dHealth 2022
G. Schreier et al. (Eds.)
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doi:10.3233/SHTI220373

Design Requirements for a (Tele-) Rehabilitation Platform: Results from a Participatory Process

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Abstract. Background: Teletherapy has the potential to foster therapy efficiency by supporting the whole therapy process. Objectives: In the ongoing project REHA2030 a service model and technology platform for telerehabilitation of stroke patients is developed. Methods: To provide a user-friendly solution, a human-centered design process was employed throughout the whole project, where stakeholders from different professions were involved. Results: Aiming at a comprehensive approach that includes the whole therapy process, structural elements from the patient data administration through planning and monitoring of exercises to documentation and reporting and communication possibilities were implemented. Flexibility in the setting and multi-professional usage with one interaction point for the patient - independent of the type of therapy - were crucial outcomes for a high user experience. Conclusion: The platform, consisting of a tablet with an app, integrable therapy devices for the patient and a web-interface for the therapist will be tested and evaluated within the project with 12 participants (patients and therapists) in a real-life setting.

Keywords. Telerehabilitation, Stroke, Universal Design, Professional-Patient Relations

1. Introduction

Studies show evidence that telerehabilitation has equal effects as conventional (in-person) rehabilitation on activities of daily living and motor function like balance or upper limb functions [1], [2]. Thus, it has the potential to act as a supplement to conventional rehabilitation pathways of stroke patients or as an alternative, depending on the requirements of the patient. The Project REHA2030 aimed to develop a service model and technology platform that provides a flexible and tailored solution for post clinical stroke rehabilitation

1.1. General Idea: Project REHA2030

Demographic change and its multifaceted characteristics and impact on a depopulation in rural areas, mobility services and infrastructure like adequate healthcare service provision [3] can lead to supply gaps in therapeutic interventions for persons in need, for

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instance after a stroke. This might lead to negative effects as continuous interventions, no gaps in service provision as well as a high number of repetitions of training is a crucial factor for success [4]. Besides that, the adherence of the patient in general has significant effects on the patient outcome and is influenced by various factors. These include patient related factors like belief in effectiveness, factors related to the rehabilitation team like communication, but also factors of rehabilitation system, insurance and social support system [5]. In case of provision of telerehabilitation, the accessibility of a rehabilitation system to all types of users regardless of their physical and cognitive abilities are further barriers that are not sufficiently taken into consideration or only marginally studied during the human-centered design of such systems [6].

The project REHA2030 (January 2019 - June 2022) addresses these challenges by developing a service model and a technology platform for telerehabilitation at home. The aim of this research project is the identification of crucial process steps for a comprehensive and flexible telerehabilitation approach, that meets the needs of all involved stakeholders. The model is intended to cover requirements imposed by the Austrian and Slovenian healthcare ecosystem. A technical demonstrator, developed in a human-centered design process will be used in a first real-life demonstration to evaluate acceptance factors and user experience. The demonstrator is limited to some therapeutic use cases (e.g. only one hardware device integrated) which will be considered when recruiting the patients for the real-life test.

It is expected, that the outcomes of REHA2030 will give valuable insights regarding the potential and weaknesses to a) support the finalization of the service model taking into consideration financial and logistic pathways for a consistent service chain and delivery and b) foster an extend of the technology platform for wider pilot projects and multidimensional evaluations.

1.2. Potential of teletherapy

Physical distancing during COVID-19-crisis due to the health-risk – especially for the elderly and vulnerable people – led to a necessary search for alternatives to conduct direct professional therapeutic measures, as stated in the law. Teletherapy was quickly implemented in practice and led to a change of attitude towards teletherapy in professionals [7]. Digitally supported therapy does come with a variety of advantages, including independence in terms of location of patient and therapist or saving of travel times and a better integration into everyday life of patients. Furthermore, the motivation of the patient and thus the therapy success can be fostered by teletherapy with its digital components by implementing and providing serious games applications and giving feedback about quantity and quality of performed exercises. This leads to a better adherence to therapy as the patient has a congruent and traceable path of therapy – from the goal setting, through gamified exercises to activity monitoring [8].

1.3. Aim of the project

Bases on technology, different approaches are given for the design of a telerehabilitation system. In order to have an impact on therapy progress, the therapist, the patient and the caregivers need to experience added value from teletherapy and intend to continue using it. The aim of the project is to exploit the potential of telerehabilitation and to define and evaluate the essential components, structures and features of such a system that is usable

in different settings for freelance and clinic therapists in outpatient services by following a participatory human-centered design process.

2. Methods

The involvement of the potential future target groups and a clear methodological approach during the whole research, innovation and development process support to avoid conceptual errors even in the design phase and leads ideally to a product with high user-experience and a high intention to use for humans and especially for vulnerable target groups as patients after a stroke.

2.1. Human-centered design

The in the project employed approach of human-centered design (HCD) [9] describes an iterative process that focusses on user's needs during the development of interactive systems. In this iterative process the specification of the context of use, specification of requirements, development of design solutions and evaluation of the design regarding to the gathered requirements are performed in an iterative way until the requirements are met. To properly address the specific needs, a participatory design approach, with target group centered methods based on a comprehensive stakeholder map are applied. Methods and practices that allow the involvement of users more actively with the goal of a continuous user-driven approach change the process and the outcomes from "Design for All" to a "Design with All" perspective [10].

Within research projects in general, parallel work-cycles (e.g. requirement analysis, technical development, evaluation planning) sometimes cannot be avoided. These cycles have strong dependencies and parallelism is only useful to a limited extend. Therefore, a well-defined and accurately conducted requirement analysis becomes even more important to shorten the technical development phase, to avoid or reduce conceptual errors in an early stage and to gather useable und accepted results [10].

2.2. Overview and dependencies of HCD activities

The strength and the success of outcomes through HCD strongly correlate with the methodology applied at the right process step with proper persons.

Within REHA2030, general requirements regarding the service provision pathways as well as specific ones needs to be gathered to define and conceptualize models, processes as well as technical aids. To accomplish this, the HCD process – which is iterative by nature – was spitted into two main loops. The first one analyses the conventional rehabilitation paths and barriers in this supply chain in Austria and Slovenia. The second loop, building on the results of the first one, focuses on the therapist – patient process for defining process steps, elements, features and their interrelationships for achieving this seamless supply chain and high-quality therapeutic interventions supported by telerehabilitation.

Figure 1 shows the HCD activities in the development process of the project, with the 4 phases (A – D) and concrete actions in the two main loops (I & II). Beginning with the understanding of conventional **rehabilitation pathways** (I) in Austria and Slovenia (A) the gaps and disruptions in service provision and the related requirements were specified (B) and represented via Personas and therapeutic process descriptions. In the

phase of designing solutions (C), scenarios for a potential clinical and outpatient (tele-) rehabilitation process and the related system architecture for a technical mapping of the process were conceptualized. Finally, the feasibility of this designed process was evaluated in different settings and institutional context (D). Subsequently, the **therapist-patient interaction process** (II) was specified (A) and various requirements like functionalities and core user interface elements for consistent interaction and communication were defined (B). Mock-Ups and a first prototype of the technology platform and the user interface were developed (C) and evaluated (D) under lab conditions. Finally, the demonstrator, developed in an iterative process, is currently evaluated in semi-lab and real-life situations.

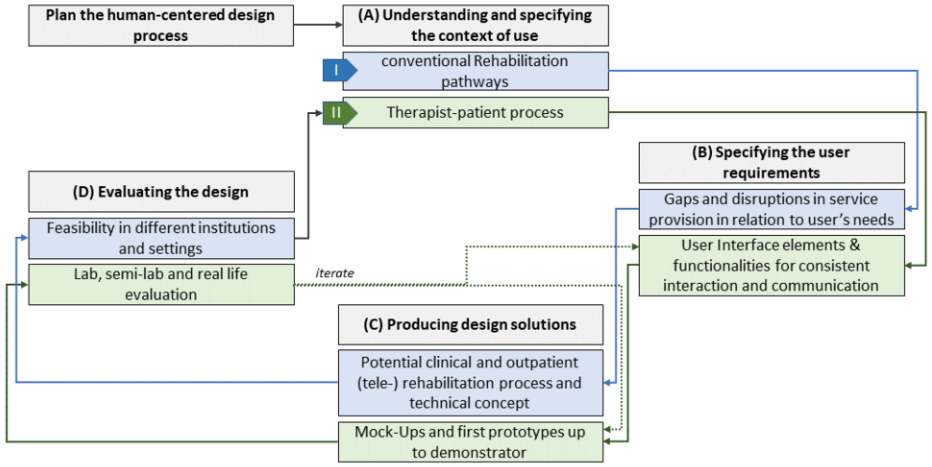

Figure 1. Interdependence of HCD activities with the two main loops: (I) rehabilitation pathways and (II) therapist-patient interaction process (source: own representation, adapted from [9])

2.3. Stakeholder in the ecosystem context

Based on a stakeholder analysis in the current ecosystem, in the methodological approach the involvement of persons from civil society, business and industry, research and education as well as public administration was considered. The stakeholder map contains target groups like SMEs, medical service providers, insurances, clinics, physicians, patients, caregivers and therapists, where some of the groups might take over more than one role. An example for that are the therapists: in the process of defining the potential future telerehabilitation process (Figure 1: phase C, loop (I)), therapists in general can take over two roles. On the one hand the individual user of a telerehabilitation system and on the other hand a service provider with additional business goals (e.g. self-employed therapists). By considering the different roles of a target group and including heterogeneous stakeholders, it is possible to draw on different expertise point of views for the definition of a comprehensive (tele-) rehabilitation model.

The target groups SMEs, insurance, therapists, physicians and medical service providers have been involved in all phases of the HCD by means of interviews and focus groups to define and validate the service model. Medical experts and therapist have been included in all process steps beginning with context of use analysis, co-creation of design solutions and evaluation. Patients and their informal caregivers have been mainly

involved in the evaluation phase like usability test of prototype and in the real-life evaluation, which is currently conducted.

3. Results

The overall research and development process can be summarized in four steps. The first project steps with the definition of the core components of the service model (without financing or logistic aspects, which have been elaborated in further phases) regarding the different rehabilitation pathways and the understanding of key success factors in the therapist-patient process and the context of use (personas, stories about rehabilitation pathways) took about 9 months. The second step with the definition of user interface elements and low fidelity mock-up as well as first usability evaluation of these mock-ups lasted another 9 months. The third step, the implementation of the demonstrator (therapist interface, patient interface, hardware) including refinements in definition of functionalities and extensive usability testing lasted about one year until the demonstrator was ready for real-life testing (step 4).

The main results of the REHA2030 project are a service model that supplements the conventional rehabilitation path of stroke patients by including tele-therapeutic aspects in an individual way. The service model focuses on the core processes of therapist-patient interaction but also includes business and service provision aspects. To support this service model, a technical platform with tablet and REHA2030 app for the patients and a web-based user interface for the therapists as the main components were developed. For high flexibility in therapy process and in achieving the therapy goals, therapy devices can be connected with the tablet, like for example the sensor-based device Pablo from Tyromotion[2].

3.1. Context and setting of use

Depending on individual technical affinity of patients, usage of telerehabilitation devices (like tablets) can be a challenging factor. One approach to prologue the initial learning phase with the REHA2030 system is to start using the system in a supervised clinical setting. This approach is foreseen in the service model of REHA2030 as a fluent transition from a clinical to an ambulant, outpatient setting to support the patient in terms of adherence to the therapy and thus foster therapy success.

If not possible to introduce REHA2030 in the clinic, a start of using telerehabilitation services can also be the outpatient sector, where freelance therapists implement REHA2030 in their daily work. This area is also the main setting for telerehabilitation.
A highly flexible model provides tailored therapeutic and training processes to the patient. Depending on individual needs, the therapist together with the patient sets the appropriate sequence and frequency of different session types: face-to-face, synchronous and asynchronous. In face-to-face and synchronous sessions, therapist and patient meet in person respectively online via video call. The flexibility in selecting the type of each session allows for efficient therapy execution. The asynchronous training is done independently by the patient without direct communication with the therapist but with different options to contact the therapist when needed and continuous progress monitoring for patient and therapist.

[2] https://tyromotion.com/en/products/pablo/

3.2. Structural elements for a flexible therapy setting

From a therapeutic point of view, it is important that the whole therapy process – form the patient data administration to reporting of therapy outcomes – is reflected in the service model and the technology platform. The system includes comprehensive assessment possibilities, where next to baseline data, all therapeutic or medical relevant information can be documented (diagnoses, medication, background information, standardized assessments, etc.). Based on this information, the therapy goals and plan can be set up and tailored exercises can be planned. Statistics on conducted exercises can be followed in the activity monitoring [11] and used for adjusting the therapy plans. Furthermore, the therapist is supported by communication and planning elements like a calendar or appointment reminder.

The Patient is supported in the rehabilitation process by providing therapy-relevant data and infrastructures. One of the core elements is the exercise plan and guidance, where the planned exercises are described and can be performed guided by instructions on the app. Additionally, serious games or therapy devices can be integrated. Information about the conducted exercises is shown in the activity monitoring which aims to foster the patient motivation and therapy adherence. Easy to use communication functionalities with video and text chat ensure a steady connection between patient and therapist.

In detail, the requirement analysis and usability tests indicate that a telerehabilitation solution with high user experience for both, the patient and the therapist includes the following components:

1. Patient data administration: All data that are needed to build the therapy upon are collected and presented in this section – personal data, assessments, therapy goals, therapy plans. This helps the therapists to keep an overview and the patient to comprehend the therapeutic measures.

2. Exercise program: The measures that are taken to ensure therapy progress are developed here. For the therapists this means an effective exercise planning, for the patient a guidance and instruction on the planned training. Three types of exercises, a) instructional exercises with description, images or videos, b) device supported exercises and c) serious games can be created and compiled to an exercise program which can be scheduled according to need. Before and after each program, the patient is asked to give feedback on the daily condition, visible to the therapist to interpret the performance.

3. Activity monitoring: This section comprises statistical data and visualization of conducted exercises. Both the therapist and the patient can follow the therapy progress and interfere and adjust when needed. For instructional exercises the amount and the names of exercises and the consumed time are visualized. Additionally, for serious games and device supported exercises success rate and measured parameter are displayed.

4. Communication: A good and steady communication between therapist and patient is essential for a common therapy strategy. The system provides all needed possibilities, also in a remote setting (videocall and chat)

5. Feedback and diary: Direct feedback on the daily condition and the exercises can be a valuable information for the therapist to adjust the therapy accordingly. The patient reflects on the conducted exercise and how daily condition impacts the performance. Furthermore, a private diary where only the patient has access to, is implemented.

6. Therapy reporting: Documentation and reporting are needed elements to guarantee a safe and reasonable therapy process. The possibility of automatic generating conclusive therapy reports, which are necessary for e.g. financing of therapy by the insurance, helps the therapist to safe time.

3.3. Modularity and transdisciplinary usage

The basic idea of the REHA2030 system is, that the patient has only one device that can be used for multiple purposes and experience high flexibility in usage. During the whole development cycle, a special focus was laid on a transdisciplinary usage of the system. This means, that different professions like occupational, physio or speech therapists and clinical psychologists can use the system without any limitations. To avoid overload for the patient, all treating therapists see the training program (frequency) and the amount and time of all conducted exercises, but no further details. Depending on the setting, therapists have furthermore the possibility to share exercises (for instance in the clinic) by making public. To ensure modularity and a multi-purpose use, the possibility to connect different therapeutic devices or apps like serious games depending on the individual needs is important.

4. Discussion

Design requirements for a telerehabilitation model are multifaceted, especially when taking into consideration different settings (clinic, freelancer) but also when aiming to design a system for physiotherapists, occupational therapists, speech therapists and further professions. Some professions need well-structured exercises with defined repetitions, time or sets, while other professions rather work with a text or graphical tools with other requirements on exercise description and execution.

Depending on the setting of therapy one discussion point was privacy settings regarding the visibility of particular information to other therapists. On the one hand it is beneficial to constantly exchange patient data like therapy progress or documentation, on the other hand freelance therapists who maybe do not know each other feel uncomfortable with that. A very detailed definition and selection of shared information was of high relevance.

One requirement that could not be implemented in the scope of the project was the interconnection with hospital information systems. This issue was of high importance for the clinic therapists but also for freelancers to improve the patient journey and the communication about patient progress between a rehabilitation clinic and freelance therapists after discharge from the clinic and also in case of a repeated stay.

In summary it pointed out that a telerehabilitation system might be of high acceptance when the flexibility in the setting of therapy and multi-professional usage with one interaction point for the patient is supported, all therapy relevant documentation, communication and monitoring functionalities are included and it can be used in different settings, e.g. starting with first contact point in the clinic to get familiar with the technical system and seamless continuation of therapy in the outpatient setting.

5. Conclusion

Applying the HCD approach with its iterations and the integration of different target groups, and in this case also two countries with differing standard process was time-consuming and required intense communication between the development and research teams. Through these iterations it was possible to design a system that fulfills requirements for freelancer therapists as well as clinical therapists who provide

outpatient therapy and is applicable in Slovenia and Austria. Although the demonstrator does not contain all functionalities (only one device was integrated), first usability evaluations showed a high flexibility in use (e.g. configuration of exercises) and good accessibility for persons after a stroke.

Currently, the REHA2030 demonstrator is tested in a small-scale real-life field trial with five patients and seven therapists over a period of about five to ten weeks (10 face-to-face / synchronous therapy sessions) to evaluate the user experience of all involved users and to gather detailed feedback about integrability in daily life and therapy processes and acceptance based on a long-term usage.

Acknowledgements

REHA2030 is co-financed by the European Regional Development Fund in the framework of the Cooperation Program Interreg V-A Slovenia-Austria.

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