn how to use the web-based exercise program.	Taylor and Todd[12]
PEU2. I would find it easy to get the web-based exercise program to do what I want it to do.	Davis [10]
PEU3. It will not be easy to become skilful to use the web-based exercise program.	Davis [10]
PEU4. I think it will be easy to operate the web-based exercise program.	Taylor and Todd [12]
Attitude ($\alpha = 0.77$)	
ATT1. Using the web-based exercise program is a bad/good idea.	Taylor and Todd [12]
ATT2. Using the web-based exercise program would be unpleasant/pleasant.	Taylor and Todd [12]
ATT3. I dislike/like the idea of using the web-based exercise program.	Taylor and Todd [12]
Intention to use ($\alpha = 0.93$)	
INT1. I have the intention to use the web-based exercise program for my treatment.	Taylor and Todd [12]
INT2. If possible, I intend not to use the web-based exercise program for my treatment.	Taylor and Todd [12]
INT3. I intend to use the web-based exercise program as much as possible in my treatment.	Taylor and Todd [12]

Results

A total of 30 participants (mean age = 40.4 years, standard deviation [SD] = 19.7) engaged in the research; 50% were women. The majority of the respondents were married or living with a partner (67%) and had a low or middle level of education (80%). More than half of the respondents were employed (60%). The mean duration of the patients' complaints was 6.9 years, with a range of 0.5—20 years. All patients had experience with the Internet, and only a small percentage of the patients had used videoconferencing (17%). There were no statistical significant differences in sample characteristics between both the experimental and control groups ($p > 0.05$), indicating homogeneity of subjects across the groups (Table 4.2).

Table 4.2: *Demographic and health characteristics of the participants.*

Characteristics	Experimental ($n = 20$)	Control ($n = 10$)	Total ($n = 30$)
Sex male: *n* (%)	10 (50.0)	5 (50.0)	15 (50.0)
Age (years) mean (SD)	42.5 (13.0)	45.1 (17.7)	43.3 (14.5)
Education *n*			
Low	8	2	12
Middle	10	6	12
High	2	2	6
Marital status *n*			
Single	7	3	10
Married/cohabiting	13	7	20
Employment *n*			
Employed	11	7	18
Unemployed	9	3	12
Experience *n*			
Internet	17	9	25
Videoconferencing	3	1	5

An ANCOVA statistical test investigated whether the changes in questionnaire pretest and posttest scores significantly differed between the experimental and control groups. An ANCOVA test was conducted for each different questionnaire construct to determine whether the questionnaire posttest scores for the experimental and control groups differed after adjustments were made for the questionnaire pretest

scores. The assumption of equal regression slopes was tested prior to analysis and was found tenable for the scores on the constructs of perceived ease of use [$F(1,27) = 0.87$, $p = 0.36$], perceived usefulness [$F(1,27) = 2.07$, $p = 0.16$], attitude [$F(1,27) = 0.22$, $p = 0.64$], and intention [$F(1,27) = 0.45$, $p = 0.51$].

The ANCOVA test (Table 4.3) revealed a significantly greater change on the constructs of perceived usefulness [$F(1,27) = 3.40$, $p = 0.08$] and perceived ease of use [$F(1,27) = 5.37$, $p = 0.03$] for the experimental group than the control group, after adjusting for the questionnaire pretest scores. This indicates that patients developed a more positive perception of the usefulness of the technology and the effort it would take to learn and use the technology, after they used the telemedicine service. The ANCOVAs performed for the constructs attitude and intention showed no statistical changes between the experimental and control groups on the change in the questionnaire pre- and posttest scores ($p > 0.05$).

Table 4.3: *Comparison of the changes in questionnaire pre- and posttest scores between groups on the questionnaire constructs.*

	Δ mean (SD) pre- and posttest scores					
	Experimental ($n = 20$)	Control ($n = 10$)	Min Δ[a]	Max Δ[a]	Δ	p
Perceived usefulness	+0.26 (0.54)	−0.10 (0.41)	−0.75	1.00	0.36	0.08[b]
Perceived ease of use	+0.44 (0.66)	−0.05 (0.26)	−0.50	2.25	0.49	0.03[c]
Attitude	+0.25 (0.68)	−0.13 (0.45)	−1.00	1.33	0.38	0.13
Intention	+0.10 (0.69)	+0.03 (0.53)	−1.67	1.67	0.07	0.76

[a] Minimum Δ and maximum Δ range: −3 to +3.

[b] $p < 0.10$.

[c] $p < 0.05$.

The descriptives of the study variables at pre- and posttest are presented in Table 4.4. The mean item ratings of the pretest scores on perceived usefulness (mean = 0.77, SD = 1.27), perceived ease of use (mean = 1.28, SD = 0.92), attitude (mean = 0.83, SD = 1.25), and intention (mean = 0.95, SD = 1.74) indicated that patients held neutral to slightly positive beliefs about the use of telemedicine.

A one-way ANOVA comparing mean differences on the questionnaire pretest scores revealed no significant differences of these beliefs between the experimental and con-

Table 4.4: *Description of the studied variables in questionnaire pre- and posttest scores between groups.*

	Experimental (N = 20)		Control (N = 10)		Total (N = 30)	
	mean	(SD)	mean	(SD)	mean	(SD)
Perceived usefulness						
Pretest	0.75	(1.21)	0.80	(1.46)	0.77	(1.27)
Posttest	1.01	(1.45)	0.70	(1.38)	0.91	(1.41)
Perceived ease of use						
Pretest	1.30	(0.88)	1.25	(1.05)	1.28	(0.92)
Posttest	1.74	(0.90)	1.20	(1.03)	1.56	(0.96)
Attitude						
Pretest	0.80	(1.31)	0.87	(1.17)	0.83	(1.25)
Posttest	1.05	(1.53)	0.73	(1.18)	0.95	(1.41)
Intention						
Pretest	1.00	(1.80)	0.87	(1.71)	0.95	(1.74)
Posttest	1.10	(1.85)	0.90	(1.54)	1.03	(1.73)

trol groups ($p > 0.05$). These results further supported the homogeneity of the subjects between groups.

Post hoc tests and paired t-tests revealed that within the control group there was no statistical change ($p > 0.05$) between the questionnaire pre- and posttest scores on the constructs of perceived usefulness [$t(9) = 0.77$, $p = 0.46$], perceived ease of use [$t(9) = 0.61$, $p = 0.55$], attitude [$t(9) = 0.94$, $p = 0.37$], and intention [$t(9) = -0.20$, $p = 0.84$].

Within the experimental group, the difference between the pre- and posttest scores on the construct of perceived ease of use [$t(19) = -2.95$, $p = 0.01$] and perceived usefulness [$t(19) = -2.17$, $p = 0.04$] proved statistically different. The differences between the questionnaire pre- and posttest scores on attitude [$t(19) = -1.64$, $p = 0.12$] and intention [$t(19) = -0.66$, $p = 0.52$] showed no statistical change.

Looking to more detail at these significant differences between the questionnaire pre- and posttest scores for the TAM constructs, the data reveal that, with respect to the number of changes, significantly more respondents from the experimental group showed a relevant change than those in the control group for both the constructs of perceived ease of use ($\chi^2 = 6.79$, $p = 0.01$) and perceived usefulness ($\chi^2 = 3.68$, $p = 0.06$). A change was considered relevant when the difference between the questionnaire pre- and posttest scores was within the 75th percentile of the total research

sample. When a patient's Δ questionnaire pre- and posttest score is within the 75th percentile, 75% of the other patients show a Δ score that is below this score. This means that the patient's Δ questionnaire pre- and posttest score is relatively high compared with the Δ score of the whole group (Table 4.5). Further analysis revealed that the majority of the patients in the experimental group who showed a relevant change on perceived usefulness and ease of use changed from a slightly positive score to a more positive score ($n = 8$). One respondent in the experimental group shifted from a negative score on the construct 'perceived ease of use' to a positive score.

Table 4.5: *Number of changes of the Δ questionnaire pre- and posttest scores within the 75^{th} percentile for the constructs 'Perceived Usefulness' and 'Ease of Use' ($n = 30$).*

	Experimental	Control
Perceived usefulness		
Relevant change ($\Delta \geq 0.75$)	9	1
Non-relevant change ($\Delta < 0.75$)	11	9
Perceived ease of use		
Relevant change ($\Delta \geq 0.50$)	12	1
Non-relevant change ($\Delta < 0.50$)	8	9

Discussion

This study investigated whether patients' perceptions of a web-based telemedicine system changed after they briefly used it. Results demonstrated that brief use of the telemedicine system leads to a positive change in perceptions regarding ease of use and usefulness of the system. Patients in the experimental group were significantly more likely to shift toward higher levels of these two constructs than patients in the control group. Specifically, the majority in the experimental group changed from a neutral or slightly positive score to a more positive score. One respondent changed from a negative pretest score to a positive posttest score on the construct of ease of use after using the service. Patients in the control group, who did not use the telemedicine service, did not significantly change their perceptions about the constructs ease of use and usefulness.

Other studies have also demonstrated this change in patients' perceptions of telemedicine after use. For example, Finkelstein et al. [13] found their patients developed more positive perceptions about the reliability and ease of use of a home telecare system after experiencing it. In addition, Demiris et al. [14] stated their patients became more familiar and confident with the technology after using their

telehomecare system.

An explanation for these findings is that patients were only able to express perceptions about the telemedicine service after they used it. Possibly, patients' perceptions, prior to their experience with the telemedicine service, were based on an inaccurate vision of the service, as all patients had no prior experience with innovative telemedicine services. These perceptions were readjusted after experiencing the service.

Second, the results could imply that patients may have been wary of the telemedicine treatment as they have no prior experience with it and, therefore, have set their expectations deliberately 'safely' low for telemedicine. Additionally, the experience turned out to be unexpectedly pleasant for these first-time users, which led to a positive change in perceptions after using the service.

These inadequate perceptions of telemedicine services could lead patients to decide not to use the service. This can be prevented by offering patients a risk-free way to explore and experiment with the service, for example, by giving them a chance to briefly explore the service before they make the decision to use it in the long term. This will foster the development of accurate perceptions and will increase patients' comfort levels and ultimately patient acceptance. This coincides with the diffusion of innovation theory of Rogers [15], who stated that the 'trialability' of an innovation will reduce risk and uncertainty about the expected consequences of using the innovation.

According to the TAM [10], one should expect an increase in both patient's attitude and intention to use the service, when there is an increase in perceived usefulness and ease of use. Remarkably, despite the fact that brief use with the telemedicine service lead to significant changes in perceived usefulness and ease of use, there was no significant change in patients' intention to use the service in the future.

This could be the result of other determinants, aside from perceived usefulness and ease of use, influencing patients' intention to use the service. A more recent theory, the Unified Theory of Acceptance and Use of Technology [16], includes a construct 'facilitating conditions,' which embodies an individual's perceived external constraints. In our research, for example, the available exercise space at home could have influenced patients' intention to use the service. Future research should further investigate these perceived constraints. In addition, the relatively small sample size could have had inadequate power to detect changes in patient's intention to use the telemedicine service. This inadequate power could also have led to the insignificant change in patient's attitudes as the corresponding p-level ($p = 0.13$) approaches significance.

Although this study demonstrated that brief usage can increase patients' perceptions in a short term, its long term effect remains unclear. It is possible that perceptions

based on brief use reflect a degree of 'over-enthusiasm.' The Gartner Hype Cycle [17] acknowledges the presence of over-enthusiasm and the subsequent disappointment that goes along with the introduction of new technologies. The Hype Cycle includes a 'peak of inflated expectations', which is followed by a 'trough of disillusionment' as the unrealistic expectations cannot be met. It is unclear whether the brief use with the telemedicine service created this peak within our patients sample, meaning the post-use perceptions measured could be a reflection of the 'over-enthusiasm' caused by the brief use. However, the research of Hanson et al. [18] leads one to suspect this fluctuation of high expectations, and disillusionment is present during the process of patient acceptance of telemedicine services. They demonstrated that their first-time users were more likely to shift their attitudes about telemedicine in a positive direction after use. On the other hand, already experienced telemedicine users were, after their experience, as likely to increase their attitudes as to decrease them [18]. This could imply that the first-time users were still at the 'peak of inflated expectations,' whereas the more experienced users already moved on to the 'trough of disillusionment.' Although the development of perceptions needs further exploration by means of longitudinal studies, this study demonstrates that perceptions are susceptible to change and are snapshots in time based on the available information at the point in time.

A limitation of this study is the limited sample size. Therefore, a relatively liberal cutoff point of $p = 0.10$ was used in this study and careful interpretation of the results is essential. However, the presence of a control group makes the results more valid. As the focus of this study was on the changes within the experimental group, more patients were allocated to this group. Future research should include more respondents who are evenly spread between both experimental and control groups to prevent for possible power problems. In addition, future studies should include other patient groups as little is known whether these results of chronic pain patients can be generalized to other patient groups.

Further, this study was limited to the fact that telemedicine intervention under investigation was a web-based telemedicine service. It can be questioned whether such a service was considered an innovative, 'really new service,' as the majority of the patients already had experience with both computers and Internet. Strikingly, the results demonstrated a positive change in perceptions regarding ease of use and usefulness of the system after use. Therefore, one could expect even greater changes in the case when patients are introduced to a treatment that involves elements that are 'really new' to the patient group, such as webcam consultation or on-body sensor monitoring. Therefore, future research should investigate the effect of brief use of

really new products on patients' perceptions.

In summary, these results show the significant positive effect of brief use of a telemedicine service on patients' perceptions of this service. Therefore, it is important to offer patients the opportunity to experiment with the service to foster the development of accurate beliefs, which will consequently result in more adequate user needs possibly benefiting patient acceptance. In this way, as a healthcare provider, one is able to be involved in 'patient expectation management' and to have some degree of control over patients' acceptance of prospective telemedicine services.

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References

1. Breivik H, Collett B, Ventafridda V, Cohen R and Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 2006; **10:** 287–333.
DOI: 10.1016/j.ejpain.2005.06.009.

2. Jensen MP, Nielson WR, Turner JA, Romano JM and Hill ML. Changes in readiness to self-manage pain are associated with improvement in multidisciplinary pain treatment and pain coping. *Pain*, 2004; **111:** 84–95.
DOI: 10.1016/j.pain.2004.06.003.

3. Blyth FM, March LM, Brnabic AJ and Cousins MJ. Chronic pain and frequent use of health care. *Pain*, 2004; **111:** 51–58.
DOI: 10.1016/j.pain.2004.05.020.

4. Agrell H, Dahlberg S and Jerant AF. Patients' Perceptions Regarding Home Telecare. *Telemedicine and e-Health*, 2000; **6:** 409–415.
DOI: 10.1089/15305620050503889.

5. Ruland CM and Moore SM. Eliciting exercise preferences in cardiac rehabilitation: initial evaluation of a new strategy. *Patient Education and Counseling*, 2000; **44:** 283–291.
DOI: 10.1016/S0738-3991(00)00189-0.

6. Jones M, Jolly K, Raftery J, Lip GY and Greenfield S. 'DNA' may not mean 'did not participate': a qualitative study of reasons for non-adherence at home- and centre-based cardiac rehabilitation. *Family Practice*, 2007; **24:** 343–357.
DOI: 10.1093/fampra/cmm021.

7. Berg M. Patient care information systems and health care work: A sociotechnical approach. *Internatational Journal of Medical Imformatics*, 1999; **55:** 87–101.
DOI: 10.1016/S1386-5056(99)00011-8.

8. Broens TF, Huis in 't Veld MHA, Vollenbroek-Hutten MMR, Hermens HJ, Halteren AT van and Nieuwenhuis LJ. Determinants for successful telemedicine implementation: a literature study. *Journal of Telemedicine and Telecare*, 2007; **13:** 303–309. DOI: 10.1258/135763307781644951.

9. Parasuraman A, Zeithaml V and Berry L. A Conceptual Model of Service Quality and Its Implications for Future Research. *The Journal of Marketing*, 1985; **49:** 41–50. DOI: 10.2307/1251430.

10. Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 1989; **13:** 319–340. DOI: 10.2307/249008.

11. Davis FD, Bagozzi RP and Warshaw PR. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 1989; **35:** 982–1003. DOI: 10.1287/mnsc.35.8.982.

12. Taylor S and Todd PA. Understanding information technology usage: A test of competing models. *Information Systems Research*, 1995; **6:** 144–176. DOI: 10.1287/isre.6.2.144.

13. Finkelstein SM, Speedie SM, Demiris G, Veen M, Lundgren JM and Potthoff S. Telehomecare: Quality, perception, satisfaction. *Telemedicine Journal and e-Health*, 2004; **10:** 122–128. DOI: 10.1089/tmj.2004.10.122.

14. Demiris G, Speedie SM and Finkelstein S. Change of patients' perceptions of TeleHomeCare. *Telemedicine Journal and e-Health*, 2001; **10:** 122–128. DOI: 10.1089/153056201316970948.

15. Rogers EM. Diffusion of innovations. 5th ed. New York: Free Press, 2003.

16. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478. DOI: 10.2307/30036540.

17. Gartner Hype Cycle. *Available at www.gartner.com/technology/research/methodologies/hype-cycle.jsp*. Visited October 2010.

18. Hanson D, Calhoun J and Smith D. Changes in provider attitudes toward telemedicine. *Telemedicine Journal and e-Health*, 2009; **15:** 39–43. DOI: 10.1089/tmj.2008.0052.

5

To accept or refuse: exploring the factors related to patients' decisions to participate in a telerehabilitation program using the UTAUT framework

An earlier version of this chapter, co-authored with IJzerman MJ, and Vollenbroek-Hutten MMR has been accepted (minor revisions pending) for publication in the International Journal of Medical Informatics.

Abstract

Background Telerehabilitation is considered a promising alternative to conventional rehabilitation in the treatment of chronic pain. At present, research in the field of telerehabilitation and chronic pain mainly focuses on effectiveness and little is known about the factors that influence patients' decisions to accept or refuse telerehabilitation.

Objective The aim of this small sample size study was to examine chronic pain patients' decisions to accept or refuse participation in a telerehabilitation program, using the UTAUT as a theoretically supported starting point. Acceptance was operationalised as patients' decisions (yes or no) at one moment in time whether or not to use the telerehabilitation service during treatment.

Methods 56 chronic pain patients were asked to participate in the telerehabilitation program. Prior to their decision to either accept or refuse the program, respondents provided information regarding their perceptions of the telerehabilitation treatment, socio-demographic information and disease specific outcome measurements. Observed choice behaviour was used as a measure of patients' technology acceptance (decision). Univariate analyses were conducted to determine which variables held a significant relationship with acceptance of telerehabilitation. Penalized logistic regression models were run to explore which determinants best explained patients' acceptance of telerehabilitation.

Results 45 patients decided to participate in the telerehabilitation program, with 35 patients completing the program; 11 patients refused telerehabilitation. Results showed that accepters of the telerehabilitation service held significantly higher levels of positive perceptions of Performance Expectancy and Facilitating Conditions. Accepters also held significantly higher autonomy levels of exercise motivation and significantly lower levels of pain catastrophising behaviour. Penalized regression analysis showed that as well as Performance Expectancy, Exercise Motivation and Catastrophising behaviour were two important factors underlying telerehabilitation acceptance.

Conclusions This study shows that both perceived telerehabilitation features and patient characteristics play an important role in the decision to participate in a telerehabilitation program. Future research, explaining patient acceptance of chronic pain telerehabilitation, could possibly benefit from including exercise motivation and catastrophising behaviour as either moderators or determinants of acceptance, and as such capturing some of the unique contextual features of telerehabilitation, focusing beyond the technology itself. Since this study was of an

exploratory nature, future studies are necessary to investigate how to adapt the telerehabilitation service to better meet patients' needs and whether addressing patients' levels of exercise motivation and catastrophising behaviour, could improve patient acceptance of the telerehabilitation service.

Introduction

Chronic pain is considered a major public health problem. It occurs in at least 19% of adult Europeans, varying from moderate to severe intensity [1]. Chronic pain is linked with an increased risk of depression and often interferes with sleep, recreational activities and with family and home responsibilities [1–3]. In addition to the physical and emotional burden chronic pain brings, it accounts for considerable healthcare costs, as well as costs such reduced work productivity [4]. Physical training has proven effective in decreasing pain and improving function [5, 6] and therefore plays an important role in conventional pain rehabilitation programs. The majority of conventional programs are clinic-based and supervised [7]. Although these rehabilitation programs improve health outcomes, poor adherence and high relapse rates have been shown to compromise the effectiveness of the programs [5, 8, 9] and as such lead to increased costs [10].

Telerehabilitation, providing healthcare in the home environment via communication technology, is considered a promising alternative to conventional rehabilitation in the treatment of chronic pain. It offers several advantages over conventional care as patients have the opportunity to rehabilitate within their own social environment [11], can avoid transportation issues [12] and are able to personally adjust exercise hours [13]. Some studies in the field of telerehabilitation have shown show encouraging results. For example, physical symptoms can be improved and telerehabilitation can increase self-management skills for patients with back pain [14]. Another study found that a telerehabilitation outpatient rehabilitation program implemented as partial replacement of face-to-face care was as effective as the conventional outpatient rehabilitation program [15].

However, a current systematic review, investigating the effectiveness of exercise-based telemedicine in the treatment of chronic pain, found that telemedicine interventions implemented as a substitution of usual care might be beneficial but that, due to the limited quality of studies, compelling evidence of the effectiveness of these treatments is currently lacking [16].

In spite of the potential of telerehabilitation, the expected benefits of telerehabilitation are only realized when the treatment is accepted by its intended users. Therefore,

an understanding of the reasons behind patients' decisions to accept or refuse telerehabilitation treatment is important. At present, research in the field of telerehabilitation and chronic pain mainly focuses on effectiveness and little is known about the reasons for acceptance or refusal of the treatment or the specific components that influence patients' decisions to accept the service. Do patient characteristics play a part in the acceptance of telerehabilitation, or it is merely influenced by the perceived characteristics of the technology itself?

Within the literature, the concept of technology acceptance is very broadly defined. Depending on the stream of research, acceptance either focuses on implementation success on an organizational level or describes individual acceptance of technology [17]. This study focuses on the exploration of individual acceptance of technology. Within this stream of research, Davis [18] describes acceptance as users' decision about how and when they will use technology. In this study, acceptance is employed as patients' observed choice (behaviour) to either accept or refuse the use of a telemedicine service that they were offered during chronic pain rehabilitation. Consequently, acceptance in this study refers to one specific (decision) moment in time and does not target patients' adherence over time.

In the field of technology acceptance, the Unified Theory of Acceptance and Use of Technology (UTAUT) is the most recent theory that explores determinants of acceptance. The UTAUT was the result of a study by Venkatesh et al [17], who synthesized eight theories of technology acceptance. The UTAUT model includes four direct determinants of technology acceptance. The model shows that, as well as the perceived ease of use of a technology (effort expectancy), the efforts that can be expected to be invested and the benefits that could be gained from technology (performance expectancy) is an essential predictor for patients' decision to accept technology. The model specifies that accepters should hold more positive perceptions of using the technology than refusers, and thus should score higher on the constructs that influence acceptance. The greater potential the value or benefit anticipated from acceptance of the technology relative to the current practice is, the more rapidly it will be adopted. Furthermore, social influence as well as patients' perceptions of facilitating conditions play a role. Although the UTAUT model has not yet been used to model patient acceptance of telerehabilitation, it has been used in studies that investigate the patient perspective in the field of home telehealth and inpatient routine care [19, 20]. These studies demonstrated that the UTAUT model is useful for conceptualization of technology acceptance in the context of telerehabilitation.

In this study, the UTAUT was used as a theoretically supported starting point to explore determinants of patients' acceptance or refusal of the use of a telerehabilitation service in the treatment of chronic pain. As such, it adds to the telerehabilitation literature which, at present is lacking from theoretically driven research [21]. Furthermore, by using a study design that has not been used before in the field of telerehabilitation acceptance, this study adds to the literature in two ways. First, we made use of observed choice behaviour as a measure of technology patients' acceptance (decision). In most studies in the field of technology acceptance, the (decision) moment of acceptance is often employed as 'patients' intention to use the technology' and represents a self-reported, imagined or hypothetical choice behaviour. As such it is unclear whether patients would actually make this same choice in 'real life.' Using observed choice behaviour addresses this problem. Second, our research design allowed for the collection of patients' perceptions at the moment when these patients also made the decision to accept or refuse the telerehabilitation service. This is important, since prior research has shown that patients' perceptions are susceptible to change over time [22].

Methods

Procedure and sample

This study was part of a larger study that investigated the implementation of a web-based telerehabilitation service in a multidisciplinary chronic pain rehabilitation program. In total, 56 chronic pain patients, who were referred to the rehabilitation program, were asked to participate in the telerehabilitation program, in which a web-based exercise program was implemented to partially replace conventional face-to-face rehabilitation. Instead of three visits per week to the clinic as was being carried out in conventional care, patients visited the outpatient rehabilitation clinic for two days and they were instructed to exercise at least once in their own environment using the exercise-based telerehabilitation service. The inclusion criteria used during the intake of patients for the rehabilitation program for chronic low back pain were:

i chronic non-specific pain $>$ 3 months,
ii motivated,
iii a psychoneurotic score $<$ 150 on the Symptom Checklist SCL-90,
iv a Body Mass Index $<$ 35, and
v $>$ 18 years old.

The appropriate ethics committee approved the study and all patients gave their informed consent prior to participation.

Home-based telerehabilitation service

The telerehabilitation service provided in this research was a web-based physical exercise program. It was designed and implemented as a partial replacement of a three-day outpatient group for patients with chronic low back pain. The service made use of a notebook with a webcam and consisted of two treatment modules. Module 1 contained a database of exercise videos to increase strength, balance, flexibility, and endurance. Module 2, a teleconference service, facilitated contact between patient and therapist. Within these modules, the therapist remotely composed an individually tailored exercise program and supervised the patient. The patient and therapist contacted each other weekly by teleconference or met each other during the remaining two days to discuss the rehabilitation progress. Based on the experience and rehabilitation progress, the therapist updated the exercise program weekly. During the first two weeks the patients visited the clinic for three days and received, in addition to their rehabilitation program, training (1 h/week) on how to use the exercise-based telerehabilitation service. From the third week on, the telerehabilitation service was delivered to the patients as partial replacement; one day at the clinic was replaced by one day of rehabilitation in their own environment. Chronic pain patients received seven weeks of clinic-based group rehabilitation.

Assessment

Acceptance Patients' decisions (yes or no) at one moment in time were used as a measure of patients' technology acceptance (decision). Patients either choose to accept telerehabilitation treatment and take home the equipment or choose to refuse telerehabilitation treatment and receive clinic-based treatment only.

Socio-demographics Respondents provided information about their demographic characteristics, namely age, gender, highest level of education and internet experience, which are considered predictors in the use of telerehabilitation services [17].

Disease specific outcome measurements Complaints and disability were assessed in the first week of the outpatient rehabilitation program. Complaints were measured by asking patients to rate their level of pain during the previous week on a visual analogue scale (VAS) [23, 24]. The psychometric properties of the VAS are sufficient. Disability was measured with the Roland Disability Questionnaire (RDQ) [25]. This questionnaire is an illness-specific 24 item functional assessment questionnaire that is frequently used for back pain. The RDQ has established validity, reliability and responsiveness to change. The Dutch version was used [26]. The Åstrand ergometer bicycle test [27] was used to assess the physical condition of the chronic pain patients. This sub maximal test, in which patients bicycle for 6 minutes at a certain intensity,

is not valid for measuring maximal oxygen intake, but is for determining its progress. With the output of the test (workload and heart rate), the VO2 max (corrected for gender, age, length and fat free mass) can be estimated with the Åstrand-Ryhming-nomogram.

Exercise motivation (RAI) The Dutch version of the BREQ-2 [28] was used to determine exercise motivation. The BREQ-2 comprises 19 items relating to five motivation types from the Self Determination Theory (SDT). The SDT describes motivation as a multidimensional concept that resides along a continuum of increasing self-determination [29]. At the lowest end of the continuum is amotivation, with an individual lacking motivation to adopt physical exercise. Intrinsic motivation, on the other end, represents the most autonomous type of motivation, it is associated with greater exercise participation [30] and involves being physically active for its own sake. In between lies extrinsic motivation which occurs if an activity is performed for a purpose other than the task itself, e.g. obtaining promised awards or achieving or avoiding other disappointment. The reasons may vary in relation to the individual's degree of autonomy, creating three categories: external regulation, internalized regulation, and identified regulation. Each item is measured on a five-point Likert-scale. The mean of the 5 retrieved subscales is calculated on a five-point scale to score the extent of each motivation type separately. The BREQ-2 can also be used as a unidimensional index of the degree of self-determination. An overall score of all subscales represents the Relative Autonomy Index [31], with higher levels representing higher autonomy levels. The present study aims to determine whether the level of motivation through SDT, using the Relative Autonomy Index of the BREQ questionnaire, is related to the choice of commencing web-based exercise telerehabilitation.

Innovation scale To measure patients' innovativeness in the domain of IT, the four items instrument of Agarwal and Prasad was used. Personal innovativeness refers to "the willingness of an individual to try out any new information technologies" [32]. Personal innovativeness represents technology-related beliefs which determine individual's pre-disposition to adopt innovative services. Therefore, given the same level of beliefs and perceptions about an innovation, individuals with higher personal innovativeness are more likely to develop positive attitudes towards adopting it than less innovative individuals [32]. Individuals who are more innovative should be more positive in their beliefs about new technology.

Pain Coping Strategy To assess the use of cognitive and behavioural strategies patients use, the Dutch version of the Coping Strategy Questionnaire (CSQ) [33] was used, the Coping met Pijn Vragenlijst [34]. It comprises six subscales for cognitive strategies:

catastrophising, ignoring pain sensations, coping self-statements, re-interpreting pain sensations, diverting attention and praying/hoping. In addition, it measures 'increasing activity level' (a behavioural strategy) and 'perceived effectiveness (how effective do participants think they are in controlling and decreasing pain). The questionnaire consists of 44 items, measured with a numerical rating scale ranging from 0 to 10 (10 cm visual analogue scales) with the end-points defined as 'never do' and 'always do', indicating how frequently the strategy is used to cope with pain. A higher score indicates a higher endorsement of the cognitive coping strategy.

UTAUT Perceptions of telerehabilitation Patients' perceptions regarding the web-based telemedicine service were measured using a questionnaire that was administered before patients made the decision to either use or refuse the telerehabilitation service during rehabilitation. Prior to the measurement of patients' perceptions, chronic pain patients received visual and written information about the telerehabilitation service. The questionnaire was based on the Unified Theory of Acceptance and Use of Technology [17] and measured its four determinants that influence the acceptance of technology: a) Performance Expectancy, b) Effort Expectancy c) Social Influence d) Facilitating Conditions.

Table 5.1: *Operationalisation of the UTAUT constructs.*

Construct	Definition	Items	Example item
Performance Expectancy	The degree to which a patient believes that using the telerehabilitation system will enhance treatment	4	I expect that telerehabilitation will be effective in the treatment of my chronic pain
Effort Expectancy	Patients' beliefs about the effort it will take to learn and use the telerehabilitation service	4	I expect that it will be easy to learn to operate the telerehabilitation service correctly
Social Influence	Patients' perception as to whether people that are important to them think they should use the telerehabilitation service	3	I think my physician would like me to use the telerehabilitation service in the treatment of my chronic pain
Facilitating Conditions	Patients' perceptions of internal (e.g. knowledge, motivation) and external constraints (e.g. resources)	6	I expect that I will have the knowledge necessary to use the telerehabilitation service

Table 5.1 shows how the UTAUT constructs were defined in this study. In total, 17 questionnaire items were formulated, derived from prior research [17, 35] and adapted to the context of the telemedicine service (cf. example items in Table 5.1). Respondents could answer on a seven-point Likert scale, varying from −3 [extremely disagree] to +3 [extremely agree]. In the current sample, the questionnaire constructs showed a satisfactory reliability (Cronbach's alphas varying from 0.76. to 0.96 for the different constructs) after the items which were worded in a negative manner received a reversed scoring. Figure 5.1 presents an overview of the research framework, including the above described measurements.

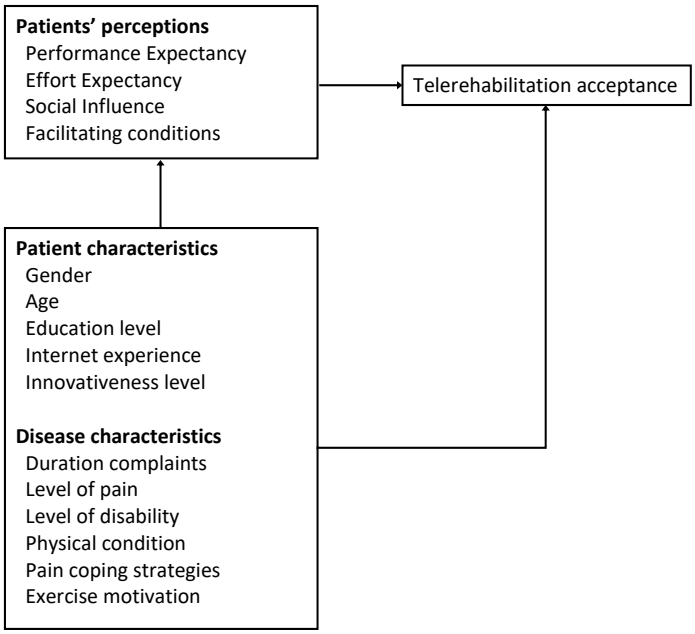

Figure 5.1: *Research framework of telerehabilitation acceptance.*

Statistical analyses

Data were analysed using SPSS 21 and R package logistf [36]. Univariate analyses were conducted using Chi-square tests and t-tests to determine which variables have a significant relationship with acceptance of telerehabilitation. Moreover, penalized logistic regression models were run to correct for potential small-sample bias [36]. The idea of the Firth logistic regression is to introduce a more effective score function by adding a term that counteracts the first-order term from the asymptotic expansion

of the bias of the maximum likelihood estimation. The term will go to zero as the sample size increases [37, 38]. Two separate penalized logistic regression analysis were used to model the predictors of treatment acceptance that were identified in the univariate analysis. Any variable having a significant univariate test at p-value cut-off point 0.25 was included in the regression analysis. Based on the small sample size of this study, we did not choose a traditional level such as 0.05, since this could fail in identifying important predictors. The first regression analysis included the UTAUT predictors only. The second analysis included the UTAUT predictors and both patient and health characteristics. The logistic analyses were performed with both a forward and backward selection approach. Both backward and forward entry showed same results, for parsimony only the results of the backward analysis are presented in this study. The two regression models were evaluated using the Akaike Information Criterion (AIC) as a goodness of fit measure. The AIC is a measure of the relative quality of statistical models for a given set of data. AIC estimates the quality of each model, and tries to balance good fit with parsimony. Hence, AIC provides a means for model selection.

Results

A total of 56 participants were assigned to receive web-based telerehabilitation (Figure 5.2). Of this group, 11 patients (20%) made the decision to refuse the telerehabilitation treatment. A majority of the group (80%) decided to start with the

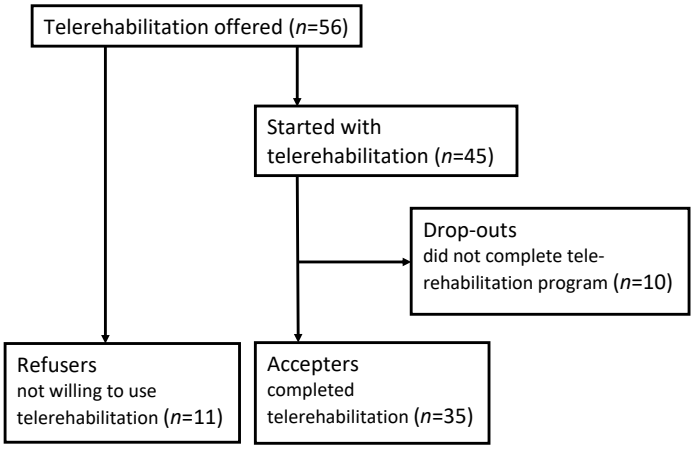

Figure 5.2: *Recruitment and enrollment rate of chronic pain patients.*

telerehabilitation treatment. However, of this group, only 35 patients completed the treatment, 10 patients discontinued the treatment. Personal circumstances, lack of motivation and time were reasons underlying patients' choices to discontinue the treatment. Analysis suggested that the drop-outs should be considered as a subgroup within the total patient group that started telerehabilitation treatment. Patients who completed telerehabilitation treatment both had significantly higher scores on Effort Expectancy ($t = 2.07$, $df = 43$, $p = 0.04$), Performance Expectancy ($t = 2.41$, $df = 43$, $p = 0.02$) and Intention ($t = 2.63$, $df = 44$, $p = 0.02$) when compared to the scores of the drop-out patients. We choose to exclude the drop-out group from analysis, in order to keep the accepter group as homogeneous as possible and to make comparison with the refuser group possible.

Differences in perceived telerehabilitation UTAUT attributes between accepters and refusers

To explore the relation between perceived telerehabilitation attributes and patients' acceptance decision, univariate analyses were performed. Results (Table 5.2) showed that accepters of the telerehabilitation service held significantly higher levels of positive perceptions of Performance Expectancy (mean = 1.09 vs. 0.30, $p = 0.03$) and Facilitating Conditions (mean = 1.77 vs. 0.98, $p = 0.04$). In general, both refusers and users held positive perceptions of the telerehabilitation service with regard to the attributes of Effort Expectancy, Performance Expectancy and Facilitating Conditions.

Table 5.2: *Differences in patients' perceptions of telerehabilitation between accepters and refusers.*

UTAUT constructs	Accepters ($n = 35$) mean (SD)	Refusers ($n = 35$) mean (SD)	Statistical result t, df, p
Effort Expectancy	1.30 (1.20)	0.80 (1.12)	1.18, 43, 0.25
Performance Expectancy	1.09 (0.96)	0.30 (0.91)	2.32, 43, **0.03***
Social Influence	0.04 (1.46)	−0.67 (0.83)	1.39, 42, 0.17
Facilitating Conditions	1.77 (1.04)	0.98 (1.13)	2.10, 43, **0.04***

Table 5.3: *Differences in patient characteristics between accepters and refusers of telerehabilitation.*

	Accepters ($n = 35$)	Refusers ($n = 35$)	Statistical result
Socio-demographics	*n* (%)	*n* (%)	χ^2, *df*, *p*
Gender - female	14 (40.0)	5 (45.5)	0.10, 1, 0.75
Lower education	14 (40.0)	7 (63.6)	1.68, 1, 0.19
Internet experience	34 (97.1)	10 (91.0)	0.78, 1, 0.38
	mean (SD)	mean (SD)	*t*, *df*, *p*
Age (years)	43.09 (11.03)	46.16 (9.51)	−0.83, 44, 0.41
Duration complaints (years)	8.16 (9.28)	6.86 (5.57)	0.44, 44, 0.67
Innovation scale	0.79 (1.33)	0.33 (0.85)	1.05, 42, 0.30
Disease assessments	mean (SD)	mean (SD)	*t*, *df*, *p*
Pain Intensity (VAS Week)	6.70 (2.16)	5.73 (3.05)	1.17, 44, 0.26
Roland Disability	12.54 (4.29)	10.09 (3.99)	1.68, 44, 0.10
VO2-max	27.20 (7.85)	25.56 (9.36)	0.56, 37, 0.58
Pain Coping Strategy			
Catastrophizing	2.63 (1.64)	4.87 (1.17)	3.84, 42, 0.00**
Perceived Effectiveness	4.48 (2.35)	4.72 (0.71)	0.30, 39, 0.77
Ignoring pain	4.20 (2.25)	4.89 (2.43)	0.79, 39, 0.43
Coping self-statements	6.01 (1.79)	6.10 (2.64)	0.12, 42, 0.90
Reinterpretation of pain	2.31 (1.73)	2.33 (1.15)	0.03, 39, 0.97
Increasing activity level	3.44 (1.84)	3.81 (2.08)	0.53, 42, 0.60
Praying/hoping	2.82 (1.87)	4.00 (2.57)	1.48, 37, 0.15
Diverting attention	2.94 (2.48)	3.72 (1.80)	0.88, 38, 0.38
Exercise Motivation (RAI)	10.84 (5.31)	6.85 (5.54)	2.07, 43, 0.04*

Differences in patient characteristics between accepters and refusers

Univariate analyses were performed to explore the relationship between patient characteristics and patients' acceptance decision. Demographic and clinical features of the sample and comparisons between those who accepted and those who refused telerehabilitation treatment are found in Table 5.3. Accepters held significantly higher autonomy levels of exercise motivation (mean = 10.84 vs. 6.85, $p = 0.04$). In addition, those who commenced with telerehabilitation were significantly more likely to hold lower levels of pain catastrophising behaviour (mean = 2.63 vs. 4.87, $p = 0.00$). There was also a trend for patients with higher reported levels of pain disability ($p = 0.10$) to accept telerehabilitation. Accepters held slightly higher disability scores.

No significant relationships were found between acceptance of telerehabilitation and gender, lower educational level, internet experience, age, duration of complaints, patients' innovativeness level, pain intensity, VO2 max level, and for all Pain Coping Strategy Questionnaire scales other than the pain catastrophising scale.

Predictors of acceptance

Two separate logistic regression analyses were performed. The first binary logistic regression analysis with backward selection of predictors for telerehabilitation acceptance/ refusal contained the four UTAUT attributes. Only Performance Expectancy ($B = -1.02$, 95% CI -2.17 to -0.16, $p = 0.02$) was retained in the final model, see Table 5.4.

Table 5.4: *Results of logistic Firth regression backward analyses with telerehabilitation choice as dependent variable for chronic pain patients UTAUT ($n = 45$).*

Predictor (independent) variables	*B*	SE	CI	*p*
Constant	-0.66	0.46	-1.58 to 0.21	0.13
Performance Expectancy	-1.02	0.50	-2.17 to -0.16	0.02*

$AIC = -3.65$; Likelihood ratio test = 5.65 on 1 df, p=0.00

Note: Variables not in the final equation are Effort Expectancy, Social Influence, and Facilitating Conditions

Second, a regression analysis was performed with the four UTAUT variables and the patient characteristics that held a p value < 0.25 on the univariate tests (Table 5.5). These included the Pain Coping Strategies subscale 'Praying/ Hoping' and 'Catastrophising', Exercise Motivation (RAI), the Roland Disability Index, and education level.

Table 5.5: *Results of logistic Firth regression backward analyses with telerehabilitation choice as dependent variable for chronic pain patients UTAUT + patient characteristics ($n = 43$).*

Predictor (independent) variables	*B*	SE	CI	*p*
Constant	0.58	2.67	-5.16 to 6.20	0.83
Exercise motivation (RAI)	-0.19	0.09	-0.39 to -0.03	0.02*
Catastrophizing (CPV-CA)	0.14	0.06	0.03 to 0.29	0.01*

$AIC = -10.29$; Likelihood ratio test= 14.37 on 2 df, $p = 0.00$

Note: Variables not in the final equation are Effort Expectancy, CPV-BH, Performance Expectancy, Education, Roland Disability Index, Social Influence, and Facilitating Conditions

The Binary logistic backward regression of predictors for telerehabilitation acceptance/ refusal retained two significant predictors, namely Exercise motivation ($B = -0.19$, 95% CI -0.39 to -0.03, $p = 0.02$) and Catastrophising ($B = 0.14$ 95% CI 0.03 to 0.29; $p = 0.01$). The Likelihood ratio test goodness-of-fit test indicated an adequate model. In addition, the more negative AIC value, compared to the AIC value of the model including the UTAUT predictors only, showed that the model including the patient characteristics provided a better fit.

Relationship between patient characteristics and perceived telerehabilitation UTAUT attributes

Within the refusers group no statistical significant results ($p < 0.10$) were found between the UTAUT constructs and the patient characteristics. However, within the accepter group, significant correlations were found between Exercise Motivation and both Effort Expectancy ($r = 0.36$, $p = 0.04$) and Performance Expectancy ($r = 0.48$, $p = 0.00$). Also, a significant correlation was found between VO2-max and Social Norms ($r = 0.51$, $p = 0.00$).

Discussion

The purpose of this study was to explore factors related to chronic pain patients' decisions to accept or refuse the use of a telerehabilitation program, using the UTAUT as a theoretically supported starting point.

In this study we found that the UTAUT partly explains patients' decisions to use telerehabilitation. Refusers held significantly lower levels of perceptions on the constructs of Effort Expectancy, Performance Expectancy and Facilitating Conditions. An exploratory regression analysis, accounting for the small study sample size, suggested

that of all UTAUT constructs, Performance Expectancy was the most important predictor of patients' decisions to accept or refuse telerehabilitation. Patients' perceptions of the benefits that they thought they could gain from using telerehabilitation during their treatment were essential for their decision to accept telerehabilitation. Patients who held less positive perceptions of the benefits of telerehabilitation had a higher likelihood of refusing telerehabilitation.

Studies in the field have shown that negative perceptions are susceptible to change and as such do not have to be a definite barrier to telerehabilitation. Patients' opinions can become more positive after patients gain experience with the service [22, 39]. As such, experience could contribute to higher levels of patients' perceptions of Performance Expectancy and consequently contribute to higher levels of acceptance of the telerehabilitation treatment. Further studies are necessary to estimate the effect of (voluntary) trial periods to gain experience with the service and to explore whether it would be beneficial to invest in such persuasion strategies.

Interestingly, next to patient's perceptions of telerehabilitation, patient characteristics played an important role in telerehabilitation acceptance as well. Both patients who held lower levels of pain catastrophising behaviour and those who held higher autonomy levels of exercise motivation were more likely to accept telerehabilitation.

Possibly, adapting future telerehabilitation services to these characteristics could be one strategy to contribute to acceptance of these services in chronic pain rehabilitation. For example, in this study, exercise motivation showed a significant relationship with patient's perceptions of Performance Expectancy, alongside its relationship with telerehabilitation acceptance. Less motivated patients held less positive perceptions of the benefits they would gain from telerehabilitation. Therefore, it could be of importance to tailor the telerehabilitation service to the individual levels of exercise motivation, including motivational strategies for those patients holding lower levels of exercise motivation. An earlier study among chronic pain patients pointed out that some patients consider telerehabilitation less beneficial since they perceive the home environment to be less motivating or feel a loss of personal contact [40]. As such, motivational strategies including exergames or social networks could potentially improve patients' perceptions of Performance Expectancy of the service and ultimately lead to improved levels of acceptance. Inclusion of cognitive behavioural treatment elements to address patients' catastrophising behaviour could be another strategy to improve patients' acceptance, since online cognitive behavioural treatment shows promise in terms of reducing catastrophising behaviour [41].

Next to adaptations in design offering psychological counselling to improve patients' exercise motivational levels and lowering high catastrophising levels, prior to the start of the telerehabilitation treatment, could be another strategy to increase acceptance levels of telerehabilitation among patients with either lower motivational levels or higher pain catastrophising levels. However, further research is necessary to investigate whether patients with increased levels of motivation or lowered levels of catastrophising behaviour do demonstrate higher levels of perceptions of telerehabilitation and whether they have higher chances of accepting telerehabilitation. At last, allowing patients to gain experience with the service prior to the moment of their decision to either accept or refuse telerehabilitation during treatment could possibly facilitate acceptance, since brief experience has the potential to increase patients' perceptions of the service and as such can improve acceptance levels [22]. Further studies are necessary to investigate whether differences exist in the effects of brief experience among the different groups holding either low or high levels of motivation, or low or high levels of catastrophising behaviour.

Although, the UTAUT proved a useful framework in understanding patient acceptance of telerehabilitation, future research could benefit from further exploring the role of patient characteristics. The UTAUT model has originally been validated in the context of employee technology acceptance [17]. This raises the question whether the UTAUT is able to capture some of the unique contextual features of telerehabilitation acceptance. Further studies, including larger sample sizes, are necessary to further investigate whether adding exercise motivation and catastrophising, both determinants that focus beyond the technology itself, can improve future models addressing patient acceptance of telerehabilitation in the field of chronic pain. These studies could also provide a better insight into whether these constructs should be considered moderators or whether they should be modelled as independent predictors.

This study also revealed a relatively high level of acceptance of the telerehabilitation treatment, with only 20% of the patients deciding to reject the use the telerehabilitation service. An interesting question remains as to whether the 'drop-outs' in our study should be considered 'accepters' or 'refusers.' When we do consider the drop-out patients to be refusers, since they made their refusal decision at a later moment in time, the refusal rate would rise to 38%. In depth research with larger patients groups would be useful to gain insight into whether it is possible to predict, based on patients' perception of the intervention and patient characteristics, whether certain patient groups have a higher probability of dropping out from treatment. Currently, there are no existing studies about acceptance or refusal rates for online treatment

targeting physical exercise and rehabilitation in the treatment of chronic pain. One study, concerning an internet-based treatment for chronic headache, reported that 17 out of 156 patients did not start treatment [42]. However, no reasons were presented why these patients did not start treatment. Another study, in the field of e-mental health, offering an open access online service, reported that 58.7% of their potential participants did not enrol in one of the treatment programs that were offered [43]. However, since the treatment is very different from the rehabilitation setting in which acceptance was studied, it is not surprising that the number of 'refusers' was much higher in their 'voluntary' setting of treatment.

Finally, our study did not find any significant relationships between acceptance of telerehabilitation and any socio-demographic patient characteristics. This is contradictory to the findings of other studies in the field. For example, a study in prostate and colorectal cancer survivors found that younger participants as well as higher educated participants were more likely to start a web-based physical activity treatment [44]. A study in the field of chronic pain found that women were less happy to accept the use of technology as a formal element of their care in the future than men [45]. Since their study sample was older than 60, and the age of this study sample was much lower, we hypothesize that this could contribute to the different findings.

In conclusion, the results add to the ongoing consideration of whether current technology acceptance models are applicable to the specific context of healthcare and whether these models need specifications for different kinds of diagnosis groups and treatment. Previous efforts have been made to improve the UTAUT by including other variables [19, 46]; however, within the field of chronic pain and the patients' perspective, up till now no such efforts exist. This study has been a first exploratory step to investigate which determinants are associated with acceptance or refusal of telerehabilitation in the treatment of chronic pain.

Limitations

This study has limitations. First, we made use of a small sample size. Although we corrected for the small sample size in our analysis by using Firth regression analysis for small sample sizes, our conclusions should be interpreted with care. Our study was intended to offer a first insight into the factors that play a part in patients' acceptance of telerehabilitation for chronic pain, using the UTAUT as a theoretical starting point. However, future large sample size studies are necessary for the further development of contextualized telerehabilitation acceptance models, such as the UTAUT, to the field of acceptance and telerehabilitation and should further investigate the exact role of disease specific characteristics, e.g. pain catastrophising and motivational levels.

Furthermore, these studies are necessary to investigate how well technology acceptance models perform in other diagnosis group, since this study was limited to chronic pain patients who were about the start chronic pain rehabilitation treatment. Also, the acceptance and refusal rates in this study were investigated in the context of a clinical trial. It is possible that higher refusal rates would occur when the treatment is offered in a less monitored setting. As such, follow-up studies that observe patients' choice behaviour during a phase following telerehabilitation implementation, with less monitoring, are necessary. Finally, in this study, patient acceptance was operationalised as a choice moment in time; however, it is unclear whether acceptance will directly translate to actual use of telerehabilitation. Follow-up studies should investigate patients' actual use levels after they decided to take part in the telerehabilitation treatment.

Conclusion

The findings of this study extend the knowledge about telerehabilitation acceptance among chronic pain patients, as there have been very few studies of acceptance from the patients' point of view. Our results made clear that the UTAUT proved a useful framework to explore patients' acceptance of telerehabilitation in chronic pain. However, next to perceived telerehabilitation characteristics, patient characteristics play an important role in the acceptance of telerehabilitation treatment for chronic pain. Future research, explaining patients' acceptance of chronic pain telerehabilitation, could possibly benefit from including exercise motivation and catastrophising behaviour as either moderators or determinants of acceptance, and as such capturing some of the unique contextual features of telerehabilitation, focusing beyond the technology itself.

However, future studies are necessary to further investigate the role of these constructs and to generate knowledge on how to translate these findings into the design of future services, since this study was exploratory of nature. Further research is also necessary to investigate whether addressing patients levels of exercise motivation and catastrophising behaviour prior to the start of the telerehabilitation treatment and by making adaptations to the current telerehabilitation service, can improve patients' acceptance of the telerehabilitation service.

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References

1. Breivik H, Collett B, Ventafridda V, Cohen R and Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 2006; **10:** 287–333.
DOI: 10.1016/j.ejpain.2005.06.009.

2. Breivik H, Eisenberg E and O'Brien T. The individual and societal burden of chronic pain in Europe: the case for strategic prioritisation and action to improve knowledge and availability of appropriate care. *BMC Public Health*, 2013; **13:** 2–14.
DOI: 10.1186/1471-2458-13-1229.

3. Elliott TE, Renier CM and Palcher JA. Chronic pain, depression, and quality of life: correlations and predictive value of the SF-36. *Pain Medicine*, 2003; **4:** 331–339.
DOI: 10.1111/j.1526-4637.2003.03040.x.

4. Lambeek LC, Tulder MW van, Swinkels I, Koppes LLJ, Anema JR and Mechelen W van. The trend in total cost of back pain in the Netherlands in the period 2002 to 2007. *Spine*, 2011; **36:** 1050–1058.
DOI: 10.1097/BRS.0b013e3181e70488.

5. Tulder MW van, Malmivaara A, Esmail R and Koes BW. Exercise therapy for low back pain. *Cochrane Database of Systematic Reviews (Online)*, 2000**:** CD000335.
DOI: 10.1002/14651858.CD000335.

6. Abenheim L, Rossignol M, Valat JP et al. The role of activity in the therapeutic management of back pain. *Spine*, 2000; **25:** 1S–33S.
PMID: 10707404.

7. Hayden JA, Tulder MW van, Malmivaara AV and Koes BW. Meta-analysis: exercise therapy for nonspecific low back pain. *Annals of Internal Medicine*, 2005; **142:** 765–775.
DOI: 10.1002/14651858.CD000335.pub2.

8. Turk DC and Rudy TE. Neglected topics in the treatment of chronic pain patients-relapse, noncompliance, and adherence enhancement. *Pain*, 1991; **44:** 5–28.
DOI: 10.1016/0304-3959(91)90142-K.

9. Hayden JA, Tulder MW van, Malmivaara A and Koes BW. Exercise therapy for treatment non-specific low back pain (review). *Cochrane Database Systematic Reviews*, 2005**:** CD000335.
DOI: 10.1002/14651858.CD000335.pub2.

10. Jordan JL, Holden MA, Mason EE and Foster NE. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Systematic Reviews*, 2010**:** CD005956.
DOI: 10.1002/14651858.CD005956.pub2.

11. Temkin AJ, Ulicny GR and Vesmarovich SH. Telerehab. A perspective of the way technology is going to change the future of patient treatment. *Rehab Management*, 1996; **9:** 28–30. PMID: 10166562.

12. Agrell H, Dahlberg S and Jerant AF. Patients' Perceptions Regarding Home Telecare. *Telemedicine and e-Health*, 2000; **6:** 409–415. DOI: 10.1089/15305620050503889.

13. Ruland CM and Moore SM. Eliciting exercise preferences in cardiac rehabilitation: initial evaluation of a new strategy. *Patient Education and Counseling*, 2000; **44:** 283–291. DOI: 10.1016/S0738-3991(00)00189-0.

14. Jansen-Kosterink S, Huis in 't Veld R, Wever D and Vollenbroek-Hutten M. Introducing remote physical rehabilitation for patients with chronic disorders by means of telemedicine. *Health and Technology*, 2015; **5:** 83–90. DOI: 10.1007/s12553-015-0111-5.

15. Jong CC de, Ros WJ and Schrijvers G. The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *Journal of Medical Internet Research*, 2014; **16:** e19. DOI: 10.2196/jmir.3000.

16. Adamse C, Dekker-Van Weering MG, van Etten-Jamaludin FS and Stuiver MM. The effectiveness of exercise-based telemedicine on pain, physical activity and quality of life in the treatment of chronic pain: a systematic review. *Journal of Telemedicine and Telecare*, 2017. DOI: 10.1177/1357633X17716576.

17. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478. DOI: 10.2307/30036540.

18. Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 1989; **13:** 319–340. DOI: 10.2307/249008.

19. Cimperman M, Makovec Brenčič M and Trkman P. Analyzing older users' home telehealth services acceptance behavior-applying an Extended UTAUT model. *International Journal of Medical Informatics*, 2016; **90:** 22–31. DOI: 10.1016/j.ijmedinf.2016.03.002.

20. Hennemann S, Beutel ME and Zwerenz R. Drivers and Barriers to Acceptance of Web-Based Aftercare of Patients in Inpatient Routine Care: A Cross-Sectional Survey. *Journal of Medical Internet Research*, 2016; **18:** e337. DOI: 10.2196/jmir.6003.

21. Or CK, Karsh BT, Severtson DJ, Burke LJ, Brown RL and Brennan PF. Factors affecting home care patients' acceptance of a web-based interactive self-management technology. *Journal of the American Medical Informatics Association*, 2011; **18:** 51–59.
DOI: 10.1136/jamia.2010.007336.

22. Cranen K, Huis in 't Veld MHA, IJzerman MJ and Vollenbroek-Hutten MMR. Change of patients' perceptions of telemedicine after brief use. *Telemedicine and e-Health*, 2011; **17:** 530–535.
DOI: 10.1089/tmj.2010.0208.

23. Karcioglu O, Topacoglu H, Dikme O and Dikme O. A systematic review of the pain scales in adults: Which to use? *American Journal of Emergency Medicine*, 2018.
DOI: 10.1016/j.ajem.2018.01.008.

24. Williamson A and Hoggart B. Pain: a review of three commonly used pain rating scales. *Journal of Clinical Nursing*, 2005; **14:** 798–804.
DOI: 10.1111/j.1365-2702.2005.01121.x.

25. Roland M and Morris R. A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine*, 1983; **8:** 141–144.
PMID: 6222486.

26. Gommans IHB, Koes BW and Tulder MW van. Validiteit en responsiviteit Nederlandstalige Roland Disability Questionnaire. Vragenlijst naar functionele status bij patienten met lage rugpijn. *Nederlands Tijdschrift voor Fysiotherapie*, 1997; **107:** 28–33.

27. Åstrand P-O and Rhyming I. A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work. *Journal of Applied Physiology*, 1954; **7:** 218–221.
DOI: 10.1152/jappl.1954.7.2.218.

28. Markland D and Tobin V. A modification of the Behavioral Regulation in Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology*, 2004; **26:** 191–196.
DOI: 10.1123/jsep.26.2.191.

29. Deci EL and Ryan RM. Handbook of self-determination research. University Rochester Press, 2002.

30. Teixeira PJ, Carraça EV, Markland D, Silva MN and Ryan RM. Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 2012; **9:** 78.
DOI: 10.1186/1479-5868-9-78.

31. Ryan R and Connell J. Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, 1989; **57:** 749–761.
PMID: 2810024.

32. Agarwal R and Prasad J. A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, 1998; **9:** 204–215.
DOI: 10.1287/isre.9.2.204.

33. Rosenstiel AK and Keefe FJ. The use of coping strategies in chronic low back pain patients: Relationship to patient characteristics and current adjustment. *Pain*, 1983; **17:** 33–44.
PMID: 6226916.

34. Spinhoven Ph, Kuile MM ter and Linssen ACG. Coping met Pijn Vragenlijst: Een experimentele handleiding. Lisse: Swets en Zeitlinger, 1994.

35. Taylor S and Todd PA. Understanding information technology usage: A test of competing models. *Information Systems Research*, 1995; **6:** 144–176.
DOI: 10.1287/isre.6.2.144.

36. G Heinze G, Ploner M, Dunkler D and Southworth H. logistf: Firth's bias reduced logistic regression. R package version, 1.20. 2013.

37. Firth D. Bias reduction of maximum likelihood estimates. *Biometrika*, 1993; **80:** 27–38.
DOI: 10.1093/biomet/80.1.27.

38. Heinze G and Schemper M. A solution to the problem of separation in logistic regression. *Statistics in Medicine*, 2002; **21:** 2409–2419.
DOI: 10.1002/sim.1047.

39. Vuononvirta T, Timonen M, Keinänen-Kiukaanniemi S et al. The attitudes of multiprofessional teams to telehealth adoption in northern Finland health centres. *Journal of Medicine and Telecare*, 2009; **15:** 290–296.
DOI: 10.1258/jtt.2009.090108.

40. Cranen K, Drossaert CHC, Brinkman ES, Braakman-Jansen ALM, IJzerman MJ and Vollenbroek-Hutten MMR. An exploration of chronic pain patients' perceptions of home telerehabilitation. *Health Expectations*, 2012; **15:** 339–350.
DOI: 10.1111/j.1369-7625.2011.00668.x.

41. Garg S, Garg D, Turin TC and Chowdhury MFU. Web-Based Interventions for Chronic Back Pain: A Systematic Review. *Journal of Medical Internet Research*, 2016; **18:** e139.
DOI: 10.2196/jmir.4932.

42. Devineni T and Blanchard EB. A randomized controlled trial of an internet-based treatment for chronic headache. *Behaviour Research and Therapy*, 2005; **43:** 277–292.
DOI: 10.1016/j.brat.2004.01.008.

43. Al-Asadi AM, Klein B and Meyer D. Pretreatment attrition and formal withdrawal during treatment and their predictors: an exploratory study of the anxiety online data. *Journal of Medical Internet Research*, 2014; **16:** e152.
DOI: 10.2196/jmir.2989.

44. Golsteijn RHJ, Bolman C, Peels DA, Volders E, Vries H de and Lechner L. A web-based and print-based computer-tailored physical activity intervention for prostate and colorectal cancer survivors: a comparison of user characteristics and intervention use. *Journal of Medical Internet Research*, 2017; **19:** e298.
DOI: 10.2196/jmir.7.

45. Currie M, Philip LJ and Roberts A. Attitudes towards the use and acceptance of eHealth technologies: a case study of older adults living with chronic pain and implications for rural healthcare. *BMC Health Services Research*, 2015; **15:** 162.
DOI: 10.1186/s12913-015-0825-0.

46. Hoque R and Sorwar G. Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model. *International Journal of Medical Informatics*, 2017; **101:** 75–84.
DOI: 10.1016/j.ijmedinf.2017.02.002.

6

Do perceptions of chronic pain patients regarding a telerehabilitation service change after use and what is the relationship with actual use?

An earlier version of this chapter, co-authored with Huis in 't Veld MHA, IJzerman MJ, Hermens HJ, Jansen-Kosterink SM, Vollenbroek-Hutten MMR is under review.

Abstract

Objective The main objective of this study was to gain insight into how patients' perceptions of telerehabilitation change over time by measuring patients' pre- and post-use perceptions and to investigate how this change is related to patients' actual use of the service. Insights into these aspects could guide efforts to prevent treatment attrition.

Materials and methods 58 chronic pain patients were asked to use exercise-based telerehabilitation as a partial replacement of conventional outpatient rehabilitation. Patients' perceptions were measured before and after receiving telerehabilitation, using a questionnaire based on both the Technology Acceptance Model and the Theory of Planned Behaviour (C-TAM-TPB).

Results 45 patients started using the telerehabilitation service, with 33 patients completing the program. On average, the service was used 1.4 (SD = 1.3) times a week. Patients showed a significant change in a negative direction on the constructs of perceived usefulness, attitude, and intention to use. Patients who demonstrated a negative change towards a negative value of the direct predictor intention to use held significantly lower frequency of use scores, than patients who showed a negative change but held positive levels of intention to use. Patients' post-use perceptions of intention to use and perceived behavioural control were significantly related to actual use and performed best in explaining variance in patients' actual use ($R^2 = .39$).

Conclusion The results of this study have shown that patients' perceptions of telerehabilitation do change after use and suggest that alongside magnitude and direction of change in patients' perceptions, it is important to consider patients' positive or negative perceptions of telerehabilitation service after use experience in relation to patients' actual use of telerehabilitation. Therefore, monitoring and addressing patients' perceptions during use could offer a opportunity to contribute to higher use levels of telerehabilitation.

Introduction

A significant amount of the population worldwide suffers from chronic pain, which increases as the population ages [1–3]. Chronic pain interferes with physical and emotional functioning in various aspects of life as it contributes to disability, anxiety and depression and poor quality of life [4, 5]. Alongside the impact on personal life, it impacts society as chronic pain accounts for considerable direct healthcare costs, as well as indirect costs such as a loss of productivity [1].

Physical exercise has proven to decrease pain and improve function [6–8] and therefore plays an important role in multidisciplinary clinic-based pain rehabilitation programs. Despite findings of initial improvement for some patients, poor adherence and high relapse have been shown to compromise the effectiveness of these programs [6, 9–11]. Research shows that conventional programs also suffer from low participation rates as a result of patients' physical symptoms that limit mobility, transportation requirements and cost constraints [12].

As such, there is a need for innovative pain rehabilitation programs that address above mentioned issues and can increase patient uptake. In this respect, telerehabilitation, providing remote delivery of rehabilitative services through internet and communication technology, is considered a promising strategy as it brings care into the patient's daily environment. Treatment can be a better fit with the patient's lifestyle and translation of the acquired skills into the patient's environment could become easier [13, 14]. Furthermore, greater patient groups could be reached.

Although telerehabilitation offers an improved approach to providing healthcare, the expected benefits of telerehabilitation are only realized when the treatment is accepted and used by its intended users. Studies have demonstrated that participants of web-based interventions show great variation in use, and they often do not complete treatment [15, 16]. Therefore, an understanding of the factors that influence actual use is important. This may contribute to better uptake and ultimately lead to better treatment outcomes. Within the field of telerehabilitation, only a small amount of studies are dedicated to the investigation of the patients' perspective on telerehabilitation [17–19]. The studies that do investigate the patients' perspective are commonly measured at one point in time, either prior to or after patients have experienced telerehabilitation [18, 19]. Whether these perceptions change during use is little explored. Insight into these changes in pre- and post-use perceptions during use is of significant importance to the implementation of future telemedicine initiatives, as it could jeopardize its success. Changing perceptions, for example, could lead to attrition in patients who choose to engage based on their positive pre-use perceptions, yet withdraw as

their expectations are not met during use [20]. Previous literature has shown that perceptions are susceptible to change. A recent study revealed that brief experience with a web-based exercise service changed patients' perceptions into a positive direction [21]. However, it remains unclear how patients' perceptions would have evolved after an extended period of use. Research suggests that the perceptions of users without prior experience with a service are likely to change into a positive direction [22, 23]. A study of Hanson [24] also revealed this effect for their first time users. However, they demonstrated that experienced users, as opposed to first time users, are equally likely to change their attitudes in a negative direction as they are to change them in a positive direction.

To our knowledge, no other studies in the field of telemedicine have investigated changes of patients' perceptions over an extended period of time. Therefore, the current study investigates in what way patients' pre- and post- use perceptions of a telerehabilitation treatment change after use and how these changes relate to patients' actual use of telerehabilitation.

Methods

Procedure and sample

The research sample consisted of chronic low back pain patients who were referred to a multidisciplinary outpatient rehabilitation program and agreed to use telerehabilitation during their treatment. During the first two weeks, patients visited the clinic for three days of conventional rehabilitation and received training on how to use the telerehabilitation service. From the third week on, patients used the telerehabilitation service that was implemented as partial replacement of conventional care; one day of conventional rehabilitation was replaced by one day of rehabilitation at home. The total rehabilitation program lasted for seven weeks.

The telerehabilitation service consisted of a notebook, including a web camera and internet access. The service consisted of two treatment modules: 1) a database of exercise videos to increase strength, balance, flexibility and 2) a teleconference service. A physiotherapist composed a weekly online individual exercise program for each patient. The teleconference service allowed patients to contact their therapist weekly. In addition, patients had the opportunity to record a specific exercise that was examined remotely by their therapist to assess the quality of the performed exercise. The inclusion criteria used during the intake of patients for the rehabilitation program for chronic low back pain were:

1. chronic non-specific pain $>$ 3 months,
2. motivated,
3. a psychoneurotic score $<$ 150 (Symptom checklist SCL-90 [25]),
4. a Body Mass Index $<$ 35, and
5. age $>$ 18 years

Patients' pre- and post-use perceptions

Patients' perceptions regarding the telerehabilitation service were measured using a questionnaire that was administered before (T_0) and after (T_1) patients completed the telerehabilitation program. Prior to the measurement perceptions at T_0, patients received visual and written information about the telerehabilitation service. The questionnaire was based on the C-TAM-TPB. [26] (Table 6.1). This theory is based on the integration of both the Technology Acceptance Model (TAM), a leading theory in health ICT acceptance [27] , and the Theory of Planned Behaviour (TPB) [28].

Table 6.1: *Operationalisation of the C-TAM-TPB constructs.*

Construct	Definition	Items	Example item
Perceived Ease of Use $\alpha = 0.80$	Patients' beliefs about the effort it will take to learn and use the technology	4	I expect that it will be easy to learn to operate the telerehabilitation service
Perceived Usefulness $\alpha = 0.72$	The degree to which a patient believes that using the system will provide benefit	4	I expect that telerehabilitation will be beneficial in the treatment of my chronic pain
Attitude $\alpha = 0.76$	Patients' positive or negative evaluative affect about using the technology	3	I expect that I will enjoy working with the telerehabilitation service
Social Norms $\alpha = 0.83$	Patients' perception as to whether people that are important to them think they should use the telemedicine service	3	I expect that my physician would like me to use the telerehabilitation service in the treatment of my chronic pain
Perceived Behavioural Control $\alpha = 0.72$	Patients' perceived internal and external constraints	6	I expect that I will have the knowledge necessary to use the telerehabilitation service
Intention to use $\alpha = 0.77$	Patients' beliefs about the effort it will take to learn and use the technology	3	I expect that I will use the telerehabilitation service

The C-TAM-TPB states that patients' actual use is determined by patients' perceived behavioural control and intentions to use. In its turn, patients' intentions to use are determined by: (i) perceived usefulness, (ii) attitude, (iii) social norms, and (iv) perceived behavioural control. Patients' attitudes are determined by patients' perceptions of ease of use and perceived usefulness.

In total, 19 questionnaire items were formulated, derived from prior research [27, 29] and adapted to the context of the telemedicine service (Table 6.2). Respondents could answer on a seven-point Likert scale, varying from −3 [extremely disagree] to 3 [extremely agree]. In the current sample, the questionnaire constructs showed a satisfactory reliability. Furthermore, open-ended questions were included in

Table 6.2: *Characteristics of telerehabilitation users ($n = 33$).*

User characteristics ($n = 33$)				
Gender	*n*			
male	20			
Age (years)	mean	(SD)		
	43.2	(11.3)		
Education	*n*			
Low	14			
Middle	11			
High	7			
Marital status	*n*			
Single	5			
Married/cohabiting	28			
Internet experience	*n*			
Yes	32			
Scale	mean	(SD)	min	max
Innovativeness scale	0.75	(1.33)	−2.75	2.75
Exercise motivation (RAI)	10.90	(5.41)	−6.00	18.33
Pain Intensity month	6.12	(2.12)	2.00	9.90
Pain Intensity week	6.64	(2.17)	2.10	9.60
Roland Disability	12.76	(4.21)	6.00	20.00
VO2-max	26.99	(7.84)	15.73	49.76
Pain catastrophizing behavior	2.64	(1.66)	0.00	6.17

in the post-use questionnaire, which addressed perceived advantages and disadvantages during use. Patients were also questioned about their preferences regarding telerehabilitation implementation (e.g. replacement of conventional care or follow-up treatment).

Actual use

Actual use was operationalised as the average amount of logged exercise sessions that a patient performed with the telerehabilitation system during five weeks. Patients were advised by their therapist to use the telerehabilitation service at least once a week and were considered compliant when they used the service at least once a week for three weeks out of five.

Outcome measures

Exercise motivation (RAI) The Dutch version of the BREQ-2 [30] was used to determine exercise motivation. The BREQ-2 comprises 19 items relating to five motivation types from the Self Determination Theory (SDT) [31]. Each item is measured on a five-point Likert-scale. An overall score of all subscales, the Relative Autonomy Index [32] was used to assess patients' autonomy levels, with higher levels representing higher autonomy levels and scores ranging between −24 to 20.

Innovation scale To measure patients' innovativeness, the willingness to try out new information technologies, the four items instrument of Agarwal and Prasad [33] was used. Given the same level of beliefs and perceptions about an innovation, individuals with higher personal innovativeness are expected to be more likely to develop positive beliefs towards the technology than less innovative individuals [33].

Pain Catastrophising To assess patients' pain catastrophising behaviour, the subscale 'catastrophising' of the Dutch version of the Coping Strategy Questionnaire (CSQ) [34] was used; the Coping met Pijn Vragenlijst [35]. The Coping met Pijn Vragenlijst consists of 44 items, measured with a numerical rating scale ranging from 0 to 10 (10 cm visual analogue scales) with the end-points defined as 'never do' and 'always do', indicating how frequently the strategy is used to cope with pain. A higher score indicates a higher endorsement of the cognitive coping strategy.

Disease specific outcome measurements Complaints and disability were assessed in the first week of the outpatient rehabilitation program. Complaints were measured by asking patients to rate their level of pain during the previous week on a visual analogue scale (VAS) [36]. Disability was measured with the Roland Disability Questionnaire (RDQ) [37]. This questionnaire is an illness-specific 24 item functional assessment

questionnaire that is frequently used for back pain. The RDQ has established validity, reliability and responsiveness to change. The Dutch version was used [38]. To assess patients' physical condition, the Åstrand ergometer bicycle test [39] was used. With the output of the test, both workload and heart rate during bicycle activity for 6 minutes, the VO2 max (corrected for gender, age, length and fat-free mass) was estimated with the Åstrand-Ryhming-nomogram. In addition, respondents provided information about their age, marital status, gender, highest level of education and internet experience.

Statistical analyses

Wilcoxon signed ranks test were applied to examine the differences between the scores on the perceptions questionnaire, before and after use of the telerehabilitation service during rehabilitation. All reported p values are for two-sided tests. A delta of the questionnaire pre-use and post-use scores was calculated for each construct. All reported p values are for two-sided tests.

Relationships between the delta scores of pre- and post-use scores and use were explored using descriptive statistics, thereby taking magnitude and direction of change into account. In order to examine the relationship between pre-use and post-use perceptions and actual use, descriptive values and Spearman's correlations were used. In addition three separate Structural Equation Models (SEM), using patients' pre-use perceptions values, post-use perceptions values and delta change perceptions values were used to investigate which of these values best predicted patients' actual use. SEM analyses were conducted using AMOS 18.0 software (IBM Corp, NY, USA). All p values were calculated using the bootstrapping method in AMOS software, a non-parametric method which allows for the estimation of statistical parameters from the sample by means of resampling by replacement. Commonly used goodness-of-fit indices [40] were employed to assess the overall model fit, including the chi-square root mean square residual (RMSEA), the comparative fit index (CFI), incremental fit index (IFI) and the Tucker Lewis Index (TLI).

Results

A total of 58 chronic low back pain patients were asked to use the exercise-based telerehabilitation service during rehabilitation, 45 patients started using the telerehabilitation service. During the program, 12 patients stopped using the service and were considered drop-outs. Reasons for discontinuation were a lack of time or motivation. One patient dropped out because of problems with the telerehabilitation equipment. In total, 33 patients completed the telerehabilitation treatment.

Results demonstrated that a higher education level was positively associated with higher scores of perceptions on ease of use, attitude, and intention. Furthermore, patients who expressed both higher levels of innovativeness and higher autonomy levels of exercise behaviour held higher scores of perceptions of ease of use, usefulness and attitude. Holding higher levels of innovativeness also was associated with higher levels of perceived behavioural control. Lastly, higher pain intensity levels were associated with lower scores on ease of use (Table 6.3).

Frequency of use and compliance

On average patients used the telerehabilitation service 7.2 (SD = 9.5) times, which corresponds to an average of 1.4 (SD = 1.3) times per week. The frequency of use for the final 2 weeks declined compared with the first 2 weeks (Figure 6.1). The service was a used for 35.7 (SD = 37.5) minutes per week on average. A total of 55% of the chronic pain patients was considered compliant and used the service at least once a week for three weeks out of five.

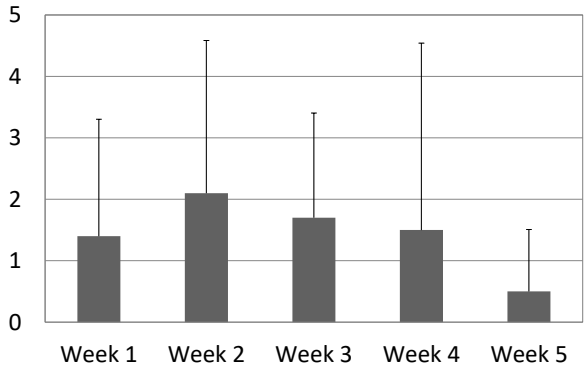


Figure 6.1: *Frequency of use, mean number and SD of sessions per week ($n = 33$).*

Changes in pre- and post-use scores on perceptions

Wilcoxon signed rank tests (Table 6.4) revealed a significant difference between the pre- and post-use scores of chronic pain patients on the constructs perceived usefulness ($Z = -4.334$, $p = 0.00$), attitude ($Z = -2.831$,$p = 0.01$), and intention to use ($Z = -4.673$, $p = 0.00$). Patients' perceptions of perceived usefulness and attitude changed from a positive score into a neutral score. Patients' intentions to use telerehabilitation changed from positive to slightly negative. The differences between the patients' pre-

Table 6.3: *Relationship between patient characteristics, frequency of use, and pre-use perceptions ($n = 33$).*

	USE	EASE	USEFULN	ATT	SN	PBC	INT
Socio-dem.	χ^2 (p)	χ^2 (p)	χ^2 (p)	χ^2 (p)	χ^2 (p)	χ^2 (p)	χ^2 (p)
Gender	-	-	-	-	-	-	-
Techn. exp.	-	-	-	-	-	-	-
	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)
Age	-	-	-	-	-	-	-
Education level	-	0.41 (0.02)	-	0.61 (0.00)	-	-	0.48 (0.01)
Duration pain	-	-	-	-	-	-	-
Innovativeness	-	0.34 (0.06)	0.51 (0.00)	0.63 (0.00)	-	0.38 (0.03)	-
Disease	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)
Pain Intensity							
month	-	-	-	-	-	-	-
week	-	-0.40 (0.02)	-	-	-	-	-
Roland disability	-	-	-	-	-	-	-
VO2-max	-	-	-	-	0.59 (0.00)	-	-
Pain catastroph.	-	-	-	-	-	-	-
Exercise motiv.	-	0.48 (0.01)	0.45 (0.01)	0.51 (0.00)	-	-	-

and post-use scores on social norms and perceived behavioural control showed no statistical change.

Table 6.4: *Changes in pre- and post-use scores in patients (n=30).*

	pre-use score mean (SD)	post-use score mean (SD)	Δ	*Z*	*p*
Perc. Ease of Use	1.40 (1.20)	1.18 (0.88)	−0.22	−0.781	0.44
Perc. Usefulness	1.19 (1.02)	−0.08 (0.87)	−1.27	−4.334	0.00*
Attitude	1.01 (0.97)	0.09 (1.58)	−0.92	−2.831	0.01*
Social Norms	−0.09 (1.46)	−0.43 (1.47)	−0.34	−1.302	0.19
Perc. Beh. Control	1.76 (1.42)	1.93 (0.93)	+0.17	−0.579	0.56
Intention to Use	2.04 (0.97)	−0.54 (1.84)	−2.58	−4.673	0.00*

Direction of changes between patients' pre-use and post-use perceptions

Looking in more depth at the changes in patients' beliefs after use, Table 6.5 shows that the majority of the patients' beliefs move in a negative direction after use. However, in the case of the constructs perceived usefulness and intention to use, about half of the patients remained positive ($+ \rightarrow +$). The only area in which a majority of patients' beliefs moved towards a negative value ($+ \rightarrow -$) was the construct of attitude.

Table 6.5: *Direction of changes.*

	Direction of change (*n*)							total
	negative Δ			positive Δ			Δ ≈ 0	
	$+ \rightarrow -$	$- \rightarrow -$	$+ \rightarrow +$	$- \rightarrow -$	$+ \rightarrow +$	$- \rightarrow +$		
Perc. Ease of Use	2	1	14	-	9	4	1	31
Perc. Usefulness	12	1	12	-	3	-	2	30
Attitude	13	1	7	-	7	-	2	30
Social Norms	7	6	4	2	1	3	9	31
Perc. Beh. Control	1	2	8	1	7	2	9	30
Intention to Use	15	1	12	-	1	1	1	31

We further explored the relationship between the changes in patients' perception and use, by looking specifically at the changes in the two constructs that are hypothesized to influence use directly, namely intention to use and perceived behavioural con-

trol. Patients who demonstrated a negative change towards a negative value of 'intention to use' held significantly lower frequency of use scores (mean = 0.90, SD = 0.54, $n = 15$), compared to patients who showed a negative change but held positive levels of intention to use (mean = 2.07, SD = 1.53, $n = 11$) ($t = -2.77$, $df = 24$, $p = 0.01$). For the construct perceived behavioural control, no significant difference was found in frequency of use between patients who showed a negative change towards a positive score (mean = 1.75, SD = 1.13, $n = 9$) and patients who showed a positive score towards a positive score (mean = 1.95, SD = 1.63, $n = 8$) ($t = 0.28$, $df = 13$, $p = 0.78$)

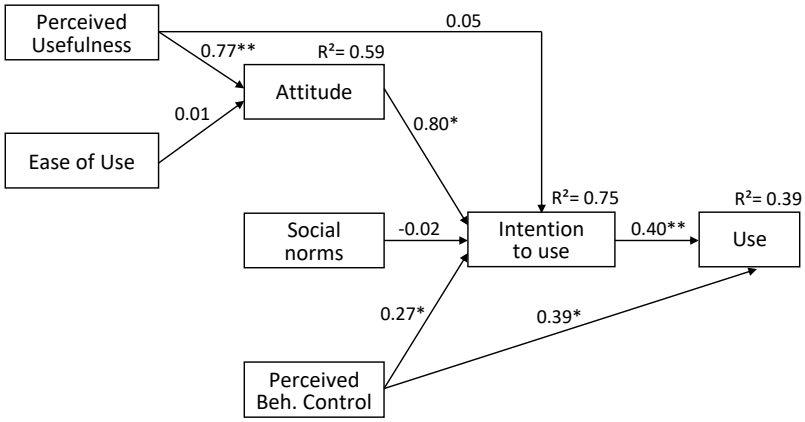
Patients' perceptions in relationship to use

To gain insight into the relationships between the C-TAM-TPB constructs and use, Spearman correlations were calculated. Table 6.6 shows that both patients' pre-use ($r = .36$, $p = 0.04$) and post-use perceptions of perceived behavioural control ($r = 0.42$, $p = 0.02$) showed a significant correlation with use. Regarding intention, post-use intention ($r = 0.52$, $p = 0.00$) as well as delta pre- and post-use intention ($r = 0.54$, $p = 0.00$) showed a significant correlation with use.

Table 6.6: *Spearman correlations (and p values) between patients' use and patients' pre-, post and delta perceptions of the C-TAM-TPB constructs* ($30 \leq n \leq 33$).

Constructs	Spearman correlations between					
	pre-use perceptions and use		post-use perceptions and use		Δ perceptions and use	
	r	*p*	*r*	*p*	*r*	*p*
PBC	0.36*	(0.04)	0.42*	(0.02)	-0.92	(0.63)
INT	0.16	(0.39)	0.52*	(0.00)	0.54*	(0.00)

To gain further insight into the relationships of the full C-TAM-TPB model, three separate SEM analyses were run to explore in what way patients' perceptions were related to actual use of the telerehabilitation service. The model, including patients' pre-use perceptions as predictors of patients' actual use, performed best in explaining patients' actual use (Figure 6.2; Table 6.7). It showed that intention to use and facilitating conditions were significant predictors of actual use and explained 39% of variance in actual use. In turn, patients' attitudes and perceived behavioural control (and indirectly patients' perceptions of perceived usefulness) could explain 75% of variance in patients' intention to use. The fit statistics indicate that the model provided an adequate fit to the data. The SEM models, including patients' pre-use perceptions and patients' delta perceptions as predictors of use, were able to explain 13% and 17% of variance in use (Appendix A).



Fit statistics:
($\chi 2(7, N=30)=7.838$, $p=.347$); CFI=.989; IFI=.991, RMSEA=.064, TLI=.968, Bollen-Stein bootstrap $p=.444$.

**$p<0.001$; * $p>0.05$

Figure 6.2: *C-TAM-TPB model Post-use perceptions relationship USE (mean frequency of use).*

Table 6.7: *Standardized regression weights and bootstrap confidence intervals for the post-use SEM model* ($n = 30$).

	Estimate	S.E.	C.R.	confidence interval	p
ATT ← PU	.775	.241	5.873	1.019 to 1.751	.001
ATT ← PEU	.008	.166	.064	−.285 to .385	.940
INT ← ATT	.797	.171	5.490	.567 to 1.226	.002
INT ← PU	.053	.318	.358	−.447 to .732	.787
INT ← SN	−.017	.122	−.181	−.234 to .222	.836
INT ← PBC	.268	.186	2.892	.282 to .780	.002
USE ← INT	.403	.107	2.704	.128 to .477	.004
USE ← PBC	.395	.214	2.651	.224 to .961	.004

Additional measures of patients' perceptions of telerehabilitation after use

Patients also reflected on both perceived drawbacks and benefits during telerehabilitation treatment (Table 6.B.1, appendix B). The most reported benefits related to avoiding travel issues, visual support at home when performing exercises and the flex-

ibility of the exercise times at home. With respect to perceived drawbacks, patients' reflected most on the absence of direct feedback on their exercise, technical issues (e.g. problems with internet connection) and a loss of motivation. Furthermore, patients responded to the question whether they would use telerehabilitation again and if so, how they would prefer telerehabilitation to be implemented (Table 6.B.2, appendix B). The majority of the patients preferred telerehabilitation to be implemented as follow-up treatment (43%), followed by a preference for additional treatment alongside conventional rehabilitation (30%).

Discussion

This study investigated whether patients' perceptions of telerehabilitation changed over time and in what way this change was related to actual use of telerehabilitation. To our knowledge this is the first study within the field of chronic pain and telerehabilitation that investigates the relationship between both pre-use and post-use determinants and actual use. Furthermore, it adds to the field of technology acceptance, since it is one of the few studies that addresses the subject of changing perceptions over time.

First, results showed that patients' perceptions of telerehabilitation changed over time. Patients' perceptions of perceived usefulness, attitude and intention, shifted towards significantly less positive levels after use. Perceptions of both perceived usefulness and attitude changed from a positive score into a neutral score, whereas patients' intention to use telerehabilitation changed from a positive score into a slightly negative score. These findings are contradictory with previous research that found inexperienced users perceptions' to change in positive directions after use [22, 24]. Possibly, in addition to a difference in population type, the nature of the telemedicine service could be underlying these differences. For example, the studies of Demiris et al [22] and Hanson et al [24] focus on the use of a teleconsultation service, whereas our telerehabilitation service targets (complex) exercise behaviour change. Furthermore, some patients reported about technical issues, such as a slow computer system and a loss of internet connection, which may have contributed to a negative change in perceptions.

Second, the results of this study suggest that as well as the magnitude and direction of change in patients' perception, it is also important to consider patients' positive or negative perceptions of the telerehabilitation service after use experience. Results demonstrated that patients who showed a negative change towards a negative post-use value of 'intention to use' used the telerehabilitation service less frequently, compared to patients who showed a change in negative direction but still demonstrated positive levels of intention to use. The fact that patients' post-use perceptions of the C-TAM-TPB performed better in explaining patients' actual use, compared to patients' delta

pre- and post- use scores on the C-TAM-TPB, further indicated that, patients' post-use perceptions are important in understanding patients' actual use of telerehabilitation.

The fact that patients' perceptions change over time and that particularly the patients' perceptions after some practical experience with the telerehabilitation service appeared important in explaining use, implies that an opportunity exists to contribute to higher levels of actual use of telerehabilitation by addressing patients' perceptions during use. In this study, patients' post-use perceptions on intention to use and perceived behavioural control affected actual use of the web-based telerehabilitation service and could explain around 39% of variance in actual use. Patients' attitudes, perceived behavioral control and perceptions of perceived usefulness (indirectly) were factors underlying patients' intention to use the service. Therefore, in this particular patient sample, we expect that by addressing perceptions regarding perceived usefulness, attitude, perceived behavioural control and intention, we could contribute to higher usage levels. For example, with respect to the constructs behavioural control and perceived usefulness, some patients reported about technical issues during use, decreased exercise motivation in the home environment and reported about a lack of direct feedback on exercise quality performance. By addressing these reported barriers, patients' use levels could be improved. Possibly, offering patients the opportunity to have additional 'live' videoconferencing on demand could contribute to resolving patients' needs regarding direct exercise feedback. Technologies such as virtual reality, which can track body movement and provide feedback, could also offer a solution and have already proved useful in rehabilitation. [41, 42]. With respect to the motivational issues mentioned by some patients, future studies are necessary to explore which strategies could improve the telerehabilitation service for chronic pain. Further tailoring of the individual consultations could possibly increase motivation[43], as well as offering a more individualized training program and integrating social (fellow-sufferer) support. One study has looked into the possibility of providing different coaching strategies based upon the variables stage of change and self-efficacy to contribute to higher physical activity levels [44]. Future studies are needed to investigate which determinants could further explain patients' use of telerehabilitation, next to the C-TAM-TPB constructs. In our study, higher autonomy levels of exercise motivation, higher levels of innovativeness and higher education levels were significantly correlated with higher scores on perceptions of ease of use, perceived usefulness and attitude. Larger studies are necessary to further explore this effect. For example, one study has found moderate evidence that health locus of control is associated with adherence to home exercise. Other studies point in the direction of poor self-efficacy and fear of pain [45–47]. As such, it would be interesting to explore how these dis-

ease characteristics can optimize the prediction of actual use of telerehabilitation and whether this changes over time.

In our study 55% of the patients completed at least two third of the program. This percentage corresponds with previous studies in the field of web-based exercise [16, 48] and can be rated as reasonably high for web-based interventions [16]. However, patients' use of the telerehabilitation service declined over time, which is also found in other research in the field of web-based treatment program [49]. In this study we have used a mean frequency use score. However, in future work it would be interesting to measure patients' perceptions at multiple points in time and to relate these to multiple measurements of use. This could help to gain a deeper understanding of the relationship between patients' actual use and changing perceptions.

Limitations

This research is subject to limitations. First, in addition to the descriptive statistics to describe the relationship between changes in perceptions and use, we used SEM analysis to model patients' acceptance of telerehabilitation. The models showed a satisfactory fit on a broad array of model fit outcomes; however, the results should be interpreted with great care as this study had a small sample size, which limits the extent to which the research findings can be generalized beyond this context.

Second, delta scores between pre- and post-use perceptions were used to explore the relationship with use. However, this approach has some limitations. When looking at changes between pre-use and post-use perceptions in relation to use, one is looking at the interrelations between three factors. One should realize that using delta scores to describe the relationship between pre- and post-use perceptions and actual use reduced it to a two-dimensional one whereas in actual practice it could better be described as a three-dimensional one. This was also pointed out by other researchers and they suggested polynomial as a way to handle these complex relationships [50, 51]. The limited sample size of this study did not allow for exploration of a three-dimensional relationship. As such, we choose to perform separate analysis on the relationship between pre-use perceptions, post-use perceptions, delta perceptions and patients' actual use. Future research, including larger study samples, is necessary in order to investigate in what way the use of such three-dimensional models could help to gain further insight into the exact way changes contribute to patients' acceptance of telerehabilitation.

Third, in this study, patients' pre-use perceptions explained less variance in use, compared to patients' post-use perceptions. Although this result coincides with other research that has demonstrated that the influence of determinants of acceptance is

different between during 'pre-use' and 'post-use' phases [52, 53], larger studies are necessary to demonstrate whether this finding should be attributed to the small sample size of this study or to the particular study sample of this study. For example, the majority of the patients included in this study were looking forward to receiving treatment; after often long waiting list periods and had high hopes that their conditions could be controlled. In addition, physicians could have expressed their enthusiasm for the telerehabilitation treatment to some degree and as such will have affected patients' pre-use perceptions. Future studies, including larger sample sizes, are necessary to gain a better understanding of whether these finding are specific to the context of innovative telerehabilitation treatments.

Finally, in this study, patients' perceptions were only measured at two points is time (pre- and post-use). Future studies which include multiple measurements in time are necessary to gain further insight into the processes underlying the changes in patients' perceptions. This would also allow for further exploration of patients' changing needs and perceptions during the rehabilitation process. For example, patients could be internally motivated at the start of treatment but need motivational strategies later on in their treatment as their motivation declines.

Conclusion

The aim of this study was to investigate how patients' perceptions of telerehabilitation changed after the use of a telerehabilitation service and how these changes were related to actual use. Patients in this study demonstrated a significant change in perceptions in a negative direction on the constructs of perceived usefulness, attitude and intention to use after using the telerehabilitation service. The results of this study suggest that as well as the magnitude and direction of change in patients' perceptions, it is important to consider patients' positive or negative perceptions of the telerehabilitation service after use in relation to patients' actual use of telerehabilitation. This suggests that an opportunity exists to contribute to higher levels of actual use of telerehabilitation, by monitoring and addressing patients' perceptions during use.

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References

1. Breivik H, Collett B, Ventafridda V, Cohen R and Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 2006; **10:** 287–333.
   DOI: 10.1016/j.ejpain.2005.06.009.
2. Abdulla A, Adams N, Bone M et al. British Geriatric Society. Guidance on the management of pain in older people. *Age and Ageing*, 2013; **42:** i1–i57.
   DOI: 10.1093/ageing/afs200.
3. Langley PC. The prevalence, correlates and treatment of pain in the European Union. *Current Medical Research and Opinion*, 2011; **27:** 463–480.
   DOI: 10.1185/03007995.2010.542136.
4. Leadley RM, Armstrong N, Reid KJ, Allen A, Misso KV and Kleijnen J. Healthy aging in relation to chronic pain and quality of life in Europe. *Pain Practice*, 2014; **14:** 547–558.
   DOI: 10.1111/papr.12125.
5. Miller LR and Cano A. Comorbid chronic pain and depression: who is at risk? *The Journal of Pain*, 2009; **10:** 619–627.
   DOI: 10.1016/j.jpain.2008.12.007.
6. Hayden JA, Tulder MW van, Malmivaara A and Koes BW. Exercise therapy for treatment non-specific low back pain (review). *Cochrane Database Systematic Reviews*, 2005**:** CD000335.
   DOI: 10.1002/14651858.CD000335.pub2.
7. Liddle SD, Baxter GD and Gracey JH. Exercise and chronic low back pain: what works? *Pain*, 2004; **107:** 176–190.
   PMID: 14715404.
8. Tulder MW van, Malmivaara A, Esmail R and Koes BW. Exercise therapy for low back pain. *Cochrane Database of Systematic Reviews (Online)*, 2000**:** CD000335.
   DOI: 10.1002/14651858.CD000335.
9. Turk DC and Rudy TE. Neglected topics in the treatment of chronic pain patients-relapse, noncompliance, and adherence enhancement. *Pain*, 1991; **44:** 5–28.
   DOI: 10.1016/0304-3959(91)90142-K.
10. Jordan JL, Holden MA, Mason EE and Foster NE. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Systematic Reviews*, 2010**:** CD005956.
    DOI: 10.1002/14651858.CD005956.pub2.
11. Morley S. Relapse prevention: still neglected after all these years. *Pain*, 2008; **134:** 239–240.
    DOI: 10.1016/j.pain.2007.12.004.

12. Bender JL, Radhakrishnan A, Diorio C, Englesakis M and Jadad AR. Can pain be managed through the Internet? A systematic review of randomized controlled trials. *Pain*, 2011; **152:** 1740–1750.
DOI: 10.1016/j.pain.2011.02.012.

13. Cooper K, Smith BH and Hancock E. Patient-centredness in physiotherapy from the perspective of the chronic low back pain patient. *Physiotherapy*, 2008; **94:** 244–252.
DOI: 10.1016/j.physio.2007.10.006.

14. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP and Gonder-Frederick LA. A behaviour change model for internet interventions. *Annals of Behavioral Medicine*, 2009; **38:** 18–27.
DOI: 10.1007/s12160-009-9133-4.

15. Rosser BA, Vowles KE, Keogh E, Eccleston E and Mountain GA. Technologically assisted behaviour change: A systematic review of studies of novel technologies for the management of chronic illness. *Journal of Telemedicine and Telecare*, 2009; **15:** 327–338.
DOI: 10.1258/jtt.2009.090116.

16. Bossen D, Veenhof C, Dekker J and Bakker D de. The usability and preliminary effectiveness of a web-based physical activity intervention in patients with knee and/ or hip osteoarthritis. *BMC Medical Informatics and Decision Making*, 2013; **13:** 61.
DOI: 10.1186/1472-6947-13-61.

17. Kairy D, Tousignant M, Leclerc N, Côté A and Levasseur M. The patient's perspective of in-home telerehabilitation physiotherapy services following total knee arthroplasty. *International Journal of Environmental Research and Public Health*, 2013; **10:** 3998–4011.
DOI: 10.3390/ijerph10093998.

18. Palazzo C, Klinger E, Dorner V et al. Barriers to home-based exercise program adherence with chronic low back pain: Patient expectations regarding new technologies. *Annals of physical and rehabilitation medicine*, 2016; **59:** 107–113.
DOI: 10.1016/j.rehab.2016.01.009.

19. Currie M, Philip LJ and Roberts A. Attitudes towards the use and acceptance of eHealth technologies: a case study of older adults living with chronic pain and implications for rural healthcare. *BMC Health Services Research*, 2015; **15:** 162.
DOI: 10.1186/s12913-015-0825-0.

20. Parasuraman A, Zeithaml V and Berry L. A Conceptual Model of Service Quality and Its Implications for Future Research. *The Journal of Marketing*, 1985; **49:** 41–50.
DOI: 10.2307/1251430.

21. Cranen K, Huis in 't Veld MHA, IJzerman MJ and Vollenbroek-Hutten MMR. Change of patients' perceptions of telemedicine after brief use. *Telemedicine and e-Health*, 2011; **17:** 530–535.
DOI: 10.1089/tmj.2010.0208.

22. Demiris G, Speedie SM and Finkelstein S. Change of patients' perceptions of TeleHomeCare. *Telemedicine Journal and e-Health*, 2001; **10:** 122–128.
DOI: 10.1089/153056201316970948.

23. Finkelstein SM, Speedie SM, Demiris G, Veen M, Lundgren JM and Potthoff S. Telehomecare: Quality, perception, satisfaction. *Telemedicine Journal and e-Health*, 2004; **10:** 122–128.
DOI: 10.1089/tmj.2004.10.122.

24. Hanson D, Calhoun J and Smith D. Changes in provider attitudes toward telemedicine. *Telemedicine Journal and e-Health*, 2009; **15:** 39–43.
DOI: 10.1089/tmj.2008.0052.

25. Derogatis LR. SCL-90-R, administration, scoring and procedures manual-II for the R(evised) version and other instruments of the psychopathology rating scale series. Towson: Clinical Psychometric Research, 1992.

26. Taylor S and Todd PA. Understanding information technology usage: A test of competing models. *Information Systems Research*, 1995; **6:** 144–176.
DOI: 10.1287/isre.6.2.144.

27. Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 1989; **13:** 319–340.
DOI: 10.2307/249008.

28. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 1991; **50:** 179–211.

29. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478.
DOI: 10.2307/30036540.

30. Markland D and Tobin V. A modification of the Behavioral Regulation in Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology*, 2004; **26:** 191–196.
DOI: 10.1123/jsep.26.2.191.

31. Deci EL and Ryan RM. Handbook of self-determination research. University Rochester Press, 2002.

32. Teixeira PJ, Carraça EV, Markland D, Silva MN and Ryan RM. Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 2012; **9:** 78.
DOI: 10.1186/1479-5868-9-78.

33. Agarwal R and Prasad J. A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, 1998; **9:** 204–215.
DOI: 10.1287/isre.9.2.204.

34. Rosenstiel AK and Keefe FJ. The use of coping strategies in chronic low back pain patients: Relationship to patient characteristics and current adjustment. *Pain*, 1983; **17:** 33–44.
PMID: 6226916.

35. Spinhoven Ph, Kuile MM ter and Linssen ACG. Coping met Pijn Vragenlijst: Een experimentele handleiding. Lisse: Swets en Zeitlinger, 1994.

36. Gift A. Visual analogue scales: Measurement of subjective phenomena. *Nursing Research*, 1989; **38:** 286–288.
PMID: 2678015.

37. Roland M and Morris R. A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine*, 1983; **8:** 141–144.
PMID: 6222486.

38. Gommans IHB, Koes BW and Tulder MW van. Validiteit en responsiviteit Nederlandstalige Roland Disability Questionnaire. Vragenlijst naar functionele status bij patienten met lage rugpijn. *Nederlands Tijdschrift voor Fysiotherapie*, 1997; **107:** 28–33.

39. Åstrand P-O and Rhyming I. A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work. *Journal of Applied Physiology*, 1954; **7:** 218–221.
DOI: 10.1152/jappl.1954.7.2.218.

40. Fan X, Thompson B and Wang L. Effects of sample size, estimation methods, and model specification on structural equation modeling fit indexes. *Structural Equation Modeling: A Multidisciplinary Journal*, 1999; **6:** 56–83.
DOI: 10.1080/10705519909540119.

41. Brodbeck D, Degen M, Stanimirov M et al. Augmented feedback system to support physical therapy of non-specific low back pain. In: *Biomedical Engineering Systems and Technologies. BIOSTEC 2009. Communications in Computer and Information Science*. Ed. by Fred A, Filipe J and Gamboa H. Heidelberg: Springer, 2010**:** 381–391.
DOI: 10.1007/978-3-642-11721-3_30.

42. Trost Z, Zielke M, Guck A et al. The promise and challenge of virtual gaming technologies for chronic pain: the case of graded exposure for low back pain. *Pain Management*, 2015; **5:** 197–206.
DOI: 10.2217/pmt.15.6.

43. Hoaas H, Andreassen HK, Lien LA, Hjalmarsen A and Zanboni P. Adherence and factors affecting satisfaction in long-term telerehabilitation for patients with chronic obstructive pulmonary disease: a mixed methods study. *BMC Medical Informatics and Decision Making*, 2016; **16:** 26.
DOI: 10.1186/s12911-016-0264-9.

44. Achterkamp R, Dekker-van Weering MGH, Evering RMH et al. Strategies to improve effectiveness of physical activity coaching systems: Development of personas for providing tailored feedback. *Health Informatics Journal*, 2018; **24:** 92–102.
DOI: 10.1177/1460458216653242.

45. Medina-Mirapeix F, Escolar-Reina P, Gascón-Cánovas JJ, Montilla-Herrador J and Collins SM. Personal characteristics influencing patients' adherence to home exercise during chronic pain: a qualitative study. *Journal of Rehabilitation Medicine*, 2009; **41:** 347–352.
DOI: 10.2340/16501977-0338.

46. Beinart NA, Goodchild CE, Weinman JA, Ayis S and Godfrey EL. Individual and intervention-related factors associated with adherence to home exercise in chronic low back pain: a systematic review. *The Spine Journal*, 2013; **13:** 1940–1950.
DOI: 10.1016/j.spinee.2013.08.027.

47. Slade SC, Patel S, Underwood M and Keating JL. What are patient beliefs and perceptions about exercise for non-specific chronic low back pain? A systematic review of qualitative studies. *The Clinical Journal of Pain*, 2014; **30:** 995–1005.
DOI: 10.1097/AJP.0000000000000044.

48. Steele RM, Mummery WK and Dwyer T. Examination of program exposure across intervention delivery modes: face-to-face versus interne. *International Journal of Behavioral Nutrition and Physical Activity*, 2007; **4:** 7.
DOI: 10.1186/1479-5868-4-7.

49. Wantland D, Portillo C, Holzemer WL, Slaughter R and McGhee EM. The effectiveness of web-based vs non-web-based Interventions: A meta-analysis of behavioural change programs. *Journal of Medical Internet Research*, 2004; **6:** e40.
DOI: doi:10.2196/jmir.6.4.e40.

50. Edwards JR. Alternatives to Difference Scores: Polynomial Regression Analysis and Response Surface Methodology. In: *Measuring and Analyzing Behavior in Organizations: Advances in Measurement and Data Analysis*. Ed. by Drasgow F and Schmidt N. San Francisco: Jossey-Bass/Pfeiffer, 2002**:** 350–400.

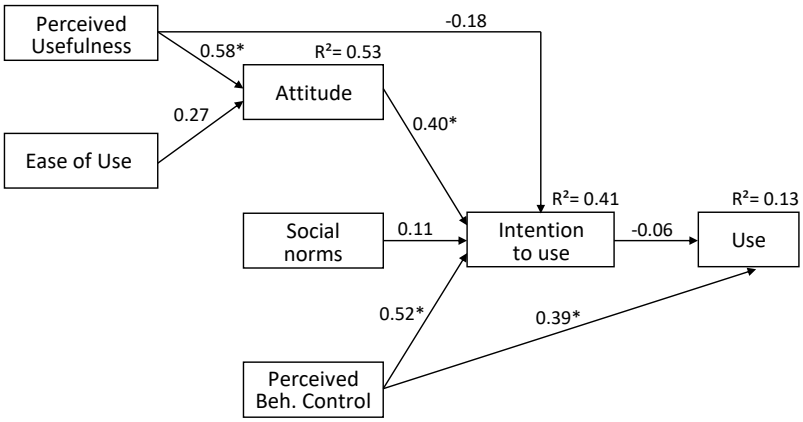
51. Brown SA, Venkatesh V and Goyal S. Expectations confirmation in information systems research: a test of six competing models. *MIS Quarterly*, 2014; **38:** 729–756.

52. Bhattacherjee A and Premkumar G. Understanding changes in belief and attitude toward information technology usage: a theoretical model and longitudinal test. *MIS Quarterly*, 2004; **28:** 229–254.
DOI: 10.2307/25148634.

53. Karahanna E, Straub DW and Chervany NL. Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, 1999; **23:** 183–213.
DOI: 10.2307/249751.

Appendix A:

Pre-use perceptions and delta perceptions SEM models



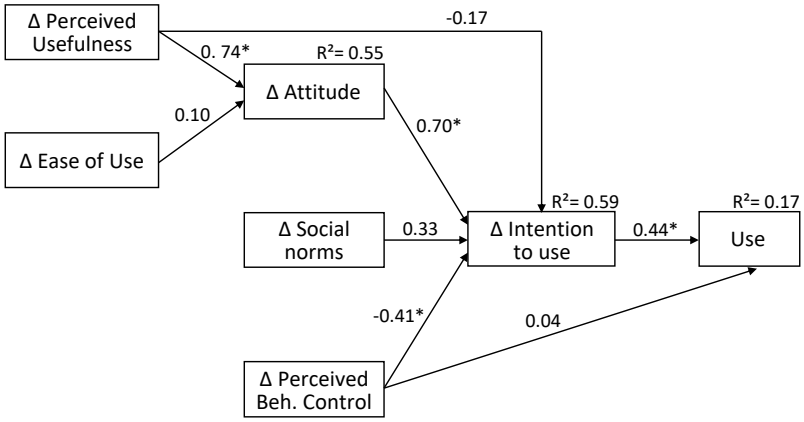
Fit statistics:
($\chi 2(7, N=33)=7.865$, $p=.345$); CFI=0.980; IFI=.985, RMSEA =.062, TLI=.941,
Bollen-Stein bootstrap $p=.592$.

**$p<0.001$; * $p>0.05$

Figure 6.A.1: *C-TAM-TPB model Pre-use perceptions relationship USE (mean frequency of use).*

Table 6.A.1: *Standardized regression weights and bootstrap confidence intervals for the pre-use SEM model* ($n = 30$).

	Estimate	S.E.	C.R.	confidence interval	*p*
ATT ← PU	.584	.123	4.480	.339 to .719	.001
ATT ← PEU	.270	.080	2.072	−.015 to .375	.141
INT ← PU	−.184	.192	−.977	−.497 to .136	.346
INT ← SN	.107	.096	.762	−.052 to .273	.316
INT ← ATT	.404	.202	2.161	.141 to .903	.015
INT ← PBC	.518	.091	3.541	.157 to .552	.002
USE ← INT	−.060	.247	−.304	−.325 to .262	.672
USE ← PBC	.393	.154	1.979	.177 to .510	.001



Fit statistics:
($\chi 2(7, N=30)=8.114$, $p=.323$); CFI: .978, IFI: .982, RMSEA = .074, TLI=.933, Bollen-Stein bootstrap $p=.251$.

**$p<0.001$; * $p>0.05$

Figure 6.A.2: *C-TAM-TPB model delta perceptions relationship USE (mean frequency of use).*

Table 6.A.2: *Standardized regression weights and bootstrap confidence intervals for the delta-use SEM model* ($n = 30$).

	Estimate	S.E.	C.R.	confidence interval	p
ATT ← PU	.743	.156	5.959	.573 to 1.173	.001
ATT ← PEU	.099	.132	.794	−.093 to .314	.381
INT ← SN	.325	.207	2.431	−.020 to .943	.111
INT ← ATT	.704	.213	3.992	.337 to 1.443	.004
INT ← PU	−.177	.286	−.936	−.845 to .250	.436
INT ← PBC	−.408	.170	−3.239	−.839 to −.193	.021
USE ← PBC	.044	.164	.251	−.175 to .220	.728
USE ← INT	.424	.121	2.437	.123 to .484	.006

Appendix B: Reported benefits and drawbacks and implementations preferences

Table 6.B.1: *Reported drawbacks and benefits, reported after using the telerehabilitation service.*

Drawbacks	Frequency	Benefits	Frequency
Lack of personal contact with the physiotherapist and/or lack of immediate feedback during exercise	17	Visual support during exercising	13
Less motivation/ discipline at home	14	Travel — less travel time and travel issues	11
Technical failures (slow computer, loss of internet connection)	9	Flexible exercise schedule	8
Loss of fellow sufferer contact	5	Exercise in the home environment without distraction, easier transition	5
Recording exercises with webcam — 'awkward' communication/ no confidence how to correct movements	4	Progress monitoring	2
No congruity with the exercise program at the clinic/ no personalized exercise schedule	3		

Table 6.B.2: *Implementation preferences of patients after using the telerehabilitation service.*

Implementation preference	Frequency
Follow-up treatment	13
Additional treatment	9
(Partial) replacement of conventional care	5
Not at all	3

7

General discussion

Despite the great potential of telerehabilitation, the intended benefits will be realised only when such treatments are accepted as fully fledged alternatives for conventional care and are subsequently used by the patient. Therefore, an understanding of the drivers and barriers related to patients' acceptance of telerehabilitation is important. The main goal of this thesis was the identification of drivers and barriers underlying patients' acceptance of telerehabilitation and to provide insights into the factors enabling telerehabilitation success. Assuming that telerehabilitation acceptance may change dependent on the degree to which patients are familiar with telerehabilitation, a process-based view was applied to gain a better understanding of its determinants. Technology acceptance models focusing on individual acceptance of technology, including the Technology Acceptance Model (TAM) [1], the Unified Theory of Acceptance and Use of Technology (UTAUT) [2] and the Combined Model of Theory of Planned Behaviour and Technology Acceptance Model [3], served as a theoretically based starting point and were adapted to the context of telerehabilitation. In this final chapter, we will report the main findings of this thesis. Subsequently, we will further reflect on the different factors that relate to patients' acceptance of telerehabilitation and discuss the implications for future research and the development of telerehabilitation in the treatment of chronic pain.

Patients' acceptance of telerehabilitation

From the studies in this thesis, it became clear that patients with chronic pain demonstrated a willingness to accept telerehabilitation in the treatment of chronic pain (Chapters 2-6). Patients without prior experience with telerehabilitation expressed positive intentions to use telerehabilitation (Chapters 2,4) and a willingness to accept telerehabilitation as an alternative to conventional care (Chapter 3). However, a majority expressed a preference for telerehabilitation to be implemented as a complementary or follow-up treatment, rather than an autonomous treatment (Chapter 2), which accords with other findings in the field of chronic pain [4]. Furthermore, the majority of the patients, who engaged in a clinical trial, decided to accept telerehabilitation in the treatment of chronic pain (Chapter 5) and exhibited positive intentions to use the service during rehabilitation prior to the start of the telerehabilitation treatment (Chapter 6). An important observation, nonetheless, was that patients' acceptance proved susceptible to change, which was demonstrated by the decline over time of patients' intentions to use, as well as their actual use of telerehabilitation (Chapter 6).

The technology acceptance models, that were utilised as a theoretical starting point in this thesis suggest that in addition to technology-related factors (perceived usefulness, ease of use and attitude), both societal factors (social norms) and factors relating to the degree to which the patient feels in control (internal and external constraints) play a role in telerehabilitation acceptance. The results of this thesis demonstrated that perceived usefulness, internal and external constraints and patients' attitudes appeared to be the most salient drivers underlying the acceptance of telerehabilitation by patients with chronic pain (Chapters 2, 4-6).

Moreover, it was demonstrated that although patients valued the benefits of telerehabilitation (such as flexible exercise times and acquiring exercise skills in the home environment), they reflected on important pre-conditions relating to 'motivation and social support' and 'feedback and face-to-face contact', that they felt were important to address (Chapters 2, 3, 5, 6). Below we will further reflect on these pre-conditions as well as on the strategies that could be integrated into telerehabilitation implementation and design to facilitate telerehabilitation acceptance.

Face-to-face contact and feedback

In the majority of telerehabilitation services, face-to-face patient-therapist contact is reduced while exercise instructions and feedback are offered through live videoconferencing, off-site video/email consultations or offline video instruction. However, patients expressed a need for immediate performance feedback during exercise as well as a preference to see their therapist face-to-face during treatment (Chapters 2, 3, 6), as they

felt this was necessary in order to receive adequate feedback (Chapters 2, 6). Patients' willingness to accept reduced face-to-face contact during exercise was affected by how confident patients were that they performed the exercises correctly, as well as by the availability of feedback- and monitoring technology during use (Chapters 2, 3). This corroborates findings of another study of chronic pain [5].

Studies in the field of exercise-based telerehabilitation services with a focus on the patients' perspective have also demonstrated the importance of feedback to increase the acceptability of telerehabilitation services, some of them reporting about patients' needs for feedback in terms of progress and treatment outcomes [6–9]. Nevertheless, none of these studies reported about patients' needs for immediate feedback during exercise and the perceived necessity of face-to-face contact with the therapist.

Thus, because these studies targeted patient populations other than those with chronic pain, the question is raised about whether the importance of face-to-face therapist contact during exercise, which became apparent from our studies, could be specific to the context of telerehabilitation in chronic pain and the role that psychological factors play in the treatment of chronic pain. In the treatment of chronic pain, patients consider being listened to, empathy and a good patient-physician relationship as important components of treatment [10]. It is possible that patients perceive remote communication as a feature that affects these components in a negative way. However, we hypothesize that patients' inexperience with remote communication could have contributed to these findings, since other studies in the field have shown that patients were highly satisfied with the remote communication with their therapist [11, 12]. Further research is necessary to explore how remote communication affects the patient-physician relationship in chronic pain rehabilitation, as currently no studies have investigated this issue.

Furthermore we hypothesize that psychological factors such as fear of pain and overly negative thinking about pain, could be underlying patients' preferences for immediate feedback and face-to-face contact during exercise. From the field of exercise in chronic pain, it is clear that psychological factors, such as fear of pain and pain catastrophising have an effect on patients' physical activity performance levels [13–16]. As such, it is possible that patients, who experience high levels of pain catastrophising (referring to patients' tendency to magnify symptoms and to feel helpless regarding self-management [17]) and high levels of fear of pain during exercise, rely on face-to-face feedback of the therapist to continue. This hypothesis was partly confirmed by the results of chapter 5 which demonstrated that refusers of telerehabilitation treatment held higher levels of pain catastrophising behaviour, compared to accepters.

Motivation and social support

The results made clear that, both prior to telerehabilitation use and during use, patients perceived that telerehabilitation led to decreased levels of (exercise) motivation (Chapters 2, 6). These findings coincide with other research in the field of exercise-based telerehabilitation [6] and are not unique to the context of chronic pain. Studies outside the field have also demonstrated declining levels of motivation and engagement [18] and demonstrate that web-based interventions suffer from attrition [19]. According to some patients, exercising in the home environment would lead to distraction and a loss of treatment motivation (Chapter 2). This is in line with other research describing that within the home environment there is the need for internal motivation, while in the clinical setting the motivation for therapy may come from the setting itself [20] and the social interaction that is present [21]. Next to the clinical environment, the physical presence and supervision of a therapist was described as an important source of exercise motivation (Chapters 2, 6) which has also been found by other studies [5, 22, 23]. In addition, for some patients, the absence of fellow-sufferers during training was perceived as a barrier for telerehabilitation acceptance since fellow-sufferers provided both emotional and motivational support (Chapter 2). The importance of fellow-sufferer contact is also demonstrated by other research in the domain of exercise-based telerehabilitation [21, 24–26]. One study investigating home-based telerehabilitation in patients found that extrinsically motivated patients exercised more irregularly as they reported that they missed group training [24]. This importance of either internal or external motivation as an underlying driver for telerehabilitation acceptance corroborates with the finding in Chapter 5, which demonstrated that lower autonomous exercise motivation exerted a negative effect on patients' decision to take part in telerehabilitation treatment.

Implications for telerehabilitation design and implementation

To overcome the drawbacks perceived by patients, the implementation of a **'blended' care model**, i.e., a combination of online and face-to-face clinic-based therapy, is recommended for the implementation of telerehabilitation for chronic pain. By retaining a certain degree of face-to-face contact with the therapist, patients' needs regarding exercise motivation and their relationship with the therapist could be addressed (Chapters 2, 6). This is expected to foster patients' acceptance of telerehabilitation. Moreover, the results of this thesis led us to believe that for some patients the home environment should not be pursued as a treatment environment. Possibly, a gym-based exercise location close to the home environment should be considered, which would address both practical considerations such as lack of space as well as the described

barrier of reduced motivation and social support (Chapter 2). In this respect, perhaps cooperation between physiotherapists and rehabilitation centers should be pursued. As technologies continue to develop, we hypothesize that it will become possible to offer personalised telerehabilitation at remote locations using monitoring and feedback technology and remote therapist contact and instruction. Up until now, studies on blended exercise-based telerehabilitation services are scarce and evidence for the ratio of combined remote care and conventional care is therefore lacking. Evidence of the effectiveness of blended care outside the field of exercise is inconsistent and non-significant for most outcome measures [27]. Future studies that focus on further understanding of the best way to combine telerehabilitation and conventional methods of treatment delivery are therefore necessary [28].

Next to blended care, the integration of both **feedback and monitoring technology** and **motivational treatment strategies** is considered important to overcome perceived barriers to acceptance of telerehabilitation. We hypothesize that feedback and monitoring or virtual reality technology could supposedly address the need for immediate feedback during exercise, although future research is necessary to investigate which parameters should be included to achieve acceptance of these systems in chronic pain rehabilitation. Including exergames or social networks could address the reported barrier of decreased motivation as well as patients' needs for fellow-sufferer contact, since other studies in the field demonstrated promising results [29, 30].

Finally, we suggest that exercise-based telerehabilitation treatment could benefit from the integration of **psychological counselling strategies**. Telerehabilitation approaches that address psychological factors in addition to biomedical factors, in accordance with the biopsychosocial approach underlying pain treatment, are expected to provide powerful benefits [31]. As such, psychological factors that appear to be related to patients' physical activity levels – for example fear of pain and pain catastrophising behaviour [13, 16, 32] – should be addressed and ultimately could contribute to increased acceptance levels of telerehabilitation.

Determinants of telerehabilitation acceptance: temporal dynamics

To contribute to the understanding of the temporal dynamics in telerehabilitation acceptance, changes in patients' perceptions after both brief experience (Chapter 5) and prolonged experience (Chapter 6) were explored. This in contrast to the majority of studies in the field of telerehabilitation which measure perceptions of services either through usability studies prior to use or with satisfaction measures, cross- sectionally, after use [7].

In line with findings from the field of information systems research, which found that attitudes, intentions and use of information technology change over time as experience is gained [33, 34], results demonstrated that patients' perceptions of telerehabilitation changed over time (Chapters 5, 6). This suggests that prior to and during actual use of telerehabilitation, opportunities exist to improve acceptance of telerehabilitation.

Monitoring patients' perceptions at multiple times during use and addressing perceptions accordingly (for example, by adjusting the telerehabilitation service) are suggested as ways to facilitate patients' acceptance (Chapter 6). First, insight into patients' experiences during use could lead to the decision to adjust the telerehabilitation service accordingly. However, strategies should be determined on how to ensure that telerehabilitation services are responsive to users' needs over time. Ideally, in the future, a telerehabilitation service could benefit from intricate motivational- and feedback strategies and should be able to adjust these strategies to the different levels of motivation that a patient displays over time. Second, measuring patients' perceptions and use at multiple moments in time allows for exploration of the idea that users' expectations stabilize and become more realistic based on repeated interactions with the system [34, 35], an idea rooted in the expectation-disconfirmation theory [36]. Using a three-period model (including perception measurements at pre-usage, t_1 and t_2) [33] would allow for exploration of whether 'unrealistic' pre-use perceptions at the start of telerehabilitation are likely to have contributed to the negative changes in perceptions that were found in Chapter 6, next to telerehabilitation system performance. Further research is necessary to investigate whether, as such, patient expectation management could be considered a useful strategy, in addition to telerehabilitation design, to facilitate patient acceptance of telerehabilitation.

Furthermore, we suggest that measurements of patients' perceptions could be integrated into current user-centred design approaches that are used within healthcare, such as contextual design [37] and participatory design [38]. These approaches employ iterative processes, which typically involve the clarification of user needs, the development of prototypes and the evaluation of telerehabilitation services. Based on our findings that brief use and prolonged use could have different effects on patients' perceptions (Chapter 6), we suggest that it is important to extend these current user-centred design approaches with a 'prolonged trial phase', in line with Clemensen's research [38]. In our view, this phase should allow patients to utilise telerehabilitation prototypes for a longer period of time in the environment in which they will be eventually implemented, such as in the home. As such, exploration of barriers apparent to

only 'experienced users' becomes possible. Moreover, it incorporates the benefit that perceptions are based on 'real' experiences gained outside the laboratory settings, in which, at present, prototypes are commonly evaluated [38].

Measuring technology acceptance of telerehabilitation: a reflection

In this thesis, we have demonstrated the value of technology acceptance models in understanding patients' acceptance of telerehabilitation as these models provided a guiding framework, as well as explanatory insights, into the factors underlying patients' acceptance of telerehabilitation (Chapters 2, 5, 6). Currently in the field of telerehabilitation, little attention is given to the patients' perspective on telerehabilitation acceptance [7, 39]. The studies that do focus on the patients' perspective are, in general, of a qualitative nature [5, 25]. In addition, the majority of the studies report about usability and satisfaction [7, 40], without using a theoretical framework that provides insight into the (inter-)relation of factors that underlie technology acceptance. To generalize findings in the field and to reach a more comprehensive view on acceptance throughout different fields in healthcare, we suggest that concepts of perceived usefulness, ease of use, attitude and perceived internal and external constraints could be integrated more into future work on patients' acceptance in telerehabilitation, thereby including the field of usability, feasibility and satisfaction regarding healthcare technology. This integration would also address the need for measures that can be applied consistently across technologies in the field of healthcare that serve the same purpose [41], so that outcomes can be compared. Some researchers have already demonstrated the use of both UTAUT and TAM in the field of usability and feasibility research [42, 43].

Although our results (Chapters 2, 4, 6) and other studies in the field [44, 45] demonstrate the value of intention-based technology acceptance models in understanding technology acceptance, these models have been criticised as being unable to capture some of the unique contextual factors of telerehabilitation or telemedicine in general [46, 47]. Outside the field of telerehabilitation efforts already have been made through integration of constructs such as 'perceived security' [44, 46]. In the field of telerehabilitation and chronic pain, we suggest further investigation of constructs that explore patients' perceptions regarding the patient-physician relationship, since our results have demonstrated that reduced face-to-face contact and social support are important for patients' intentions to accept telerehabilitation (Chapters 2, 3).

Furthermore, future (larger sample size) studies are important to achieve further contextualization through specification and validation of factor measurements. In this thesis, for the measurement of the factors of the models (Chapters 4-6), we relied on scales that were developed and tested outside the telerehabilitation field [2, 3]. Although we adapted these scales as best we could to the context of telerehabilitation, based on prior research, many of our choices were necessarily ad-hoc. This lack of validated measurement tools is in fact illustrative of the broader field of eHealth. Currently, few validated measures are present to evaluate eHealth technologies, including measurements relating to the patients' perspective [41]. In addition, future larger-scale studies could contribute to a further validation of constructs, because , presently, disagreement and variation exist in how constructs, such as perceived usefulness and facilitating conditions, are measured [46].

To gain a broad understanding of the factors underlying telerehabilitation acceptance, we used a mixed-methods approach, including the use of qualitative interviews and discrete choice experiments. Qualitative interviews proved useful in gaining detailed contextual insight into the factors underlying acceptance and would also be useful in studies exploring changes in patients' perceptions over time. However, this methodology consumes a significant amount of time to gather and analyse results. The use of a discrete choice experiment (DCE) was valuable as it provided a better understanding of the factors that are most important to patients and, as such, the results could be used to inform patient-centred telerehabilitation design. One important drawback, though, was the cognitively demanding task it provided for patients. In this thesis, the DCE methodology was employed to estimate preferences on a group level. This provided insight into the importance of the telerehabilitation attributes, as well as the desirability of the different telerehabilitation scenarios compared to conventional care. Alternatively, the use of preference elicitation techniques could be explored to estimate individual preferences for treatment and to investigate whether this type of technique could be used in clinical practice to guide decision-making on preferred treatment for patients.

Other methodological considerations

Our results demonstrate that patients' perceptions changed after brief use. Nonetheless, it needs to be remarked that in our study (Chapter 4), the majority of patients held positive perceptions of perceived usefulness and ease of use prior to use. Thus, we were not able to investigate the effect of brief experience on patients holding negative perceptions. Besides, in this thesis the focus was on patients with chronic pain and relatively small sample sizes were used. This consideration raises the question

whether these findings are specific for the pain group and to what extent these results can be translated to the field of telerehabilitation in general. Also, two studies in this thesis were conducted during the implementation of a telerehabilitation service at a rehabilitation clinic in the Netherlands. As such, we hypothesize that both the research team and the therapists will have influenced patients' perceptions to a certain degree. Furthermore, the 'technical' failures experienced during this phase may have contributed as well.

General conclusions

From the studies presented in this thesis, it can be concluded that patients' perceptions of perceived usefulness, patients' attitudes and patients' perceptions of internal and external constraints are important factors underlying patients' acceptance of telerehabilitation in chronic pain treatment [1–3]. We found that the integration of face-to-face therapist contact, the possibility to exercise in a clinical environment and the inclusion of remote monitoring and feedback technology into telerehabilitation treatment are important strategies to reduce patients' perceived barriers and may therefore be considered principal driving forces for patients' acceptance of telerehabilitation in chronic pain treatment (Chapters 2, 3). Next to perceived telerehabilitation characteristics, patients' characteristics were found to be drivers of telerehabilitation acceptance. Lower autonomous exercise motivation and higher levels of pain catastrophising behaviour exerted a negative influence on patients' decision to take part in telerehabilitation treatment (Chapter 5). Brief exposure to telerehabilitation contributed to changes in positive direction of patients' perceptions of telerehabilitation (Chapter 4). Hence, offering patients the possibility to explore and experiment with a telerehabilitation service is proposed as a promising strategy that requires further investigation. It is important to note, nevertheless that, although patients' positive perceptions of telerehabilitation prior to use were drivers of patients' actual decision to accept telerehabilitation, these perceptions could explain patients' actual use of telerehabilitation to only a small extent (Chapters 5, 6). We conjecture that the observed changes in patients' perceptions after use of telerehabilitation might be underlying this finding. The results imply that next to magnitude and the direction of change in patients' perceptions, patients' positive or negative perceptions of telerehabilitation services after use are important to consider in relation to patients' actual use of telerehabilitation. This implication suggests that an opportunity exists to contribute to higher levels of actual use of telerehabilitation, by monitoring and addressing patients' perceptions during use and by adapting telerehabilitation design accordingly.

References

1. Davis FD, Bagozzi RP and Warshaw PR. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 1989; **35:** 982–1003. DOI: 10.1287/mnsc.35.8.982.
2. Venkatesh V, Morris MG, Davis GB and Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003; **27:** 425–478. DOI: 10.2307/30036540.
3. Taylor S and Todd PA. Understanding information technology usage: A test of competing models. *Information Systems Research*, 1995; **6:** 144–176. DOI: 10.1287/isre.6.2.144.
4. Currie M, Philip LJ and Roberts A. Attitudes towards the use and acceptance of eHealth technologies: a case study of older adults living with chronic pain and implications for rural healthcare. *BMC Health Services Research*, 2015; **15:** 162. DOI: 10.1186/s12913-015-0825-0.
5. Palazzo C, Klinger E, Dorner V et al. Barriers to home-based exercise program adherence with chronic low back pain: Patient expectations regarding new technologies. *Annals of physical and rehabilitation medicine*, 2016; **59:** 107–113. DOI: 10.1016/j.rehab.2016.01.009.
6. Cox NS, Alison JA, Button BM, Wilson JW and Holland AE. Feasibility and acceptability of an internet-based program to promote physical activity in adults with cystic fibrosis. *Respiratory Care*, 2015; **60:** 422–429. DOI: 10.4187/respcare.03165.
7. Kairy D, Tousignant M, Leclerc N, Côté A and Levasseur M. The patient's perspective of in-home telerehabilitation physiotherapy services following total knee arthroplasty. *International Journal of Environmental Research and Public Health*, 2013; **10:** 3998–4011. DOI: 10.3390/ijerph10093998.
8. Bennell KL, Nelligan R, Dobson F et al. Effectiveness of an Internet-Delivered Exercise and Pain-Coping Skills Training Intervention for Persons With Chronic Knee Pain: A Randomized Trial. *Annals of Internal Medicine*, 2017; **166:** 453–462. DOI: 10.7326/M16-1714.
9. Eriksson L, Lindström B, Gard G and Lysholm J. Physiotherapy at a distance: a controlled study of rehabilitation at home after a shoulder joint operation. *Journal of Telemedicine and Telecare*, 2009; **15:** 215–220. DOI: 10.1258/jtt.2009.081003.
10. Chou L, Ranger TA, Peiris W et al. Patients' perceived needs of health-care providers for low back pain management: a systematic scoping review. *The Spine Journal*, 2018. DOI: 10.1016/j.spinee.2018.01.006.

11. Hinman RS, Nelligan RK, Bennell KL and Delany C. "Sounds a Bit Crazy, But It Was Almost More Personal:" A Qualitative Study of Patient and Clinician Experiences of Physical Therapist– Prescribed Exercise For Knee Osteoarthritis Via Skype. *Arthritis Care and Research*, 2017; **69:** 1834–1844.
DOI: 10.1002/acr.23218.

12. Giunti G, Kool J, Rivera Romero O and Dorronzoro Zubiete E. Exploring the Specific Needs of Persons with Multiple Sclerosis for mHealth Solutions for Physical Activity: Mixed-Methods Study. *JMIR eHealth and uHealth*, 2018; **6:** e37.
DOI: 10.2196/mhealth.8996.

13. Sullivan MJ, Rodgers WM, Wilson PM, Bell GJ, Murray TC and Fraser SN. An experimental investigation of the relation between catastrophizing and activity intolerance. *Pain*, 2002; **100:** 47–53.
PMID: 12435458.

14. Thibault P, Loisel P, Durand MJ, Catchlove R and Sullivan MJ. Psychological predictors of pain expression and activity intolerance in chronic pain patients. *Pain*, 2008; **139:** 47–54.
DOI: 10.1016/j.pain.2008.02.029.

15. Crombez G, Vlaeyen JW, Heuts PH and Lysens R. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. *Pain*, 1999; **80:** 329–339.
PMID: 10204746.

16. Swinkels-Meewisse IE, Roelofs J, Oostendorp RA, Verbeek AL and Vlaeyen JW. Acute low back pain: pain-related fear and pain catastrophizing influence physical performance and perceived disability. *Pain*, 2006; **120:** 36–43.
DOI: 10.1016/j.pain.2005.10.005.

17. Quartana PJ, Campbell CM and Edwards RR. Pain catastrophizing: a critical review. *Expert Review of Neurotherapeutics*, 2009; **9:** 745–758.
DOI: 10.1586/ERN.09.34.

18. Kelders SM, Kok RN, Ossebaard HC and Van Gemert-Pijnen JE. Persuasive system design does matter: a systematic review of adherence to web-based interventions. *Journal of Medical Internet Research*, 2012; **14:** e152.
DOI: 10.2196/jmir.2104.

19. Wantland D, Portillo C, Holzemer WL, Slaughter R and McGhee EM. The effectiveness of web-based vs non-web-based Interventions: A meta-analysis of behavioural change programs. *Journal of Medical Internet Research*, 2004; **6:** e40.
DOI: doi:10.2196/jmir.6.4.e40.

20. Hale L, Bennett D, Bentley M, Crawshaw A and Davis H. Stroke rehabilitation - Comparing hospital and home-based physiotherapy: the patient's perception. *New Zealand Journal of Physiotherapy*, 2003; **31:** 84–92.

21. Jansons PS, Robins L, Haines TP and O'Brien L. Barriers and enablers to ongoing exercise for people with chronic health conditions: Participants' perspectives following a randomized controlled trial of two interventions. *Archives of Gerontology and Geriatrics*, 2018; **76:** 92–99.
DOI: 10.1016/j.archger.2018.02.010.

22. Escolar-Reina P, Medina-Mirapeix F, Gascón-Cánovas JJ et al. How do care-provider and home exercise program characteristics affect patient adherence in chronic neck and back pain: a qualitative study. *BMC Health Services Research*, 2010; **10:** 1–8.
DOI: 10.1186/1472-6963-10-60.

23. Karlsson L, Gerdle B, Takala EP, Andersson G and Larsson B. Associations between psychological factors and the effect of home-based physical exercise in women with chronic neck and shoulder pain. *SAGE Open Medicine*, 2016; **4:** 1–12.
DOI: 10.1177/2050312116668933.

24. Kersten S, Mahli M, Drosselmeyer J et al. A pilot study of an exercise-based patient education program in people with multiple sclerosis. *Multiple Sclerosis International*, 2014; **14:** 1–11.
DOI: 10.1155/2014/306878.

25. Dunphy E, Hamilton FL, Spasić I and Button K. Acceptability of a digital health intervention alongside physiotherapy to support patients following anterior cruciate ligament reconstruction. *BMC Musculoskeletal Disorders*, 2017; **18:** 471.
DOI: 10.1186/s12891-017-1846-0.

26. Nøst TH, Steinsbekk A, Riseth L, Bratås O and Grønning K. Expectations towards participation in easily accessible pain management interventions: a qualitative study. *BMC Health Services Research*, 2017; **17:** 712.
DOI: 10.1186/s12913-017-2668-3.

27. Kloek C, Bossen D, Bakker DH de, Veenhof C and Dekker J. Blended Interventions to Change Behavior in Patients With Chronic Somatic Disorders: Systematic Review. *Journal of Medical Internet Research*, 2017; **19:** e418.
DOI: 10.2196/jmir.8108.

28. Ruehlman LS, Karoly P and Enders C. A randomized controlled evaluation of an online chronic pain self management program. *Pain*, 2012; **153:** 319–330.
DOI: 10.1016/j.pain.2011.10.025.

29. Lange B, Flynn SM and Rizzo AA. Game-based telerehabilitation. *European Journal of Physical and Rehabilitation Medicine*, 2009; **45:** 143–151.
PMID: 19282807.

30. Chomutare T, Arsand E and Hartvigsen G. Mobile peer support in diabetes. *Studies in Health and Technology and Informatics*, 2011; **169:** 48–52.
PMID: 21893712.

31. Dobson F, Hinman RS, French S et al. Internet-mediated physiotherapy and pain coping skills training for people with persistent knee pain (IMPACT - knee pain): a randomised controlled trial protocol. *BMC Musculoskeletal Disorders*, 2014; **15:** 279.
DOI: 10.1186/1471-2474-15-279.

32. Marshall PWM, Schabrun S and Knox MF. Physical activity and the mediating effect of fear, depression, anxiety, and catastrophizing on pain related disability in people with chronic low back pain. *PLoS One*, 2017; **12:** e0180788.
DOI: 10.1371/journal.pone.0180788.

33. Bhattacherjee A and Premkumar G. Understanding changes in belief and attitude toward information technology usage: a theoretical model and longitudinal test. *MIS Quarterly*, 2004; **28:** 229–254.
DOI: 10.2307/25148634.

34. Szajna B and Scamell RW. The Effects Information System User Expectations on The Performance and Perceptions. *MIS Quarterly*, 1993; **17:** 493–516.
DOI: 10.2307/249589.

35. Boulding W, Kalra A, Staelin R and Zeithaml VA. A Dynamic Process Model of Service Quality: From Expectations to Behavioral Intentions. *Journal of Marketing Research*, 1993; **30:** 7–27.
DOI: 10.2307/3172510.

36. Oliver RL. A Cognitive Model for the Ancedents and Consequences of Satisfaction. *Journal of Marketing Research*, 1980; **17:** 460–469.
DOI: 10.2307/3150499.

37. Martin JL, Murphy E, Crowe JA and Norris BJ. Capturing user requirements in medical device development: the role of ergonomics. *Physiological Measurements*, 2006; **27:** R49–62.
DOI: 10.1088/0967-3334/27/8/R01.

38. Clemensen J, Larsen SB, Kyng M and Kirkevold M. Participatory design in health sciences: Using cooperative experimental methods in developing health services and computer technology. *Qualitative Health Research*, 2007; **17:** 122–130.
DOI: 10.1177/1049732306293664.

39. Adamse C, Dekker-Van Weering MG, van Etten-Jamaludin FS and Stuiver MM. The effectiveness of exercise-based telemedicine on pain, physical activity and quality of life in the treatment of chronic pain: a systematic review. *Journal of Telemedicine and Telecare*, 2017.
DOI: 10.1177/1357633X17716576.

40. Mair FS, Goldstein P, May C et al. Patient and provider perspectives on home telecare: preliminary results from a randomized controlled trial. *Journal of Telemedicine and Telecare*, 2005; **Suppl 1:** 95–97.
DOI: 10.1258/1357633054461976.

41. Wakefield BJ, Turvey CL, Nazi KM et al. Psychometric Properties of Patient-Facing eHealth Evaluation Measures: Systematic Review and Analysis. *Journal of Medical Internet Research*, 2017; **19:** e346.
DOI: 10.2196/jmir.7638.

42. Stütz T, Emsenhuber G, Huber D et al. Mobile Phone-Supported Physiotherapy for Frozen Shoulder: Feasibility Assessment Based on a Usability Study. *JMIR Rehabilitation and Assistive Technologies*, 2017; **4:** e6.
DOI: 10.2196/rehab.7085.

43. Cook N and Winkler SL. Acceptance, Usability and Health Applications of Virtual Worlds by Older Adults: A Feasibility Study. *JMIR Research Protocols*, 2016; **5:** e81.
DOI: 10.2196/resprot.5423.

44. Cimperman M, Makovec Brenčič M and Trkman P. Analyzing older users' home telehealth services acceptance behavior-applying an Extended UTAUT model. *International Journal of Medical Informatics*, 2016; **90:** 22–31.
DOI: 10.1016/j.ijmedinf.2016.03.002.

45. Kohnke A, Cole M and Bush R. Incorporating UTAUT predictors for understanding home care patients' and clinician's acceptance of healthcare telemedicine equipment. *Journal of technology management & innovation*, 2014; **9**.
DOI: 10.4067/S0718-27242014000200003.

46. Holden RJ and Karsh BT. The technology acceptance model: its past and its future in health care. *Journal of Biomedical Informatics*, 2010; **43:** 159–172.
DOI: 10.1016/j.jbi.2009.07.002.

47. Peek ST, Wouters EJ, Hoof J van, Luijkx KG, Boeije HR and Vrijhoef HJ. Factors influencing acceptance of technology for aging in place: a systematic review. *International Journal of Medical Informatics*, 2014; **83:** 235–248.
DOI: 10.1016/j.ijmedinf.2014.01.004.

Summary

Chronic pain is considered a major public health problem. In addition to the physical and emotional burden that chronic pain brings, it gives rise to significant health care costs. Although conventional rehabilitation programs are effective, the use of telerehabilitation, providing remote care via communication technologies, is expected to offer several advantages over conventional clinic-based rehabilitation because it affords patients to rehabilitate within their own social environment. This can facilitate the care delivery process, increase access of care and improve patients' well-being and quality of life. However, despite the great potential of telerehabilitation, its intended benefits will only be realized when these treatments are accepted and used by patients as fully fledged alternatives to conventional care. Therefore, an understanding of patients' reasons for accepting or refusing telerehabilitation is crucial.

The aim of this thesis is to identify drivers and barriers related to patients' acceptance of exercise-based telerehabilitation for chronic pain. This will provide more insight into strategies that may improve telerehabilitation design and as such may facilitate the uptake of prospective telerehabilitation services.

In this thesis, acceptance of telerehabilitation is considered a dynamic process, since it is presumed that acceptance and underlying beliefs are likely to change as patients gain knowledge of and experience with telerehabilitation. In the first two studies (Chapter 2, 3) acceptance of telerehabilitation services was measured of patients with limited knowledge of and no prior experience with such services; patients elaborated on hypothetical telerehabilitation scenarios. During the third study (Chapter 4), patients' acceptance was analysed before and after brief exposure to a telerehabilitation service in an experimental setting. In the last two studies (Chapter 5, 6) a group of patients was subjected to a telerehabilitation service that was actually implemented and used during their chronic pain rehabilitation program, and their acceptance behaviour was investigated.

Throughout this thesis, different methodologies stemming from psychology, sociology and behavioural economics are employed to achieve a multi-faceted understanding of the drivers and barriers underlying patients' acceptance. Technology Acceptance Models, focusing on individual acceptance, are applied as a theoretically based starting point.

Chapter 2 focuses on patients' perceptions and intentions regarding the use of prospective telerehabilitation services. Patients' arguments were arranged according to

the Unified Theory of Acceptance and Use of Technology (UTAUT) and were found to primarily relate to the constructs of performance expectancy and facilitating conditions. In general, patients considered telerehabilitation helpful as a complementary or follow-up treatment, rather than an autonomous treatment. They appeared to value benefits including reduced transportation barriers, flexible exercise hours and the opportunity to better integrate acquired skills into daily life. However, many patients also feared losing treatment motivation and expressed concerns about both reduced fellow-sufferer contact and reduced face-to-face contact with their therapist. They found such contact essential for effective feedback and exercise instructions as well as emotional support. Some patients were willing to accept feedback through remote monitoring and feedback technology later in their treatment. Therefore, it is concluded that future initiatives should retain conventional care to some degree and focus on patients' attitudes as well, either by offering information to increase patients' confidence in telerehabilitation or by addressing reported drawbacks into the future design of these services.

Chapter 3 describes a discrete choice experiment that demonstrates which treatment characteristics (attributes) are most important to chronic pain patients and which telerehabilitation scenario they are most likely to accept as an alternative to conventional rehabilitation. In this experiment, physician communication mode, the use of monitoring and feedback technology and exercise location were the most important treatment characteristics on which patients based their treatment preference. An 'intermediate' scenario, combining attributes of both conventional rehabilitation and telerehabilitation, was preferred the most. Patients were willing to accept less frequent physician consulting offered mainly through video communication, provided that they were offered feedback and monitoring technology (FMT), some face-to-face consulting and could exercise outside their home environment at flexible exercise hours. Consequently, it is concluded that prospective telerehabilitation services should incorporate (at least part of) these attributes in order to be considered promising alternatives to conventional chronic pain rehabilitation.

Chapter 4 zooms in on the effect of brief experience with a telerehabilitation service on patients' perceptions of that service. It was found that patients who had the opportunity to briefly use the telerehabilitation service in an experimental setting, showed a significantly greater change in positive direction in their perceptions of perceived usefulness and perceived ease of use, than patients in the control group who displayed no change in their perceptions. Therefore, offering patients, with no prior telerehabilitation experience, the opportunity to explore and experiment with a telerehabilitation

service is proposed as a promising strategy that requires further investigation.

Chapter 5 describes patients' acceptance of an an exercise-based telerehabilitation program that was designed and implemented as a partial replacement of an outpatient multidisciplinary group rehabilitation program. Patients' decisions to either accept or refuse participation in the telerehabilitation program were observed and underlying factors were explored. Patients who accepted the telerehabilitation program had significantly more positive perceptions of performance expectancy and facilitating conditions than those who rejected it. Furthermore, lower autonomous exercise motivation and higher levels of pain catastrophising behaviour exerted a negative influence on patients' decision to take part in telerehabilitation treatment. Based on these findings, it is concluded that both perceived telerehabilitation features as well as patient characteristics play an important role in patients' decision to participate in a telerehabilitation program. It is therefore advised that future studies investigate how a telerehabilitation service can be effectively adapted and better tailored to different levels of exercise motivation and catastrophising behaviour.

Chapter 6 investigates the changes in patients' perceptions over time by measuring patients' pre- and post-use perceptions of telerehabilitation. It also explores how these perceptions relate to patients' actual use of the telerehabilitation service. In this study it was found that patients' attitudes and their perceptions of perceived usefulness decreased over time, from a positive to a neutral score. Furthermore a decline in both patients' intentions to use telerehabilitation as well as their actual use was observed. Patients' post-use intention to use and post-use perceived behavioural control performed best in explaining patients' actual use. The results suggest that in addition to the magnitude and direction of change in perceptions, it is important to recognize the fact that patients' actual use of telerehabilitation is also affected by the positive or negative perceptions that are developed after gaining experience. This implies that an opportunity exists to contribute to higher levels of actual use of telerehabilitation, by monitoring and addressing patients' perceptions during use and by adapting telerehabilitation design accordingly.

The final chapter (Chapter 7) integrates and discusses the findings of the previous studies and proposes recommendations for telerehabilitation design and future research. It also elaborates on the strengths and weaknesses of the methodologies used to understand patients' acceptance, and describes the added value of combining methodologies from different disciplines. It asserts that, although the technology acceptance models used in this thesis are applicable to investigating chronic pain patients' acceptance of telerehabilitation, there are two important features lacking in these models.

First, they do not account for the temporal dynamics involved in patients' acceptance. Second, these models could benefit from further contextualization of the factors predicting patients' acceptance; this can provide more detailed insight into how to address patients' perceptions and needs.

In this thesis it is concluded that alongside patients' characteristics (e.g. exercise motivation and pain catastrophising behaviour), patients' attitudes and perceptions of perceived usefulness, as well as internal and external constraints are important drivers/barriers of patients' acceptance for telerehabilitation. Since, in line with our presumptions, these perceived drivers and barriers regarding telerehabilitation appeared to change with patients' experience, patients' acceptance should not be considered static but dynamic. Offering patients the possibility to gain experience with telerehabilitation prior to their decisions to use these treatments, as well as monitoring and addressing patients' perceptions during use are considered promising strategies that need further exploration.

Although patients seem to value certain benefits of telerehabilitation (e.g. the possibility to acquire exercise skills at home and have flexible exercise times), we also conclude that it is important –in order to facilitate patients' acceptance– to take into consideration patients' needs for immediate performance feedback and therapist face-to-face contact, as well as their needs for emotional and motivational support. To address these needs, the implementation of a 'blended' care model, i.e., a combination of telerehabilitation and conventional rehabilitation is recommended. This allows for the incorporation of face-to-face contact with the therapist, the opportunity to exercise in a clinical environment and the inclusion of remote monitoring and feedback technology; these features were found to be principal driving forces for patients' acceptance of telerehabilitation. Further research is necessary to establish to what extent different approaches, such as the use of virtual communities, (movement) tracking sensors, virtual reality, motivational and persuasive strategies, and the integration of psychological counselling, constitute effective means to address patients' needs. Furthermore, future studies are necessary to provide insight into the ideal combination of telerehabilitation and conventional care and to understand how this combination may vary over time.

Samenvatting

Chronische pijn komt wereldwijd veel voor en wordt beschouwd als een maatschappelijk probleem. Naast het persoonlijk leed op zowel lichamelijk als psychisch vlak dat chronische pijn met zich mee brengt, gaat het gepaard met grote zorg- en maatschappelijke kosten. Hoewel traditionele revalidatieprogramma's voor de behandeling van chronische pijn effectief blijken, is de verwachting dat de inzet van telerevalidatie (zorg op afstand met behulp van informatie- en communicatie technologie) voordelen kan opleveren. Het feit dat chronische pijnpatiënten op deze manier het revalidatieprogramma in hun eigen omgeving kunnen volgen, kan bijdragen aan zowel een grotere toegankelijkheid van zorg als aan een verhoogd welzijn en een grotere kwaliteit van leven. Ondanks het grote potentieel van telerevalidatie, zullen de verwachte voordelen alleen gerealiseerd kunnen worden wanneer patiënten deze diensten ook daadwerkelijk accepteren en gebruiken als volwaardige alternatieven voor conventionele behandelprogramma's. Een goed begrip van de redenen die de patiënt heeft om telerevalidatie te accepteren of af te wijzen is daarom van groot belang.

Het doel van dit proefschrift is om inzicht te verkrijgen in de factoren die de acceptatie van telerevalidatie door chronische pijnpatiënten bevorderen of juist belemmeren. Deze kennis helpt te achterhalen welke strategieën mogelijk kunnen bijdragen aan een verbeterd ontwerp van toekomstige telerevalidatiediensten. Een beter ontwerp kan op zijn beurt weer bijdragen aan een meer succesvol gebruik van deze diensten.

In dit proefschrift is acceptatie van telerevalidatie beschouwd als een dynamisch verschijnsel, omdat acceptatie en de ideeën die daaraan ten grondslag liggen mogelijk veranderen naarmate patiënten meer kennis en ervaring opdoen met telerevalidatie. Met de eerste twee studies (hoofdstuk 2 en 3) werd acceptatie onderzocht bij chronische pijnpatiënten die weinig kennis over telerevalidatie hadden en ook geen eerdere ervaring daarmee hadden opgedaan. Er werd hen gevraagd te reflecteren op hypothetische telerevalidatie scenario's. In de derde studie (hoofdstuk 4) werd acceptatie van de patiënten gemeten voor en nadat zij kort ervaring hadden opgedaan met een telerevalidatiedienst, die aangeboden werd binnen een gecontroleerde onderzoeksomgeving. In de laatste twee studies (hoofdstuk 5 en 6) werd onderzocht in welke mate telerevalidatie werd geaccepteerd door patiënten aan wie het gebruik van een telerevalidatie service werd aangeboden die daadwerkelijk was geïmplementeerd en werd gebruikt tijdens hun revalidatie.

Om tot een zo goed mogelijk begrip te komen van de factoren die acceptatie van telerevalidatie bevorderen of belemmeren en om zo veel mogelijk facetten te belichten, werd gebruik gemaakt van verschillende methoden. Deze waren afkomstig uit het veld van de psychologie en sociologie, evenals uit het domein van de gedragseconomie. Technologie-acceptatiemodellen, gericht op het verklaren van acceptatie door een individu, werden gebruikt als theoretisch startpunt.

Hoofdstuk 2 brengt in kaart hoe chronische pijnpatiënten dachten over telerevalidatiediensten zoals die in de toekomst mogelijk bestaan en of zij de intentie hadden deze diensten te gebruiken wanneer mogelijk. Patiënten oordeelden dat telerevalidatie waardevol leek als nabehandeling of als aanvullende behandeling op het traditionele revalidatieprogramma, maar niet als vervanging van het traditionele revalidatieprogramma. De antwoorden van de patiënten werden gestructureerd aan de hand van de Unified Theory of Acceptance and Use of Technology (UTAUT). Hieruit bleek dat de meeste van de aangedragen onderwerpen te maken hadden met het verwachte voordeel van telerevalidatie (performance expectancy) en met de mate waarin patiënten zich in staat gesteld voelden de behandeling met telerevalidatie ook daadwerkelijk succesvol te volgen (facilitating conditions). Meer specifiek werd gevonden dat patiënten het waardeerden dat telerevalidatie zou leiden tot verminderde reistijden, dat het makkelijker zou zijn de aangeleerde kennis direct toe te passen in het dagelijks leven en dat men de behandeling op eigen gekozen tijden kon volgen. Aan de andere kant vreesden veel patiënten dat het gebruik van telerevalidatie motivatieverlies voor het volgen van het revalidatieprogramma tot gevolg zou hebben. Bovendien toonden zij zich bezorgd over het feit dat telerevalidatie zou leiden tot een verminderd direct contact met zowel de therapeut als met lotgenoten. Dit contact werd als essentieel gezien voor het ontvangen van effectieve feedback-instructies en emotionele ondersteuning. Sommige patiënten gaven aan bereid te zijn een deel van de terugkoppeling te ontvangen via monitoring en feedback-technologie (op afstand) op een later moment in hun behandeling. Concluderend kan worden gesteld dat het aan te raden is om bij toekomstige telerevalidatie-initiatieven een deel conventionele revalidatie te integreren. Daarnaast zou de houding van patiënten wellicht beïnvloed kunnen worden door bij het ontwerp van toekomstige diensten (en bij het geven van voorlichting) rekening te houden met de gevonden belemmerende factoren.

In hoofdstuk 3 werden de voorkeuren van chronische pijnpatiënten voor telerevalidatie bepaald door middel van een ‘discrete choice experiment’. Patiënten werd gevraagd hun voorkeuren uit te spreken voor een aantal alternatieve behandelingen. De resultaten lieten zien dat de aanwezigheid van face-to-face contact met de therapeut,

het gebruik van monitoring en feedback-technologie en de oefenlocatie belangrijke criteria waren die de keuze voor een bepaalde telerevalidatiebehandeling bepaalden. Bovendien bleek dat patiënten de voorkeur gaven aan een behandeling die elementen van zowel telerevalidatie als conventionele revalidatie combineerde (het zogenaamde 'intermediate' scenario). Patiënten bleken bereid om minder frequent contact met hun therapeut, dat grotendeels via video-consultatie verloopt, te accepteren wanneer zij gebruik kunnen maken van monitoring en feedback technologie, een deel van het face-to-face contact met de therapeut behouden blijft en zij de mogelijkheid hebben om te oefenen op een locatie buiten de thuisomgeving. Het is dan ook aan te bevelen om (een deel van) deze elementen in toekomstige telerevalidatiediensten te integreren om zo een behandeling te kunnen bieden die door de patiënt als een volwaardig alternatief wordt beschouwd voor traditionele revalidatie.

In hoofdstuk 4 is het effect van kortdurende ervaring met telerevalidatie onderzocht. De resultaten lieten zien dat patiënten die de mogelijkheid hadden om telerevalidatie uit te proberen in een experimentele onderzoeksomgeving, positiever oordeelden over het nut (perceived usefulness) en het gebruiksgemak (ease of use), dan patiënten die deze ervaring niet hadden opgedaan. Het aanbieden van een mogelijkheid om vrijblijvend ervaring op te doen met telerevalidatie, voordat een patiënt daadwerkelijk besluit om de dienst te willen gaan gebruiken, wordt dan ook gezien als een veelbelovende strategie, die echter wel nader onderzoek vereist.

In hoofdstuk 5 werden de beslissingen van patiënten om een telerevalidatieprogramma binnen hun behandeling te accepteren of te weigeren evenals de factoren die hieraan ten grondslag lagen onderzocht. Dit programma richtte zich op fysieke training en werd ingezet als gedeeltelijke vervanging van een conventioneel, multidisciplinair groepsrevalidatieprogramma. Het bleek dat de patiënten die besloten om het telerevalidatieprogramma te gaan gebruiken, positiever oordeelden over het verwachte nut (performance expectancy), dan patiënten die deelname weigerden. Bovendien voelden patiënten die wilden deelnemen zich beter in staat het programma te gebruiken (facilitating conditions). Daarnaast werd gevonden dat een lage intrinsieke motivatie om te oefenen en hoge niveaus van pijn-catastroferend gedrag een negatieve invloed uitoefenden op de beslissing van patiënten om deel te nemen aan het telerevalidatie programma. Dit leidde tot het inzicht dat niet alleen de verwachtingen die de patiënt heeft ten aanzien van de telerevalidatie maar ook individuele kenmerken van de patiënt een belangrijke rol spelen bij de acceptatie van telerevalidatiediensten. Verder onderzoek is noodzakelijk om inzichtelijk te maken hoe telerevalidatiediensten beter afgestemd kunnen worden op de verschillende niveaus van motivatie en pijn-

catastroferend gedrag van de patiënt.

In hoofdstuk 6 zijn de percepties van patiënten gemeten voor en na het gebruik van een telerevalidatiedienst en werd onderzocht welke rol deze percepties speelden bij het daadwerkelijk gebruik van deze dienst door de patiënt. Het bleek dat patiënten na gebruik een minder positieve attitude hadden ten aanzien van telerevalidatie; deze veranderde van een positieve naar een neutrale attitude. Wat betreft het verwachte nut (perceived usefulness) werd eenzelfde effect gevonden. Daarnaast was er ook een daling te zien in de intenties van patiënten om de dienst te gebruiken en werd deze daling ook zichtbaar in het daadwerkelijk gebruik van de dienst over de tijd. De percepties van patiënten, gemeten na een periode van gebruik, bleken het meest voorspellend voor het daadwerkelijk gebruik. De resultaten lieten zien dat het niet alleen belangrijk is om de grootte en richting van verandering in percepties in ogenschouw te nemen bij het voorspellen van daadwerkelijk gebruik, maar ook in hoeverre de gevormde percepties van patiënten op basis van ervaring positief dan wel negatief zijn. Door percepties van patiënten tijdens het gebruik van telerevalidatie te monitoren en te beïnvloeden, en door het telerevalidatie-ontwerp aan te passen, kan mogelijk worden bijgedragen aan een hoger daadwerkelijk gebruik.

Ten slotte zijn in hoofdstuk 7 de bevindingen van de hiervoor besproken studies bediscussieerd en vergeleken met de resultaten van andere studies die zijn uitgevoerd in het bredere veld van telerevalidatie. Daarnaast is ingegaan op de sterke en zwakke punten van de methodologieën die zijn gebruikt om acceptatie door de patiënt te begrijpen. Ook werd besproken in hoeverre het combineren van methoden uit verschillende onderzoeksvelden toegevoegde waarde biedt. Er is beargumenteerd dat de gebruikte technologie acceptatiemodellen weliswaar toepasbaar zijn binnen het veld van telerevalidatie en chronische pijn, maar dat twee belangrijke eigenschappen ontbreken. Allereerst wordt het dynamische karakter van acceptatie en percepties van de patiënt niet onderkend. Ten tweede kunnen deze modellen verbeterd worden door de factoren van de modellen nader te specificeren voor telerevalidatie bij chronische pijn. Zulke modelaanpassingen kunnen bijdragen aan een meer gedetailleerd inzicht in de strategieën die nodig zijn om tegemoet te kunnen komen aan de verwachtingen en behoeften van patiënten.

Samenvattend, luidt de conclusie van dit proefschrift dat de acceptatie van telerevalidatie voor chronische pijn op substantiële wijze beïnvloed wordt door factoren zoals patiëntkenmerken (motivatie en pijn-catastroferend gedrag), de attitude van een patiënt, de percepties met betrekking tot nut en de verwachte/ervaren interne of externe beperkingen. Omdat ervaring van invloed is op de mate waarin deze facto-

ren gevoeld worden als bevorderend of belemmerend, moet acceptatie niet worden beschouwd als een statisch, maar als een dynamisch verschijnsel dat aan verandering onderhevig is. Het bieden van de mogelijkheid aan een patiënt om ervaring op te doen met een telerevalidatiedienst voorafgaand aan zijn/haar beslissing om deze dienst al of niet te gaan gebruiken, evenals het monitoren en het beïnvloeden van percepties van patiënten tijdens het gebruik van telerevalidatie, worden beschouwd als strategieën die veelbelovend zijn, maar wel verder onderzoek behoeven. Patiënten blijken bepaalde kenmerken van telerevalidatie te waarderen, maar tevens kan worden geconcludeerd dat patiënten groot belang hechten aan de mogelijkheid tot het ontvangen van directe feedback tijdens het uitvoeren van fysieke oefeningen. Ook hebben zij behoefte aan face-to-face contact met de therapeut en aan motiverende en emotionele steun tijdens de behandeling. Om tegemoet te kunnen komen aan deze behoeften en zo acceptatie van telerevalidatie voor chronische pijn bij de patiënt te bevorderen, wordt geadviseerd gebruik te maken van een 'blended' care model: een combinatie van telerevalidatie en conventionele revalidatie. Zo heeft een patiënt de mogelijkheid om face-to-face contact te hebben met de therapeut, de oefentherapie uit te voeren op een externe locatie en monitoring en feedback te krijgen via technologie. Hiervan is aangetoond dat dit belangrijke factoren zijn om de acceptatie van telerevalidatie te bevorderen. Verder onderzoek moet uitwijzen in hoeverre het gebruik van bijvoorbeeld virtuele communities, (bewegings)sensoren, virtual reality, motivatie- en persuasieve strategieën en de integratie van psychologische begeleiding, kan bijdragen aan het afstemmen van telerevalidatie op de behoeften en de wensen van de patiënt. Daarnaast is vervolgonderzoek noodzakelijk om inzicht te krijgen in de optimale combinatie van telerevalidatie en conventionele zorg en hoe deze combinatie zou moeten veranderen naarmate een patiënt zich verder in de behandeling bevindt.

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Curriculum vitae

Karlijn Cranen werd geboren op 26 juni 1983 in Wijchen. Na het afronden van haar VWO-opleiding aan het Maaswaal College te Wijchen koos zij voor de studie Communication Science, specialisatie gezondheid en voorlichting, aan de Universiteit Twente. Deze studie rondde ze in maart 2007 af en kwam daarna als promovendus in dienst bij Roessingh Research and Development. Behalve aan haar promotieonderzoek, werkte ze daar in de hoedanigheid van projectlid of projectleider aan verscheidene projecten op het gebied van telemedicine, waaronder Euregio — Healthcare without Borders, Teleloco, CLEAR, de Online Exercise Coach en TeleACT. Naast haar wetenschappelijke bezigheden, werkte zij op vrijwillige basis bij SVWO/ Arcon en RTV Oost als interviewer en redactioneel lid van het radio programma UIT DE WEG, dat zich richtte op onderwerpen op het gebied van welzijn en gezondheidszorg. In 2012 verhuisde zij voor vier jaar naar de Verenigde Staten wat de facto voor een onderbreking van haar wetenschappelijke carriere zorgde. Aan de Washington School of Photography rondde ze een vakopleiding fotografie af en begon een eigen fotografie bedrijf. Na terugkeer in Nederland, hervatte zij haar promotieonderzoek waarvan dit proefschrift het eindresultaat is.

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