

Telerehabilitation applications could solve the barriers of meaningful rehabilitee pathways in early stage of Multiple Sclerosis – A case study

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Abstract

Multiple Sclerosis (MS) is a neurological disease affecting particularly the working age population. The prevalence of MS in Finland is one of the highest in the world. Finnish social, health care and rehabilitation services providers need to solve many complex challenges, for example, how to increase the cost-effectiveness of the services, simultaneously meeting the essential needs of rehabilitees. Physiotherapy is one of the most common rehabilitation modalities for rehabilitees with MS. Telerehabilitation as a novel mode of physiotherapy has been recognized in Finland, but its applicability for successful physiotherapy remains unclear.

This study is part of an interdisciplinary project conducted at the University of Jyväskylä, Finland. The goal of the project has been to develop a tentative prototype application of telerehabilitation for early stage MS rehabilitees. Information search was conducted to proof of concept of the telerehabilitation applications. Professional's consultations were conducted to understand the applicability and usability of our application. In addition, the application development principles for our development purposes were discussed.

In this study we report the idea of the developed telerehabilitation application as a product of a multi-professional development process. Findings of this study highlights the importance of critical and open reflection at every stage of any application development work to support interdisciplinary product development, cocreation process, as well as research, development and innovation (RDI) activities at various organizations.

Keywords: digitalisation, telerehabilitation, physiotherapy, Multiple Sclerosis

Introduction

In general, telerehabilitation is a rapidly developing area. Researchers and software developers need to

understand how digital technology can support health care services while also considering issues related to safety and ethics. In physiotherapy, there is a great need to include (remote) technology as

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part of the clinical practice settings, either to supplement the services or to replace some of them [1-3]. In the past, the focus of the development work has been on digital technologies itself. Less attention has been given to how telerehabilitation could be used with entirely new innovative approaches [3-4]. In the future, an open-minded approach involving new technologies is crucial in the Finnish public social and health care services to develop more personalized services and to ensure human resources [5]. There are ethical concerns related to telerehabilitation, including accessibility, privacy policy and autonomy of rehabilitees. Concerns arising from management of the patient information, decision-making of the authorities, work of the physiotherapists, and equal possibilities of the rehabilitee's participation should be taken into consideration when using telerehabilitation services [6]. The attitudes and opinions of rehabilitees should be considered already during the telerehabilitation development processes [3-4,7]. Several terms are used when talking about technology-assisted physiotherapy (i.e., blended treatment; remote, tele- or e-rehabilitation). In this article, we will use the term telerehabilitation, recommended by the American Physical Therapy Association [8]. Telerehabilitation is an umbrella term for digital(-assisted) physiotherapy [9].

Turning point of social and health care services in Finland

The goal of the social and health care reform introduced in Finland at the beginning of 2023 was to provide the best possible outcomes at the lowest possible costs. The aim was to “strengthen the financial basis of service delivery, to guarantee equal access to health and social services, and to reduce inequalities in health and well-being” [10]. These services still need to be reformed in a more cost-effective and efficient direction [11]. One often

presented solution is to offer social and health services through digital platforms.

Use of digital services is common in Finnish outpatient care [12], and Finland is one of the first countries to use health data for knowledge-based management [5]. At an individual level, the use and competencies in technology skills are quite convincing, since approximately 79 % of Finns have basic digital skills. Nevertheless, approximately 40 % of the Finnish population have problems in using more demanding digital technologies [13].

Applications for digital health are strictly regulated in European Union, including Finland [14-20], because they might be categorized as medical devices (MDs) which are used for observing or alleviation of diseases. All MDs must be submitted to risk assessment, and outcome effectiveness and cost-effectiveness assessment [21]. Previous studies on digital health services have reported several challenges e.g., overlap and ambiguity of registry data, lack of the scientific knowledge, and limited national resources and incentives [22]. Telerehabilitation applications critical concerns include safety [23], user friendliness, personalization, availability [24], accessibility and integration [12], data privacy, security and accuracy of digital components [25].

Application prototype development and cocreation are collaborative and innovative processes operating within a service ecosystem which facilitates the development process by connecting and bringing people together [26] and emphasizing value creation [27]. The need for transdisciplinary competencies to develop and design human-centric, effective and evidence-based services has been detected [28,29]. Service, Technology, Organization and Finance (STOF) domain model [30] can be used to demonstrate business design domains and challenges of the development process. Various stakeholders and actors can be involved in the cocreation

process [31]. Cocreated platforms in health care, and business model-based data sharing in collaboration between private and public sector stakeholders [5] is one presented solution for health care development.

Working age rehabilitees with Multiple sclerosis (MS)

MS is a chronic neurological disease that is typically diagnosed between the ages of 20 and 50. The disease affects the human nervous system and is classified into subtypes based on disease symptoms and progression. Symptoms vary between individuals, but the main symptoms are fatigue, decline of cognitive ability, mood changes, visual impairment, sensory loss, and difficulties with coordination and walking [32]. The direct health care costs, direct nonmedical costs, and productivity costs per person per year for different subtypes of disease in Finland were 36 000–71 000 euros in 2015. Early retirement was one of the main reasons for MS-related costs [33]. The prevalence of MS in Finland is one of the highest in the world [34]. Based on current legislation, the responsibility for organizing physiotherapy services in Finland is shared between private sector stakeholders and the public sector [34,35].

The physical approaches in physiotherapy are based on evaluating the unique functioning of rehabilitees using the International Classification of Functioning, Disability and Health (ICF) model. MS-related impairment in body functions and structures lead to problems performing activities of daily living [36]. International guidelines of physiotherapy show how rehabilitees with MS should exercise during periods of stability, during and after relapse and with disease progression [32,37]. Rehabilitation should also include ongoing information and support for various symptoms [38]. Physiotherapists need to consider rehabilitee cognition,

technology skills, risk of falling [39] and motivation to engage in regular exercise [40].

The use of telerehabilitation is low [41,42] and its effectiveness is limited [43–45], particularly among rehabilitees with stroke or MS [1,46,47]. Telerehabilitation might be more flexible than traditional physiotherapy when considering exercise scheduling and lessened need to travel [4,39], thus creating more expectations for applying telerehabilitation to exercises on physical activity, mobility, balance and activities of daily living [48]. The attitudes and experiences of rehabilitees [4,49,50] and physiotherapy professionals [2,51] have not been a research focus area until very recently, i.e. in the early 2020s. In conclusion, the understanding of the significance of telerehabilitation is insufficient [4,50,52]. At the same time, the need for medical rehabilitation, including physiotherapy, is increasing internationally [53] and nationally [54]. In Finland, intensive medical rehabilitation has increased from 20 000 rehabilitees to almost 40 000 rehabilitees in less than 15 years [54]. Success in this challenging situation depends on achieving more in-depth knowledge and understanding of telerehabilitation [4,55].

Materials and methods

Aim

The aim of the study was to evaluate the applicability of the University of Jyväskylä (JyU), Finland, learning platform for creating a telerehabilitation application for rehabilitees with MS in Finland, and to identify the general components for such a telerehabilitation application. This study presents the idea of the telerehabilitation application creation as a cocreation process using this platform. Even though we are not focusing on the various functionalities of the JyU learning platform as such. The

research question was: “Is the University’s learning platform applicable for telerehabilitation in rehabilitees with early stage of Multiple Sclerosis”?

Design

This study is part of the interdisciplinary product development project at the JyU [55]. The project was undertaken by Faculty of Information Technology, JyU, and its duration was three months. Two physiotherapists and two engineers were in the project team. The project steering group consisted of project supervisor (PhD. Health Sci.), and ICT, RDI and rehabilitation professionals from JyU, at total five people. Stakeholders were from Hospital Nova (Central Finland) and Istekki Oy, Jyväskylä, Finland. STOF was used to guide the project team discussions and development of prototype. The first phase of the project was information search, and the second phase aimed at developing a telerehabilitation application prototype for the JyU learning platform including testing and introducing the idea (Figure 1).

Information search (Phase 1)

The project supervisor from the JyU has chosen rehabilitees with MS as the focus group, based on previous research focusing on physiotherapy experiences involving working age rehabilitees with MS in Finland [1,4,47,56]. Information search was conducted in September 2023 focusing on telerehabilitation applications for rehabilitees with MS. Applications were identified from Ebsco and Medline Ovid databases and from internet by the project team. In this phase, the main goal was to find out the amount and content of the telerehabilitation applications. Applications included had to meet the following inclusion criteria: 1) rehabilitees with mild to moderate stage of MS, 2) physical exercises were based on physiotherapy guidelines [37-38]. In total, we found two publications dealing with telerehabilitation platforms [57,58] and five publications with mobile applications [59-63] designed for rehabilitees with MS. One mobile application [60] was partially designed in Finland.

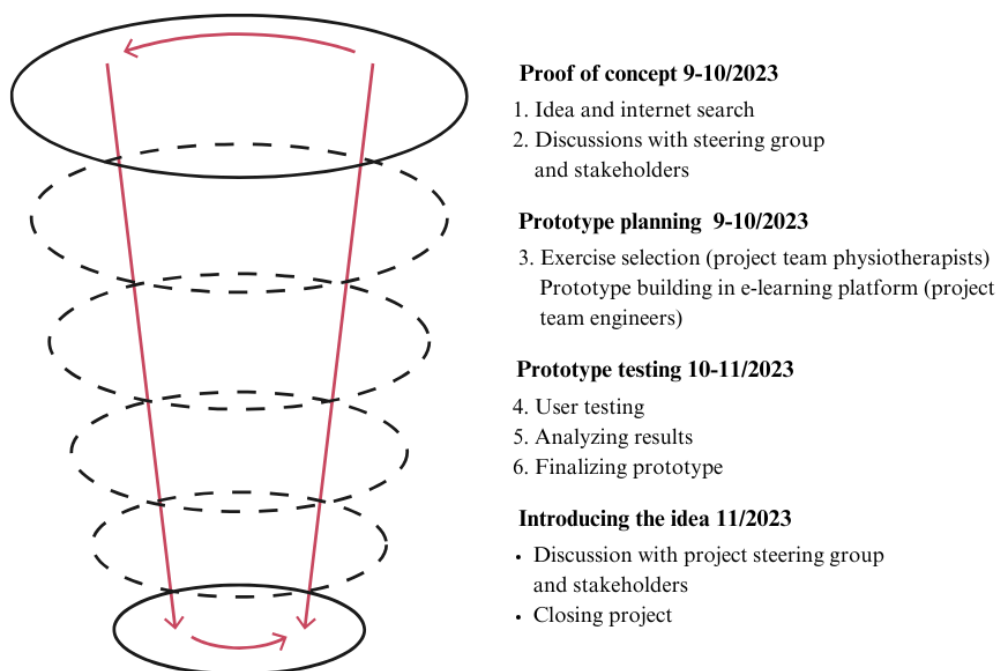


Figure 1. Overview of telerehabilitation application cocreation process [55].

Development of telerehabilitation application (Phase 2)

After the information search, the cocreation session (No: 1, ideation) was conducted by the project team. The idea of the eKuntoutus application was to attract rehabilitation professionals and their rehabilitees as users of a single platform, which enables to offer different exercise ideas based on the unique functioning of the rehabilitee. The cocreation session (No: 2, discussions) were held with stakeholders to proof of concept in two 60 min. separate meetings. First meeting was with rehabilitation professional from Hospital Nova, the project supervisor and project team members. Second meeting was with project team members and two ICT specialists from Istekki Oy. In addition, the project team met with members of the steering group to test the idea.

Following discussions, the cocreation session (No: 3, prototype planning) was held to plan and build the prototype. The project team used STOF framework in discussions to support the application development phases. Exercises in the application were selected by team physiotherapists based on physiotherapy guidelines for rehabilitees with MS. The JyU learning platform was used to demonstrate the idea of the prototype and its core functionalities of the rehabilitee site of the application. The prototype was built by team engineers using components already available on the learning platform. The cocreation session (No: 4, user testing) was conducted with the project supervisor, a rehabilitation professional from the project steering group, and project team members. Following the testing session, a subsequent cocreation session (No: 5, analyzing results) were held during the project team meeting to evaluate the outcomes. Finally, the cocreation session (No: 6, finalizing prototype) took place to discuss the results of the prototype testing

and gather input from project team discussions. In the final phase of the product development project, the project team, steering group members, and stakeholders from Istekki and Hospital Nova discussed the applicability and usability of the learning platform for telerehabilitation practices.

Results

The main findings are the platform complexity, scalability limitations when managing rehabilitees and creating new content, the lack of essential security requirements, and the impossibility to determine whether the application could be classified as a MD or not MD. Due to the complexity of the application management, the functionalities of the management site of the JyU learning platform are not appropriate for our specific purposes. Our study shows that it's important to develop digital solutions that are useful and efficient for Finnish rehabilitation practices. The prototype of eKuntoutus can be seen as the first Finnish national rehabilitation pathway, which brings together the rehabilitees and their professionals on a single platform. It has the potential to work as a base for future applications to enable a sense of meaningfulness and autonomy in one's rehabilitation pathway.

The core structures of eKuntoutus

The eKuntoutus is an application for three end user groups, and it includes the maintenance of technical support. There are different interfaces for the end user groups: the rehabilitee user site, and the site for content creators, professionals, and technical support administrators (Figure 2). From the rehabilitees point of view, the application offers a single platform to perform the exercises of the rehabilitation program and manage their own rehabilitation path.

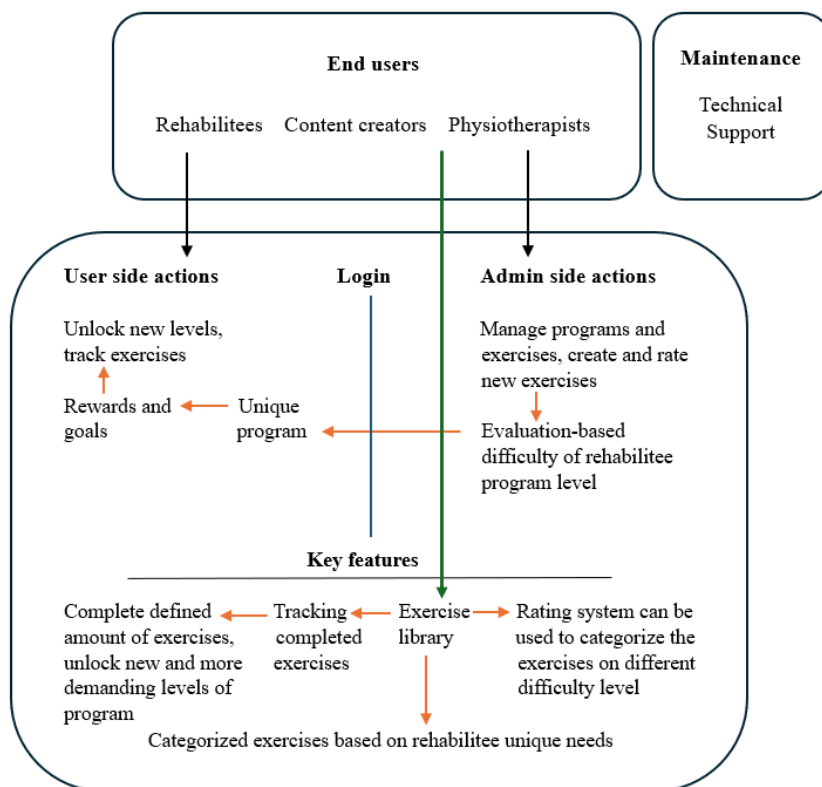


Figure 2. Overview of the eKuntoutus core structures [55].

The application has features for self-tracking progression, which helps the rehabilitees stay motivated and may thus improve rehabilitation outcomes. The physiotherapist can use the application to assign exercises to their rehabilitees from an exercise library created by health care professionals (content creator). Cocreation and versatility of the exercise library are the key factors when evaluating the usefulness of the application in a telerehabilitation setting. The prototype of eKuntoutus didn't include the exercise library, nor was it tested with actual rehabilitees.

From the perspective of rehabilitees, the end user can track their progress and unlock new, more demanding exercises by performing a set of exercises at their current level. The application gives the rehabilitees freedom to perform exercises that are appealing and increases their motivation to perform them. The autonomy to track and perform

exercises could provide inspirational goals and a feeling of freedom and progress. The actual ability of the application to meet these expectations remains unclear, because the application has not been tested on rehabilitees with MS.

In professional context, physiotherapists can use the application as an admin to manage and track the rehabilitees' progression in their rehabilitation program (performed exercises and tasks). Sets of exercises can be assigned based on rehabilitee's needs and capabilities to perform the exercises. The exercise categorization into different difficulty levels reflects the rehabilitees' physical and cognitive ability to perform different exercises and tasks. This supports the physiotherapists' ability to consider the unique functioning ability of a rehabilitee in selecting the baseline difficulty level for the exercise program.

Feedback on eKuntoutus was obtained from a rehabilitation specialist at the JyU through demonstrations made by developers. From the perspective of constantly evolving legislation, changes in the organization of rehabilitation, as well as funding of social, health care and rehabilitation services, should serve as a foundation for these types of projects.

Service, technology, organization and finance domains of eKuntoutus

The greatest issues of development and use of the telerehabilitation applications in Finland arise from the cost structure, revenue streams, and legislation. Possible issues should be thoroughly addressed during the preliminary phase of the product development process before advancing to subsequent stages. STOF model demonstrates more detailed business design domains and possible challenges of eKuntoutus prototype (Table 1).

Table 1. The prototype domains based of the Service, Technology, Organization and Finance (STOF) - model.

Critical Design Issues	Description	Balancing requirements
Service domain		
Targeting	How to define the target group of the rehabilitation service	KELA vs. wellbeing services county vs. private sector organization
Creating value	How to create value for end users	Technological possibilities vs. user needs and wishes
Branding	How to promote/brand the service	Pricing vs. technological modelling
Trust	How to enhance end users' trust in the service	Security vs. ease of use; Privacy vs. added value
Customer retention	How to stimulate recurrent usage of the service	Customer lock-in vs. customer annoyance
Technology domain		
Accessibility	Health service needs to be accessible to everyone	Accessibility vs. simplicity
Security and processing of personal data	Service contains sensitive personal information and therefore security needs to be top-notch	Security vs. Costs
System integration	Integration with existing systems (Oma-Kanta, KELA)	Seamless integration vs. costs
Organization domain		
Partner selection	What partnership could be beneficial for both parties (THL, STM, etc.)	Quality vs. quantity
Network openness	Who are allowed to offer the service	Private owned vs. public owned
Finance domain		
Division and valuation of costs and revenues between network actors	Assessment of valuation is based on access to resources, direct revenue and strategic benefits	Cost-benefit valuation on level of network versus cost benefits for individual partners
Investments	Capital investment and risk assessment	Operational financial interest vs. intangible benefits
Pricing	Price level for service providers	Pricing seems to be aligned with maximizing profits vs. creating market share vs. nonprofit business modelling

THL = The National Institute for Health and Welfare; Kela = the Social Insurance Institution of Finland; STM = Ministry of Social Affairs and Health

Suggestions for future development

From the end user's point of view, exercise variation, rehabilitee's functional ability and willingness to use a telerehabilitation application, user-friendliness and data protection are the key factors of a successful product. In addition, the coloring and typing of the design and text are important aspects of accessibility. All accessibility principles should be resolved early in the development process. From a technical perspective, the application should have at least the following aspects: user support, e.g., chatbots, feedback possibilities, improved user interfaces, more versatile rehabilitation tasks, the possibility of interaction between rehabilitees and health care professionals, and the use of a mobile application that complements the online version. Possible further needs will arise during the later phases of the product development process.

Discussion

The aim of this study was to increase knowledge and understanding of telerehabilitation, and to identify factors that can promote or prevent development and use of telerehabilitation applications in Finland. Our application prototype was developed for rehabilitees with MS, which is a common neurological disease in Finland. Previous studies have shown that the knowledge of telerehabilitation utility and effectiveness is rapidly increasing worldwide [23]. The main finding in this study is that the University's learning platform is not suitable for this type of telerehabilitation application mainly due to the security, availability and accessibility.

Our study supports the idea that the starting point for developing telerehabilitation is either the goal of changing operations or developing a completely new operating model, which is often presented as a process. This process includes modelling,

evaluating and measuring operational processes and implementing selected improvement measures. These practices from an iterative process of quality improvement, aimed at evaluating and implementing changes in line with the objectives, treating them as controlled elements within a systematic and continuous process [64].

In this creating process is important to understand the maturity level of the used telerehabilitation technology. Previous literature [3] has identified the following application development stages: 1) application concepts and design formulations, 2) proof of concept with key technological functions, 3) demonstration of an integrated system with full functionality, 4) effectiveness testing with the general population or in a controlled environment, and 5) effectiveness testing or clinical trial target users in the intended use environment. Our prototype of the eKuntoutus is currently in stage 2, where now, for the first time, we have created a concept with key technological functions in rehabilitees with MS.

According to the previous literature, the market value of telerehabilitation is quickly increasing [65], which might attract a wide variety of operators to the market. From an ethical point of view, it's important that technology promotes justice, improves quality of life, minimizes the harm caused by technology [66] and considers how the unethical use of systems can be prevented [67]. Telerehabilitation should focus on supporting a sense of meaningful life and human dignity in the part of the physiotherapy process.

In general, the design of rehabilitation-oriented techniques begins with a rehabilitee-oriented approach, examining societal objectives and activities from an interdisciplinary perspective, from which new technologies are expected to emerge. Nevertheless, only a few studies have considered end user perceptions and experiences of rehabilitees

with MS [4]. It appears that once accessibility is improved, rehabilitees can participate and engage, requiring less assistance to follow the prescribed exercises [3].

Finally, the essential conditions for the meaningful use of telerehabilitation include identifying the rehabilitees' current functioning, needs and goals, supporting their motivation and commitment, choosing relevant and meaningful activities, creating safe and variable environments, and enabling social interaction and relationships. These are the key elements for promoting rehabilitees' individual self-rehabilitation pathways and functional ability [4]. Treating rehabilitees as part of the cocreation process might be the only ethical way to develop an effective and user-friendly telerehabilitation applications.

Limitations

The study was part of an interdisciplinary project of the JyU, and it has some limitations. Firstly, the project was conducted in three months while corresponding projects usually take at least six months. Secondly, the application was built on the University's learning platform, whence the research team had no previous experience, which made the product development process more difficult. Thirdly, we were unable to evaluate rehabilitees' perceptions of eKuntoutus to provide insights into its meaningfulness. Thus, essential factors for users may have been ignored in the design.

Conclusion

Our study shows how open and critical reflection of use of the telerehabilitation application and the learning platform, could support the future research, development and innovation work of the universities. The idea of the meaningfulness of physiotherapy as a part of telerehabilitation is promising, but more information about the perceptions of rehabilitees is needed. The next step is to complete the prototype and test it in rehabilitees with MS. Research and reporting on ongoing telerehabilitation product development at different stages of maturity is a crucial foundation for designing system functions and selecting appropriate technologies. Those results can also be used more widely to identify telerehabilitation challenges and possibilities, especially at level two, which is the stage of "proof of concept with key technological functions".

Conflict of interest

None.

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