eRehabilitation after stroke: the interplay between the effectiveness, the implementation and the context

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Colofon

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eRehabilitation after stroke

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‘Sometimes I think you believe in me more than I do’, said the boy.
‘You’ll catch up’, said the horse.

Charlie Mackesy (2020) | *The Boy, the mole, the fox and the horse*

TABLE OF CONTENTS

1

General introduction

GENERAL INTRODUCTION

Definition, consequences and epidemiology of stroke

Stroke, or cerebrovascular accident, is a medical condition in which the blood flow to the brain is interrupted. Stroke can be either ischemic, when a clot in a blood vessel blocks the blood flow to the brain (80% of the cases), or haemorrhagic, when a blood vessel in the brain ruptures (20% of the cases). As a consequence, brain areas are deprived of oxygen and nutrients, causing damage to the brain tissue [1]. Abilities controlled by these areas can be lost or impaired. Survivors commonly experience disabilities in motor function, speech and/or cognition [2,3] and may have lifelong restrictions in daily activities and participation in society [4].

Stroke is the second leading cause of death in the world [5], with 1 in 6 people worldwide suffering from stroke in their lifetime. In the Netherlands in 2018, the incidence of stroke was estimated to be 40,000 (20,2000 men and 19,800 women) with a prevalence of 356,400 people living in the community with the consequences of stroke [6]. Worldwide, the absolute number of stroke and the people affected by stroke is expected to increase [7]. This is mainly due to an aging population and to the improved quality of stroke care, especially early thrombolysis, resulting in declining mortality rates [8]. In the Netherlands, the annual prevalence of stroke is expected to increase with 54% between 2015 and 2040 [6].

Medical management & specialized rehabilitation

In the acute phase, stroke patients are treated in a hospital (emergency room, intensive care, medium care, stroke unit and/or neurology ward). In 2018, in the Netherlands, 30% of the people with an ischemic stroke and 11% of those with a haemorrhagic stroke died within 30 days [9]. Hospital stay is generally short, with an average length of stay of 6 days [10], and ends when the patient is medically stable. After hospital discharge, approximately 25-30% of the patients is discharged to a nursing home for geriatric rehabilitation. These are mostly older patients with limited potential for recovery and who are not able to return home (yet). About 60-65% of the patients is discharged to their homes [11], where treatment can be provided by healthcare professionals close to home (primary care) or during outpatient rehabilitation in specialized rehabilitation facilities. The remaining 10% is discharged to specialized rehabilitation facilities for inpatient stroke rehabilitation [12].

Inpatient and outpatient stroke rehabilitation in a specialised rehabilitation facility is offered mostly to patients in the working age with potential for recovery and more complex participation goals [13]. In the Netherlands, about 3,200 stroke patients receive this treatment each year [14]. In 2020, 18 of the 36 members of the overarching organization for medical rehabilitation in The Netherlands (Revalidatie Nederland) deliver specialized stroke rehabilitation [15].

Stroke rehabilitation in specialized rehabilitation facilities includes a comprehensive, multidisciplinary process aiming to restore impaired functions, activities and/or participation restrictions [2]. The multidisciplinary team usually includes a rehabilitation physician, a physical therapist, an occupational therapist, a speech therapist, a psychologist and a social worker. Depending on local availability, additional professionals such as a recreational therapist or dietician can also be involved. Rehabilitation typically follows a process of assessment, goal setting, therapy and reassessment [2]. For each patient, a tailored rehabilitation plan is defined, depending on the type and severity of the impairments and the patients' personal rehabilitation goals. The length of stroke rehabilitation ranges between 3 and 26 weeks [16]. Multidisciplinary stroke rehabilitation reduces the likelihood of long-term disability and increases independence in daily activities [17,18], and approximately 90% of the patients are able to live independently after stroke rehabilitation [13].

Digital health technology in rehabilitation (eRehabilitation)

Recently, there is an increasing interest in the application of digital health technologies in healthcare in general, including in stroke rehabilitation [19,20]. The use of digital health technologies in rehabilitation is often referred to as eRehabilitation. eRehabilitation can be used for several purposes. First, it may improve quality of care, by the possibility to monitor compliance, progress and health behaviour better [21] and by supporting self-management and self-ownership [21]. Second, it may improve access to care during rehabilitation [21], between inpatient and outpatient rehabilitation [22,23], after rehabilitation [24] and at a distance when face-to-face treatment is impossible [21]. Third, it may increase (cost) effectiveness [25], in the absence or scarcity of resources [26,27]. The use of eRehabilitation may facilitate all phases of the rehabilitation process, i.e. assessment, diagnosis, goal-setting, therapy, and education [28] and may be applied by means of various devices such as a smartphone, laptop or tablet.

Several classifications exist to order eRehabilitation technologies, such as the framework published by Chen and colleagues [29]. Based on that classification, multiple technologies are described which can be part of an eRehabilitation intervention. *Games and exercise programs* are conducted to perform rehabilitation activities by using online exercise programs or by playing games [30,31]. This includes exercise games which are developed for commercial purposes and applied for stroke rehabilitation, or programs specifically developed for therapeutic purposes [32]. Those games and exercise programs are mostly provided as an addition to conventional stroke rehabilitation [22]. *Telecommunication technologies* include the use of digital technologies such as telephone and video conferencing for communication purposes only, to help patients receive medical services from healthcare professionals remotely [33]. *Sensors,* such as smartwatches are devices to measure for instance patients' daily activity[34]. *Virtual reality* devices provide a virtual environment that simulates the physical environment, making exercising more realistic [35].

Barriers and facilitators in the context of eRehabilitation

In order to successfully start using eRehabilitation, the context in which eRehabilitation will be implemented needs to be known. According to the implementation theory of Grol, the use of healthcare innovations is influenced by barriers and facilitators in the context of the setting, in this case the specialized rehabilitation facilities [36]. Barriers and facilitators in the context may be identified at six levels: the Innovation, the Organizational context, the Individual professional, the Individual patient, the Social context and the Political and economic context. For eRehabilitation after stroke, previous literature identified factors at five levels. Barriers and facilitators at the level of the Intervention included concerns about ease of use [37] and security of data transfer [38]; at the level of the Organisational context insufficient time for the implementation [39] and the lack of integration of eRehabilitation into the existing stroke rehabilitation services [40]; at the level of the Individual patient and Individual healthcare professional lack of technical expertise [28,37] and fear of reduced face-to-face contact [41]; and at the level of the Political and economic context problems with insurance [42].

Although abovementioned barriers and facilitators give some insight into the acceptability and feasibility of eRehabilitation, it remains unknown which barriers and facilitators have the greatest impact on the use of eRehabilitation. These insights are necessary in order to tailor an implementation strategy to factors that influence the use of eRehabilitation the most, making an implementation strategy more effective [41,43].

Effectiveness of eRehabilitation

In the past 10 years, a number of systematic reviews was published on the effectiveness of eRehabilitation after stroke. It was concluded that eRehabilitation in a controlled research environment may result in improved healthcare outcomes, like walking speed, balance and mobility [35], cognition and mood [44] and health-related quality of life [45]. Despite the increasing body of evidence with a growing number of randomised controlled trails (RCT), it is hard to draw conclusions about the effectiveness since interventions and outcome measures varied greatly and few studies were adequately powered [25].

Most studies concerning the effectiveness of stroke eRehabilitation focused on interventions targeting only one domain of stroke rehabilitation, e.g. hand function [25]. However, as most stroke patients face multiple and distinct problems, evaluating different eRehabilitation modalities simultaneously may be useful. As such, eRehabilitation programs can be used for multiple purposes and combining exercise programs (including cognitive, speech and physical exercise programs), communication technologies and sensors like activity tracking. Combining eRehabilitation interventions would greatly increase ease of use [46]. However, evidence on the effectiveness of eRehabilitation interventions combining various digital interventions is scarce. In the recent published systematic review about eRehabilitation for stroke [25,29,35,44,45], only three RCTs are performed combining multiple interventions in one digital environment, i.e. online exercises combined with activity tracking and/or stroke-related education. In this, eRehabilitation was compared with conventional rehabilitation in patients less than one year post stroke. All showed comparable outcomes for conventional rehabilitation and eRehabilitation with respect to motor function and knowledge about stroke [47-49].

As mentioned previously, research concerning the effectiveness of eRehabilitation after stroke is mainly performed in a controlled setting [25,50]. However, the clinical context and the employed implementation strategy may be of great influence on the effectiveness [51]. Moreover, eRehabilitation should be offered and investigated in combination with conventional stroke rehabilitation to achieve its full potential [42]. Pragmatic trials, in which the effectiveness of eRehabilitation is studied when integrated in the context of a stroke rehabilitation facility, are barely performed but could be a valuable next step in increasing the use of eRehabilitation after stroke [25].

Implementation of eRehabilitation

Worldwide, the translation of recent developments of digital healthcare technologies into the use of eRehabilitation in specialized rehabilitation facilities has been slow [52]. This is remarkable since the potential benefits of eRehabilitation are evident [25], eRehabilitation becomes more and more available [22] and patients and healthcare professionals are very willing to use eRehabilitation [53,54]. Although literature is available concerning the feasibility of eRehabilitation and its implementation, a profound evaluation of what works and why regarding implementation strategies for eRehabilitation has not previously been performed in a clinical setting for stroke rehabilitation. This knowledge can be very important to support future implementation of eRehabilitation and to interpret the results of pragmatic effectiveness studies [25,55].

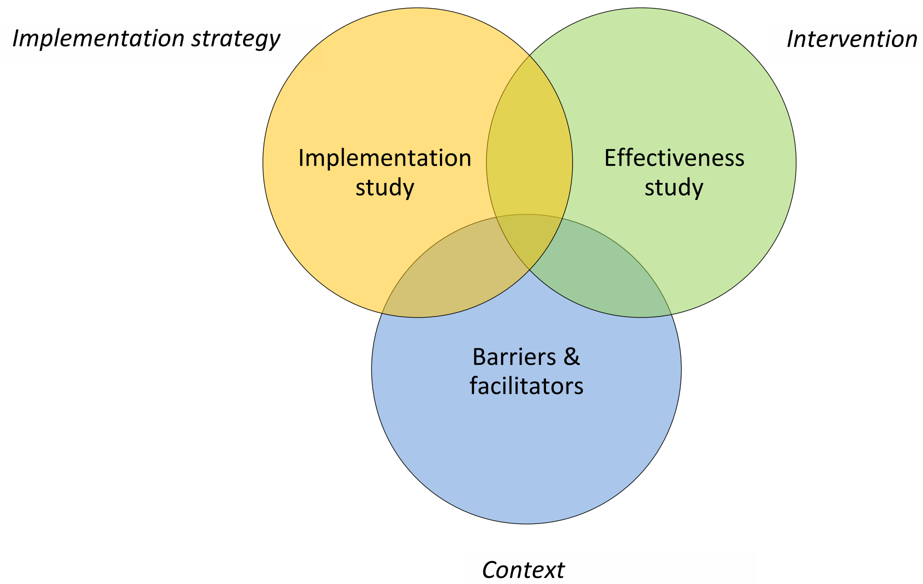

Figure 1. The complex interplay between the barriers and facilitators in the context, the effectiveness and the implementation strategy for the use of eRehabilitation after stroke [51]

The interplay between effectiveness, implementation and context

For successful use of eRehabilitation in specialized rehabilitation, the complex interplay between the intervention, the implementation strategy and the barriers and facilitators in the context is important (Figure 1). An optimal method to investigate this interplay is performing a hybrid implementation and effectiveness study, combined with an exploration of the barriers and facilitators. In such a hybrid implementation and effectiveness study, the eRehabilitation intervention and the implementation strategy are tested simultaneously. A benefit of a hybrid design is that it supports a more rapid translation of evidence into clinical practise and provides a more valid assessment of the clinical effectiveness [56].

Outline of this thesis

The effectiveness of eRehabilitation is not only influenced by the intervention itself, but also by the implementation strategy and the context in which the intervention is implemented. The latter two aspects often vary from one intervention, organisation or country to the other. Since knowledge about these specific areas is scarce, this thesis aims to provide insight in the interplay between the effectiveness, the implementation strategy and the context of eRehabilitation after stroke, as delivered in a specialized rehabilitation facility. To study this interplay, the sub aims of this thesis were:

- Identify the (most important) barriers and facilitators of patients, informal caregivers and healthcare professionals regarding the use of eRehabilitation after stroke (Chapters 2, 3, 4).
- Investigate the effectiveness of a multidisciplinary eRehabilitation intervention embedded in conventional stroke rehabilitation, using a hybrid implementation and effectiveness study design (Chapter 5).
- Investigate what works and why in the implementation of a multidisciplinary eRehabilitation intervention in conventional stroke rehabilitation, using a hybrid implementation and effectiveness study design (Chapter 6).

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2

Why the uptake of eRehabilitation programs in stroke care is so difficult: a focus group study in the Netherlands

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ABSTRACT

Background: The uptake of eRehabilitation programs in stroke care is insufficient, despite the growing availability. The aim of this study was to explore which factors influence the uptake of eRehabilitation in stroke rehabilitation, among stroke patients, informal caregivers, and healthcare professionals.

Methods: A qualitative focus group study with eight focus groups (6–8 participants per group) was conducted: six with stroke patients/informal caregivers and two with healthcare professionals involved in stroke rehabilitation (rehabilitation physicians, physical therapists, occupational therapists, psychologists, managers). Focus group interviews were audiotaped, transcribed in full, and analysed by direct content analysis using the implementation model of Grol.

Results: 32 patients, 15 informal caregivers, and 13 healthcare professionals were included. A total of 14 influencing factors were found, grouped to 5 of the 6 levels of the implementation model of Grol (Innovation, Organizational context, Individual patient, Individual professional, and Economic and political context). Most quotes of patients, informal caregivers, and healthcare professionals were classified to factors at the level of the Innovation (e.g., content, attractiveness, and feasibility of eRehabilitation programs). In addition, for patients, relatively many quotes were classified to factors at the level of the individual patient (e.g., patients characteristics as fatigue and the inability to understand ICT devices), and for healthcare professionals at the level of the organizational context (e.g., having sufficient time and the fit with existing care pathways).

Conclusion: Although there was a considerable overlap in reported factors between patients/informal caregivers and healthcare professionals when it concerns eRehabilitation as innovation, its seems that patients/informal caregivers give more emphasis to factors related to the individual patient, whereas healthcare professionals emphasize the importance of factors related to the organizational context. This difference should be considered when developing an implementation strategy for patients and healthcare professionals separately.

BACKGROUND

Stroke is a major cause of disability [1], including long-term problems with motor function, cognition, communication [2], and participation [3]. Specialized rehabilitation has shown to be effective in recovery of these functions [4]. Due to the increasing incidence of stroke [5], an increased need for rehabilitation care is expected in the future [6]. To meet this increasing demand and at the same time limit the growth of stroke rehabilitation costs, blended care in which information and communication technology (ICT) are used alongside conventional therapy offers a potential solution. ICT is in the last decennia increasingly accessible, affordable, and remotely available 24/7. ICT can for example be used to relieve healthcare professionals from manual labour and make rehabilitation accessible to a larger number of stroke patients while maintaining or increasing the effectiveness of rehabilitation [7].

The use of ICT in rehabilitation, eRehabilitation, can be seen as an additional way of delivering stroke rehabilitation, in which a service is delivered via a wide variety of possible ICT devices like telephone, computer, tablets, smartphone, virtual reality, and robotic devices. It can target communication, cognitive problems, motor deficits or aphasia [8], and includes physical and cognitive exercise programs, serious gaming, goal setting, education, information [8, 9], and e-consultations for remote communication and monitoring [10]. Recent randomized clinical trials have shown that eRehabilitation programs are effective in improving health of stroke survivors [11, 12]. In addition, eRehabilitation may facilitate self-directed home-based rehabilitation, decrease chronic disability after stroke, cardiac arrest, COPD [13], and offers possibilities to continue treatment after discharge from rehabilitation [9].

Literature about the perspective and acceptance of technologies like eRehabilitation in both patients [14–16] and healthcare professionals [17, 18] showed that most stakeholders are interested in eRehabilitation after stroke; among others to improve communication, including the possibility to call healthcare professionals in case of questions or concerns and improve social contact between patients, to increase participation in therapeutic activities and adherence, and to facilitate better rehabilitation outcomes.

Despite this positive view of the end-users and widespread agreement about the importance and potentials of eRehabilitation, use of eRehabilitation in clinical practice is lacking [19]. Literature of the last decade shows that acceptance and willingness to adopt eRehabilitation in stroke rehabilitation is hampered by the fact that not all patients are confident with ICT devices like smartphone and tablet [14] and both patients [15, 16] and healthcare professionals [18] do not want eRehabilitation to replace more social face-to-face contact. A study about the uptake of eRehabilitation in India concluded that healthcare professionals were especially worried about adapting the existing workflow into a new way of service delivery [20]. Concerns about installation of and using ICT devices, the lack of face-to-face contact, the limited scope of exercise, and stroke-related impairments were raised as well [20]. When using tablet-based therapies, patient had the most difficulties with following complex instructions when trying to understand how to use ICT devices [8]. Besides, as requirement for successful uptake, healthcare professionals have stressed the importance of tailoring a program to the patients' personal situation [18] and having sufficient time for the uptake of such innovations [17].

Although abovementioned studies give some insight into the possibilities and feasibility of eRehabilitation and characteristics of its end-users, a thorough investigation of all barriers and facilitators for the uptake of eRehabilitation for stroke in a western country, including opinions of multiple end-users, is lacking. To improve this uptake and support healthcare professionals and patients in the use of eRehabilitation, such insights are needed [14, 21]. Therefore, this study aimed to identify factors influencing in the uptake of eRehabilitation after stroke among patients, informal caregivers, and healthcare professionals.

METHODS

1. Design

To identify factors influencing the uptake of eRehabilitation, a qualitative focus group study was conducted among stroke patients, informal caregivers, and healthcare professionals. Focus groups were chosen as method since this type of data collection contributes to a better understanding of end-users' attitudes, experiences, and expectations [22]. In order to allow participants to speak freely about their treatment and experiences in the rehabilitation centre, separate groups were organized for patients/informal caregivers and healthcare professionals. Moreover, it was expected that separate groups would stimulate more discussion since participants have shared experiences. The intended group size was six to eight participants, but up to ten patients were invited to account for participants who declined at short notice [23]. We planned to continue with focus group interviews until data saturation was reached. Data saturation was reached when no additional factors emerged during three consecutive interviews [24]. The COREQ guidelines were used for adequate design and reporting of the study [25].

2. Recruitment and inclusion

Patients, informal caregivers, and healthcare professionals were recruited from two Dutch rehabilitation centres; Sophia Rehabilitation in The Hague and Rijnlands Rehabilitation Centre in Leiden.

2.1 Patients/informal caregivers

In January 2016, the electronic patient registries of the rehabilitation centres were searched for potentially eligible patients based on the following inclusion criteria: (1) older than 18 years, (2) diagnosed with stroke, and (3) completed rehabilitation which started after June 2011. From a group of approximately 2700 potential participants which are treated in 1 of both rehabilitation centres, 200 patients from each centre were randomly selected. Those 400 patients received a letter with information about the study and an invitation to participate. Invitations to patients were directed to the informal caregiver as well, which could be a partner, child, parent, or friend who is involved in the daily life of the patient. An invitation was also sent to five former stroke patients who met on a regular basis to discuss on-going innovation and research projects in rehabilitation ("innovation partners").

The invitation included a self-developed questionnaire concerning impairments as a consequence of stroke (physical, communication, cognition), use of ICT devices (smartphone, tablet, laptop, pc), and the purpose of this use (applications, email, information, games, exercises). This was done to select a diverse group of patients with respect to type of impairments and the use of ICT devices within each focus group.

Patients and informal caregivers could indicate their willingness to participate by filling in the informed consent and their availability for the focus groups. Patients willing to participate were selected to be part of the focus groups based on their availability and type of impairment. Some patients were not invited because of their availability. Use of ICT devices was comparable for all participants. No reminders were sent since the number of patients that responded without reminder was expected to be high enough to reach data saturation. All responding patients and informal caregivers received an e-mail informing them whether they were invited for a focus group or not.

2.2 Healthcare professionals

Certified healthcare professionals (rehabilitation physician, physical therapist, occupational therapist, psychologist, and speech therapist) with at least 2 years of work experience in a specialized rehabilitation team for stroke patients were invited for the focus groups (n = 56, 29 at Sophia Rehabilitation, 27 at Rijnlands Rehabilitation Centre). All eligible healthcare professionals received an email with information about the study and an invitation to participate.

3. Focus group

Each focus group was conducted by three persons; a moderator (MW; MSc, female/BB; MSc, female), an assistant (BB; MSc, female/HB; MSc, female), and an observer (HB; MSc, female/SH; physiotherapist, male/PK; MD, female). The assistant contributed with questions, made sure all participants were involved in the discussion, and managed the tape-recorders and time, the observer observed and took notes. The moderator and assistant have a master's degree in health sciences or human movement sciences and were involved in research projects in the rehabilitation centre but not in daily care practice. Their education included training in the conduct of interviews and both were not involved in care of the participants. The participants had no personal background information on the interviewers.

The focus groups lasted 2 h, including a 15-min break. More breaks were provided if necessary. At the end, all patients received travel cost reimbursement and were rewarded with a gift card of €10, for participating in the focus group. Patients received feedback of the results of the focus groups by means of a newsletter. The focus groups took place between January and March 2016 in the two involved rehabilitation centres in the Netherlands.

4. Interview guideline

A semi-structured interview guide was developed, including open-ended questions in the following domains: (1) the content of an eRehabilitation service, (2) appearance and accessibility, and (3) factors influencing the uptake.

Multiple models are designed to describe and categorize factors that influence the uptake of an innovation in healthcare. Example are the implementation model by Grol [26], the model by Cabana [27], determinants of change model by Fleuren [28], or consolidated framework by Damschroder [29]. For this study, the implementation model of Grol was chosen since it offers a framework to identify and categorize factors in the uptake of innovations in healthcare [26]. Especially, the innovation, in this case eRehabilitation, is included in the model, which is expected to be of major influence on the implementation.

The model of Grol suggests that the following groups of factors can be defined: (1) Innovation; in this case eRehabilitation, including advantages of its use in practice and the feasibility, accessibility, and attractiveness of eRehabilitation programs; (2) Organizational context; for example organization of care practices, staff, capacities, resources, structures; (3) Individual patient; for example knowledge, skills, and attitude of the patients, including stroke-specific characteristics; (4) Individual professionals; for example, the awareness, knowledge, skill, and motivation to change of the healthcare professionals working in the rehabilitation centre; (5) Economic and political context; including financial arrangements, regulations, and policies; and (6) Social context; including opinion of colleagues, culture of the network, and collaboration.

Each focus group started with an introduction, including the aim of the meeting, timeline, and rules. Participants also gave permission for audio recording. During this introduction, a global idea about eRehabilitation was given, in which it was explained what eRehabilitation is and an example was shown on a screen. Prompts (e.g., example of eRehabilitation, pictures, questions, etc.) were included in the interview guide to support participants in verbalizing thoughts about an abstract concept as eRehabilitation. Examples of questions asked are: “What do you need in order to be able to use eRehabilitation in daily practice?” or “What kind of problems do you anticipate when using eRehabilitation?”

A pilot focus group with the five innovation partners was conducted to test the interview guide. Although they did not meet the inclusion criterion of start rehabilitation after June 2011, the pilot session did not lead to major changes in the study protocol. The data collected were added to the study data.

5. Data analysis

The audio-tapes of all focus groups were transcribed in full. The transcripts were then qualitatively analysed by two of four researchers separately [MW/BB/PK/SH]. Directed content analysis was used, in which the researchers used a theory or relevant research findings as guidance for initial coding [30], in this case the implementation model of Grol [26]. During these analyses, transcripts were read and quotes were marked with a code. Discrepancies between researchers were discussed in order to reach consensus. If researchers still disagreed, a third researcher (JM) who was not involved in the analysis made a final decision. All quotes with a code were collected in one database. Codes with comparable content were merged into sub-factors, sub-factors with comparable content were merged into factors, which were then assigned to the overarching levels of the model of Grol. Additionally, the (sub-)factors identified were discussed by the research group. Transcripts were not returned to the participants for correction. The software package Excel 2010 was used to organize codes, (sub-)factors, and levels. Descriptive statistics are used to describe basic characteristics of patients and informal caregivers.

6. Ethical approval

All participants gave written informed consent prior to participation. Patients were assured their anonymity and told that participation in the study would not affect their treatment position in the rehabilitation centre. The study was approved by the Medical Ethical Review Board.

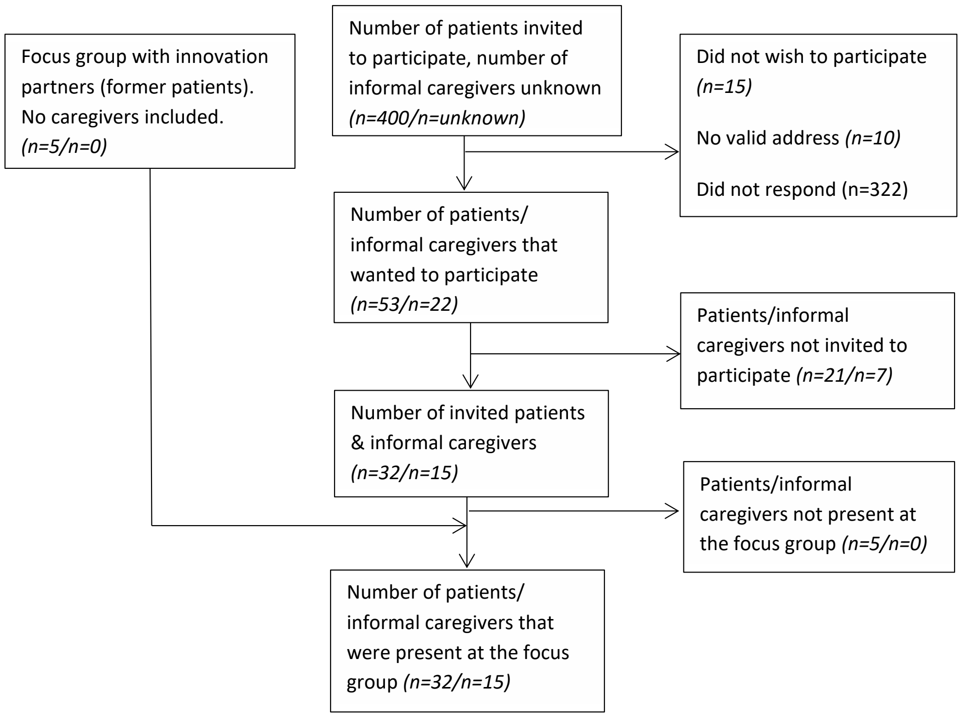

Figure 1. Flow of inclusion of participants in the focus group study

RESULTS

Participants

Patients/informal caregivers

A total of 53 patients (response rate 13%) and 22 informal caregivers responded to the invitation (Figure 1). Six focus groups (including the pilot session with the five innovation partners) were conducted with a total number of 32 patients and 15 informal caregivers; 26 patients and 7 informal caregivers were not available at the scheduled time of the focus groups. Basic characteristics of patients and informal caregivers are shown in Table 1.

Healthcare professionals

In total, 24 of the 56 healthcare professionals agreed to participate in the study (response rate 43%). Eleven healthcare professionals were not able to be present at the scheduled time, so 13 healthcare professionals were included, divided in 2 focus groups. These healthcare professional groups included physiotherapists, psychologists, occupational therapists, speech therapists, physicians, and managers (Table 1).

Table 1. Characteristics of participating stroke patients, informal caregivers and healthcare professionals

Characteristic	Patients (n=32)	Informal caregivers (n=15)	Healthcare Professionals (n=13)
Gender; number male (%)	19 (59)	4 (27)	3 (23)
Patient & Informal caregiver			
Mean age in years (SD)	56.9 (15.1)	60.6 (9.9)	
Time since stroke in months (SD)	27.8 (14.0)		
Communication problems; number (%)	16 (50)		
Motor problems; number (%)	20 (63)		
Cognitive problems; number (%)	24 (75)		
Using digital devices in daily life; number (%)	32 (100)		
Purpose of using digital devices:			
Email; number (%)	18 (56)		
Applications; number (%)	15 (47)		
Searching information; number (%)	10 (31)		
Games; number (%)	14 (44)		
Exercises; number (%)	8 (25)		
Healthcare professional			
Physiotherapist; number (%)			3 (23)
Psychologist; number (%)			1 (8)
Occupational therapist; number (%)			3 (3)
Speech therapist; number (%)			1 (8)
Rehabilitation specialist; number (%)			4 (31)
Manager; number (%)			1 (8)

SD; standard deviation

Factors influencing the uptake of eRehabilitation

From the transcripts of the 8 focus groups, quotes from patients, informal caregivers, and healthcare professionals could be merged into 21 sub-factors, which could subsequently be merged into 14 factors (Table 2). These factors were allocated to five out of the six levels of the implementation model of Grol; Innovation, Organizational context, Individual patient, Individual professional, and Economic and political context. No factors were identified at the level of the Social context.

In the transcripts of the focus groups with patients/informal caregivers, 18 sub-factors could be identified. Most quotes of patients and informal caregivers were at the level of the Innovation (n = 234, 42% of total number of quotes) and the level of the Individual patient (n = 226, 40% of total number of quotes). From the transcripts of the focus groups with healthcare professionals, also 18 sub-factors could be identified. Most quotes of healthcare professionals were at the level of the Innovation (n = 108, 39% of total number of quotes), and the level of the Organizational context (n = 89, 35% of total number of quotes).

Table 2. Factors influencing the uptake of eRehabilitation programs after stroke

Level	Factor	Sub-factor	Patient & caregiver	Profes-sional
Innovation	Accessibility	Period in which eRehabilitation is accessible	x	x
		Devices on which eRehabilitation is accessible	x	x
	Feasibility	Helpdesk function	x	x
		Tailored to patients' situation	x	x
	Attractiveness	Ease of use of eRehabilitation	x	x
		Content of eRehabilitation program	x	x
	Privacy	Privacy and safety of patient data	x	x
	Advantages of use	Characteristic of innovation with added value	x	x
Organizational context	Organization of care	Tasks and responsibilities professional	x	x
		Tasks and responsibilities informal caregiver	x	x
		Tasks and responsibilities organization	.	x
	Resources	Software	x	x
		Hardware	.	x
		Space at home	x	.
	Time	Time	x	x
Individual patients	Motivation to change	Reasons (not) to use eRehabilitation for patients	x	x
	Knowledge	Knowledge about use of eRehabilitation	x	.
	Skill	Skills with use eRehabilitation	x	.
	Patient characteristics	Impairment after stroke	x	x
Individual professional	Motivation to change	Reasons (not) to use eRehabilitation for professionals	.	x
Economic and political context	Financial arrangements	Insurance	x	x

For the patients/informal caregivers, no new factors emerged after three focus groups; for the healthcare professionals, both focus groups resulted in new factors. In the following sections, the factors within each level will be discussed, first for the patient/informal caregiver and then for the healthcare professional.

1. Factors at the level of Innovation (eRehabilitation program)
This level included the following factors: accessibility, feasibility, attractiveness, privacy, and advantage of use.

Accessibility: Patient and informal caregivers reported that the uptake of eRehabilitation would be limited when the accessibility of the eRehabilitation programs was restricted to the rehabilitation centre or to their clinical rehabilitation time. "I think it should be a continuation of regular rehabilitation" (Informal caregiver 2.1). Furthermore, an eRehabilitation program should be accessible on multiple devices like a computer, laptop, tablet or smartphone.

Healthcare professionals agreed that eRehabilitation should be accessible for the patient during and after rehabilitation, on a device that patients preferred.

Feasibility: Patients/informal caregivers felt that eRehabilitation was only feasible when (1) a helpdesk for assistance in case of problems with the uptake of eRehabilitation programs was available, (2) the eRehabilitation program would be tailored to the patients' personal situation, and (3) eRehabilitation would be supplemental to conventional therapy. Patients said eRehabilitation cannot replace traditional rehabilitation because patients felt they needed daily care at the start of rehabilitation and severe motor problems cannot be solved by a digital program. "At the start I could not speak or swallow. How does a program [eRehabilitation] teach me that?" (Patient 1.5).

Healthcare professionals reported the importance of an ICT-helpdesk to address technical questions about, e.g., internet connection. "I don't want that we as therapists get all those questions about the program and installation of it. Where should patients go with their questions? I think a helpdesk." (Healthcare professional 2.4). Additionally, they agreed that eRehabilitation cannot replace traditional rehabilitation and mentioned that patients also benefit from peer contact in the rehabilitation centre.

Attractiveness: Attractiveness of an eRehabilitation program was influenced by its ease of use and content. Patients/ informal caregivers reported that an eRehabilitation program should, among others, consist of cognitive and physical exercises, serious games, information, peer contact, goal setting, an agenda, and an exercise schedule. Ease of use would increase when all components of an eRehabilitation program are organized on one website, icons are used instead of text and no noise, flash signals or unclear layout was used and the design should be adjustable to personal preferences. "Maybe with a sweet voice, or a sweet little music." (Informal caregiver 3.1).

Healthcare professionals mentioned that an eRehabilitation program would benefit from the inclusion of a clear day schedule with planned and performed exercises. The uptake of an eRehabilitation program would decrease if not all exercises healthcare professionals want to prescribe are included, and ease of use would decrease if it would not be possible to set up an exercise program easily.

Privacy: Patients did not perceive it as a violation of their privacy when a therapist would have access to their personal data. Even more, patients reported that it would be extra motivating when healthcare professionals were able to see the exercises they did (not) perform: "For me, it [access for the healthcare professional to exercises data] would be very motivating, since your performance is monitored." (Patient 2.2).

For healthcare professionals, (internet) connections which could not guarantee the privacy and safety of personal data was a barrier in the uptake of eRehabilitation. "It is a must that eRehabilitation programs meets the privacy requirements. Data transport must be safe." (Healthcare professional 1.1).

Advantage of use: Patients reported many advantages of eRehabilitation. Among others, this included the possibility to have a clear overview of planned and performed exercises and perform those exercises at a time of their own preference. Furthermore, it offers a possibility to continue an exercise program after discharge. A patient described this as "not feeling abandoned after discharge from the rehabilitation centre." (Patient 2.4). Besides, patients reported a possible benefit from receiving feedback about daily activities and performed exercise.

These advantages of use were also reported by healthcare professionals. "The advantage for patients is the possibility to continue exercising, which is not limited to the rehabilitation centre anymore." (Healthcare professional 2.1). In addition, the professionals also reported the possibility to have an e-consult with patients as an advantage.

2. Factors at the level of Organizational context

At the level of the Organizational context, three factors were identified: organization of care, resources, and time.

Organization of care: Patients reported that healthcare professionals needed to set up and adjust an eRehabilitation exercise program, since patients perceived they were unable to do this themselves. "They [the healthcare professionals] obviously know the patient. So, I mean, they can say, this is what the patient needs, and adjust the program after a certain time" (Patient 4.1). The presence of an informal caregiver who could assists the patient was reported as a beneficial bonus that could increase the uptake of eRehabilitation. "She has plenty of time to learn how to use eRehabilitation but she needs someone to practice it with." (Informal caregiver 4.6).

In line with the patients, healthcare professionals reported that an exercise program needed to be tailored to the patient's situation, and set up by a healthcare professional. This was supplemented with the task of the organization to ensure a good fit with the existing care pathways, and to arrange all necessary software and hardware. "I think that just all the computers in the rehabilitation centre must be sufficiently updated with all necessary software." (Healthcare professionals 2.6).

Resources: Resources needed for successful uptake included software, hardware, and physical space. Problems with the software were reported as limiting for the uptake of eRehabilitation in all focus groups sessions. Patients/informal caregivers said they would not use eRehabilitation when problems with the software occurred which were not resolved quickly. Concerning the hardware, patients were willing to purchase required hardware like a tablet when necessary. Besides, some patients reported not having enough space (3 × 3 m) at home to perform exercise safely.

For healthcare professionals, problems with the software were mentioned as a major barrier as well. "When you plan an e-consultation with the patient and the internet connection is bad or the webcam fails, you have to reschedule the consultation. I see some large potential problems." (Healthcare professional 2.2). Additionally, some healthcare professionals expected that the uptake among patients would be less when it was required to buy a new device, while others mentioned that most patient possess one or more ICT devices.

Time: Some patients reported that the uptake of eRehabilitation would be limited due to lack of time, others perceived an eRehabilitation programs as useful daytime activity. "I was sick and had no work, so the use of eRehabilitation would have been a welcome change" (Patient 3.1).

Healthcare professionals reported that the uptake of eRehabilitation would decrease if they lacked the time to get to know the program, for instance by education from the supplier. "A reason why I do not use eRehabilitation, is because I am not familiar with all the possibilities. It takes time to make it my own, leaving less time for the patients." (Healthcare professional 1.5). Besides, lack of time to monitor the progress of patient in the eRehabilitation program was reported as barrier as well.

3. Factors at the level of Individual patient

Quotes at this level could be grouped into the factors motivation to change, skills, knowledge, and patient characteristics.

Motivation to change: A motivation to start using eRehabilitation was, among others, the possibility to have peer contact with other stroke patients or other informal caregivers. In addition, patients frequently mentioned that exercises would be more stimulating using eRehabilitation, since a variety of games or exercises would be more fun than exercises on paper. Reasons not to use eRehabilitation were the chance of getting overstimulated by using ICT devices, and the replacement of personal contact by digital contact. Contact via an eRehabilitation program was perceived less personal than face-to-face contact. "You cannot replace human contact with contact by digital devices. That is always a loss." (Patient 2.5).

Healthcare professionals reported that eRehabilitation would be motivating for patients since it would give them the opportunity to exercise outside treatment hours and after discharge or could reduce travel time and costs if e-consultations were available. However, healthcare professionals were, like patients, also afraid for overstimulation of the patients and loss of social contact. "What I hear from many clients, especially on the long-term, is loneliness. There are possibilities to prevent loneliness, but I think this [eRehabilitation] is an individualistic way of training." (Healthcare professional 1.1).

Skills and knowledge: Opinions about skills and knowledge to use ICT devices for eRehabilitation programs differed within patients and within informal caregivers. Some patients and informal caregivers reported that their skills and knowledge would be sufficient: "I can deal well with a smartphone, a tablet or a laptop." (Patient 5.2). Other patients and informal caregivers reported not having enough knowledge or skills for the uptake of eRehabilitation programs, "I am also alone and I am not very technical, so it cannot do it on my one." (Patient 2.2). Patients reported that they need to be taught how to use the eRehabilitation program by a healthcare professional.

Healthcare professionals did not report any factors related to skills and knowledge at the level of the individual patient.

Patient characteristics: Patients and informal caregivers agreed that the use of an eRehabilitation program would not be suitable for every stroke patient, due to varying impairments and limitations. Among others, these limitations could concern the loss of the ability to understand ICT devices or loss of energy due to their stroke. Several informal caregivers mentioned that eRehabilitation was not suitable for their partner or family member. "It [handling ICT devices] does not work now. Every time you join the group class it goes well, but when you come home you do not know how to do it anymore." (Informal caregiver 6.3 talking to partner).

Healthcare professionals also mentioned that eRehabilitation would not be feasible for all patients in rehabilitation, but others reported that they are willing to try. "Sometimes, I want try it with a patient but I do not know if it is feasible. Then the patient really likes it and you can see another side of him; the person is very fanatical and is being active, that is very surprising." (Healthcare professional 1.5).

4. Factors at the level of Individual professional

Only from the transcripts of the healthcare professionals, one factor assigned to the level of the individual professional was identified: motivation to change, in other words why a healthcare professional would or would not start using eRehabilitation programs. Healthcare professionals expected that working as a multidisciplinary team would be easier after the uptake of an eRehabilitation program. An eRehabilitation program could improve insight in the prescribed exercises and actions taken by other disciplines. Healthcare professionals mentioned that they were cautious to prescribe eRehabilitation for a longer time since they were afraid to give false hope if it was advertised that eRehabilitation program would be accessible forever. Healthcare professional: "A forever-accessible program could imply that exercising via an eRehabilitation program would be useful in the chronic phase after stroke, while most exercises promote improvement only in the period directly after stroke." (Healthcare professional 2.1).

5. Factors at the level of Economic and political context

Financial arrangements, in particular reimbursement, were the only factor identified at this level. Some patients said that the absence of reimbursement of the costs of an eRehabilitation program made it impossible for them to start using eRehabilitation, since they could not spare the money to pay for it. Others perceived it as an extra motivation to actually use eRehabilitation when paid for it. “If it is for free, you work less hard for that.” (Informal caregiver 3.1). “So a certain payment seems good to me.” (Patient 3.2) “Or a subscription.” (Informal caregiver 3.1). “Yes, that would reinforce the involvement.” (Patient 3.2).

Healthcare professionals mentioned the absence of reimbursement only as a restricting factor for the uptake of eRehabilitation. “Implementation of eRehabilitation costs a reasonable amount of money. There is no direct return of the investment or reimbursed yet. So that is still a big bottleneck.” (Healthcare professional 1.2).

DISCUSSION

This qualitative focus group study explored factors influencing the uptake of eRehabilitation programs in stroke care in western country, from the perspective of patients, informal caregivers, and healthcare professionals. Fourteen factors influencing the uptake were identified, grouped into 5 levels: Innovation, Organizational context, Individual patient, Individual professional, and the Economic and political context. No factors related to the social context were found.

Considerable overlap between patients/informal caregivers and healthcare professionals was found, especially at the level of the Innovation. Many participants expressed positive beliefs about the potentials of eRehabilitation, like the possibility to continue therapy after discharge and more motivation for therapy-related activities. However, all end-users emphasized the importance of the possibility to get to know the eRehabilitation program; for patients, this included education from their healthcare professionals how to use the program; for the healthcare professionals, this included education and time to get used to the program. Differences between patients/informal caregivers and healthcare professionals were found as well. Patients/informal caregivers reported more quotes in the level of the Individual patient (i.e. patients’ characteristics as fatigue and the inability to understand ICT devices), where healthcare professionals reported more at the level of the Organization context (i.e. having sufficient time and the fit with existing care pathways). Therefore, end-users were focused in the same extent to factors related to the Innovation, but patients/informal caregivers were more concerned about factors related to the Individual patients where healthcare professionals were more concerned about factors related to the Organizational context.

Concerns about the Organizational context were found before in the implementation of eRehabilitation in stroke [20]. Although it seems clear that eRehabilitation will affect the way daily rehabilitation is delivered [10], previous research stated that rehabilitation therapy should start with face-to-face contact to establish a good patient-professional relationship [31]. The current research stresses the importance of supplementing eRehabilitation to traditional rehabilitation instead of replacing it as well; all end-users reported that eRehabilitation would only be feasible when added to traditional rehabilitation. Therefore, to optimize stroke rehabilitation, it seems best to offer blended care in which eRehabilitation programs are added to regular face-to-face treatment and to integrate care supported by ICT with traditional care [14, 32].

This study did not find any factors related to the social context. This is in line with findings from previous studies that assessed factors influencing the implementation of eRehabilitation [10, 33, 34]. A previous study about the implementation of virtual reality [34] reported, for example, only factors related to the organizational context, individual patient, healthcare professional, and technological aspects. In addition, a policy statement reported as well, only legal, technological, and financial barriers [10]. Also after implementation, during the actual use of eRehabilitation, healthcare professionals were not worried about social pressures of colleagues [33]. A possible explanation is that the use of eRehabilitation in our study would be voluntary. The study of Schaper and Pervan [35] showed that voluntary use of technologies in the rehabilitation setting, healthcare professionals', especially physical and occupational therapists', intention to use eRehabilitation were not significantly influenced by colleagues; the decisions to use eRehabilitation was made independent from other team members. As a result, factors related to the social context had little influence on healthcare professionals' uptake of technologies like eRehabilitation.

Next to the results considering blended care and the absence of factors in the social level, the results of our study confirm findings from previous studies. Healthcare professionals previously stressed the importance of getting the time and opportunity to become familiar with eRehabilitation programs [17]. In addition and in line with our findings, support of informal caregivers and the role of the healthcare professional to introduce eRehabilitation to the patients seemed crucial for successful uptake [31]. Important aspect for the feasibly of eRehabilitation is the usability for those with less capabilities and adjusted to characteristics of those clinical conditions [10].

Additional to the observed similarities, differences between previous research and this research were also found. In previous research in both patients and healthcare professionals, patients had a more positive view at eRehabilitation than the healthcare professionals [20]. It this study, that difference was not noticed, but not explored in detail as well. A possible reason for this is that healthcare professionals involved in the study of Tyagi [20] were previously involved in eRehabilitation, which was not the case for most healthcare professionals in this study. Another difference was that in our study, patient characteristics (mostly as a consequence of stroke) were reported as possible barrier, in contrast to literature about uptake of eRehabilitation not specified to stroke [33, 36]. Therefore, it is recommended that implementation strategies must be tailored to both end-users and to specific impairments of the disease as well. In order to implement interventions with the right content and sufficient ease of use, involvement of patients/informal caregivers and healthcare professionals in the development of eRehabilitation is important.

A limitation of this study is that we could not aim for data saturation among healthcare professionals. Whereas six focus groups were conducted with patients/informal caregivers and data saturation was reached, for the healthcare professionals this was not possible due to practical issues. Differences in results between patients/informal caregivers and healthcare professionals may have resulted from this imbalance. A second limitation was that the participants of the pilot study did not meet the inclusion criterion of start of rehabilitation after June 2011. This inclusion criterion was set because we believe that patients with a longer time since start of rehabilitation are not familiar with the recent stroke rehabilitation and innovations like eRehabilitation, which is a prerequisite to be able to contribute to the conversation during the focus groups. However, since the participants of the pilot study are discussing innovations in stroke rehabilitation on a regular basis, they still have a good feeling with recent developments and current stroke care. Therefore, we believe that a longer time since start of rehabilitation of these participants did not affect their opinions and statements.

Based on this study, it was not possible to determine which factors have the largest impact on the uptake of eRehabilitation, or how these are associated with characteristics of patients and healthcare professionals. Such insights are crucial since it is practically impossible to tailor an implementation strategy to all factors that may influence the uptake. To increase the uptake of eRehabilitation programs, future research should focus on such insights and factors identified as most important should be considered in the development and implementation strategy of eRehabilitation innovations for stroke rehabilitation. Those interventions should be assessed on its (cost)-effectiveness in randomized and controlled trails.

For clinical practice, we recommend that implementation strategies for eRehabilitation must be tailored to factors influencing the uptake of eRehabilitation among end-users. As a consequence of differences in the factors found between end-users, the used strategies must be different for patients/informal caregivers and healthcare professionals. For patients, this means that it is important that future eRehabilitation programs increase the ease of use, especially for of impaired body functions, to ensure eRehabilitation is applicable for as many patients as possible [37]. For uptake among healthcare professionals, it seems crucial that the eRehabilitation program is attractive, but also fits well into existing process of care. Since the uptake of eRehabilitation starts with the healthcare professional using eRehabilitation and introducing it to the patients [18], the factors mentioned by healthcare professionals should be an important starting point in increasing of uptake of eRehabilitation for, e.g., policy makers. To make sure that eRehabilitation programs have the right content and sufficient ease of use, involvement of all end-users in the development of the eRehabilitation innovation is important.

CONCLUSION

This research identified factors influencing uptake of eRehabilitation in a western country. Although there was a considerable overlap in reported factors between patients/informal caregivers and healthcare professionals when it concerns eRehabilitation as innovation, this research shows that patients/informal caregivers give more emphasis to factors related to the individual patient, whereas healthcare professionals emphasize the importance of factors related to the organizational context. This difference should be considered when developing an implementation strategy.

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3

Factors associated with willingness to use eRehabilitation after stroke: a cross-sectional study among patients, informal caregivers and healthcare professionals

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ABSTRACT

Objective: Despite the increasing availability of eRehabilitation, its use remains limited. The aim of this study was to assess factors associated with willingness to use eRehabilitation.

Design: Cross-sectional survey.

Subjects: Stroke patients, informal caregivers, healthcare professionals.

Methods: The survey included personal characteristics, willingness to use eRehabilitation (yes/no) and barriers/facilitators influencing this willingness (4-point scale). Barriers/ facilitators were merged into factors. The association between these factors and willingness to use eRehabilitation was assessed using logistic regression analyses.

Results: Overall, 125 patients, 43 informal caregivers and 102 healthcare professionals participated in the study. Willingness to use eRehabilitation was positively influenced by perceived patient benefits (e.g. reduced travel time, increased motivation, better outcomes), among patients (odds ratio (OR) 2.68; 95% confidence interval (95% CI) 1.34–5.33), informal caregivers (OR 8.98; 95% CI 1.70–47.33) and healthcare professionals (OR 6.25; 95% CI 1.17–10.48). Insufficient knowledge decreased willingness to use eRehabilitation among patients (OR 0.36, 95% CI 0.17–0.74). Limitations of the study include low response rates and possible response bias.

Conclusion: Differences were found between patients/ informal caregivers and healthcare professionals. However, for both groups, perceived benefits of the use of eRehabilitation facilitated willingness to use eRehabilitation. Further research is needed to determine the benefits of such programs, and inform all users about the potential benefits and how to use eRehabilitation.

INTRODUCTION

Stroke is a major cause of disability worldwide [1], including long-term physical and cognitive impairments [2]. Recovery of these functions requires specialized multidisciplinary stroke rehabilitation [3]. Due to the increasing incidence of stroke and the major increase in the cost of healthcare [4], there is a need for more efficient rehabilitation strategies. The rapid growth of accessible and affordable information and communication technology (ICT) offers a potential solution, and may improve the effectiveness of rehabilitation [5, 6].

The use of ICT in rehabilitation (i.e. eRehabilitation) is a method for delivering rehabilitation in addition to conventional modes of delivery in the sub-acute and chronic phases of rehabilitation. eRehabilitation is delivered using a variety of possible ICT devices, such as computers, tablets and smartphones, and includes exercise programmes, serious gaming (conducting rehabilitation through playing games), education and e-consultations [7]. Randomized clinical trials (RCTs) showed that eRehabilitation can decrease stroke-related impairments [6, 8, 9], reduce physical effort required from healthcare professionals, make rehabilitation accessible to larger number of stroke patients [5], make it possible to continue therapy-related cognitive and physical activities after discharge [10], decrease chronic disability, and facilitate home-therapy [11, 12]. A positive attitude toward the use of eRehabilitation was found among all end-users, including stroke patients, informal caregivers [13–15] and healthcare professionals [16, 17]. The use of eRehabilitation has been associated with enjoyment, extra feedback, physical and cognitive benefits and the possibility to address the limitations of the current rehabilitation system, such as limited therapy hours, low motivation and poor adherence to exercise [18].

Despite these promising results and widespread agreement about the importance and potential of eRehabilitation, its implementation (i.e. making eRehabilitation effective in stroke rehabilitation) is lagging behind [19]. A previous focus group study explored which factors influence the implementation of eRehabilitation [20]. This study, together with other literature, reported that the implementation of eRehabilitation is hampered by a lack of confidence about using hardware or software [15, 21] and the fear that eRehabilitation could replace face-to-face contact [13, 16, 20]. Skilled healthcare professionals or informal caregivers are needed to support patients in using complex ICT programs [11, 14, 20]. Healthcare professionals raised concerns about adapting the rehabilitation process when adding eRehabilitation [22]. Moreover, eRehabilitation is feasible only if tailored to the individual needs of the recovering patient [18, 20]. In addition, the safety of unsupervised rehabilitation exercises is unknown [11] and lack of substantial reimbursement by insurers is hampering its widespread implementation [6]. Healthcare professionals' decision to start using eRehabilitation is influenced by their beliefs about how eRehabilitation helps them in performing their work [23].

Although the above-mentioned studies have identified some factors influencing the use of eRehabilitation, it is not known which factors have the greatest impact. This insight is necessary in order to tailor an implementation strategy to the factors that may influence use of eRehabilitation, and to develop an effective implementation strategy to increase the use of eRehabilitation in stroke patients. Therefore, the aim of this study was to assess which factors are associated with willingness to use eRehabilitation after stroke, for patients, informal caregivers and healthcare professionals.

METHODS

1. Design and setting

This cross-sectional study within the Dutch medical specialist rehabilitation setting used a single online survey, based on the results of a previous focus group study [20]. The present study was conducted in June 2016, among stroke patients, their informal caregivers and healthcare professionals at 2 rehabilitation centres (Basalt The Hague and Basalt Leiden). It was approved by the Medical Ethics Review Board of Leiden University Medical Centre [P15.281]. STROBE statements were used for adequate sampling, analyses and reporting.

2. Subjects

Stroke patients were selected if they met the following inclusion criteria: aged ≥ 18 years, having started rehabilitation after June 2011 and completed it before May 2016, living independently, able to understand and read Dutch, and having an email address. A total of 400 patients, 200 from each rehabilitation centre, were randomly selected from a list of approximately 2,700 eligible patients. They received an invitation email from a rehabilitation physician who was involved in this study, including an introduction to the study and a link to the online survey. The email also included information for the informal caregivers and a link to a separate survey for the informal caregivers. Since not all patients had an informal caregiver, the number of informal caregivers invited is unknown.

Healthcare professionals were eligible if they had at least 2 years of experience working in a multidisciplinary stroke team and were still actively seeing stroke patients in rehabilitation care in the Netherlands. Invited healthcare professionals included 3 disciplines that are commonly involved in stroke rehabilitation: rehabilitation physicians, psychologists and physiotherapists. These disciplines were invited since the eRehabilitation intervention in this study concerned physical and cognitive training, 2 domains that are mostly addressed by these disciplines. A Dutch medical address book including most healthcare professionals in the Netherlands was used to identify members of the 3 disciplines. All eligible healthcare professionals who worked in rehabilitation care received an invitation email.

Non-responders received 2 reminders via email, 2 and 4 weeks after the invitation. Immediately after completing the survey, participants were sent a note thanking them for their willingness to participate. Although participants were invited by email, they completed the survey anonymously, with only the IP address known to the researchers. The personal characteristics collected were not traceable (e.g. age was used instead of date of birth). Participants did not receive the results of the study.

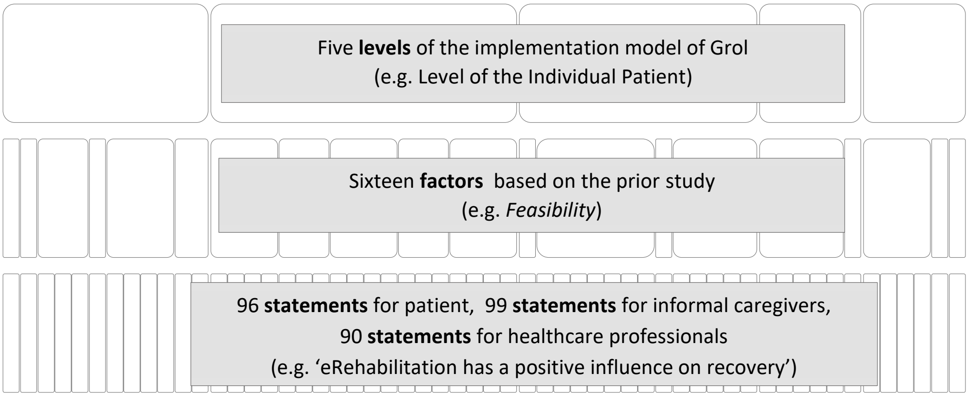

Figure 1. Relation between levels, factors and statements

3

3. Development and content of surveys

3.1 Preceding focus group study

The survey was developed based on the results of an earlier focus group study [20]. In 8 focus groups (2 with healthcare professionals and 6 with patients/ informal caregivers), barriers and facilitators for willingness to use eRehabilitation were identified. Participating healthcare professionals included physiotherapists, psychologists, occupational therapists, speech therapists, rehabilitation specialists and managers. Participating patients were selected using purposeful sampling. The analysis and results of the focus group study have been published in detail elsewhere [20].

Barriers/facilitators regarding related topics were merged into factors based on Grol's implementation model [24]. This model includes 6 levels; the innovation, the organizational context, individual patients, individual professionals, the social context, and the economic and political context. The focus group study identified 14 factors at 5 levels (Fig. 1). Factors at the social level were not identified and therefore not incorporated in the present survey. One change was made to the factors identified in the focus group study; for the purpose of the survey the factors Motivation to change, at the level of both the Individual patients and the Individual professionals, was divided into Motivation to change and Motivation not to change, resulting in 16 factors being included in the present study.

3.2. Survey content

Separate surveys were developed for patients, informal caregivers and healthcare professionals. The surveys consisted of 3 parts: 1. questions about responder characteristics, 2. statements about barriers and facilitators influencing willingness to use eRehabilitation for stroke patients, and 3. questions about willingness to use eRehabilitation;

1. *Responder characteristics.* All 3 surveys included questions about age and sex. In addition, patients and informal caregivers were asked about the time since the stroke (in months), living status (living alone or living with partner/ family), employment (paid job, no paid job), self-perceived impairment (cognitive, physical, communicative), use of electronic devices in daily life (smartphone, tablet, laptop, computer) and previous experience with eRehabilitation (no, yes; if yes: exercises, games, information).
   For healthcare professionals, the survey started with the question "Are you working with stroke patients?" If not, the survey was ended. If yes, 12 questions followed, regarding their work setting (primary care, rehabilitation centre, general hospital), years of work experience, number of new stroke patients per month and their current use of eRehabilitation (no, yes; if yes: exercises, games, information).

2. *Barriers/facilitators statements.* For the current study, each potential barrier and facilitator identified in the focus group study was translated into a neutral statement. A total of 69 statements were formulated, based on the transcripts of the focus group sessions of patients, informal caregivers and healthcare professionals. For patients and informal caregivers, 26 statements were formulated, based on barriers/ facilitators that were not reported by the healthcare professionals. This concerned the design of the eRehabilitation in terms of colour, use of pictographs and beliefs about the skills and knowledge required to use eRehabilitation. Three statements were formulated for the informal caregivers alone, concerning the information provided to them. Nineteen statements were formulated for the healthcare professionals only. These included organizational constraints, integration of eRehabilitation in the current rehabilitation process, and monitoring patients' results. The barrier/facilitator statements thus included 95 (69 + 26) statements for the patients, 98 (69 + 26 + 3) statements for the informal caregivers and 88 (69 + 19) statements for the healthcare professionals (see Appendix 1 for all statements). The influence of the barriers/facilitators mentioned in the statements on willingness to use eRehabilitation was rated on a 4-point Likert scale (1=unimportant, 2=somewhat unimportant, 3=somewhat important, 4=important, or 1=disagree, 2=partly disagree, 3=partly agree, 4=agree).

3. *Willingness to use eRehabilitation*. Since eRehabilitation is still not widely used, the surveys included 1 question about willingness to use eRehabilitation: "Would you like to use eRehabilitation in addition to the regular rehabilitation care?" (yes, no).

The surveys were tested in a pilot study with 3 stroke patients who were still undergoing rehabilitation treatment (1 male, 2 females; mean age 59 years; mean time since stroke 10 weeks; all undergoing in-patient rehabilitation for stroke) and 3 healthcare professionals (2 males, 1 female; 2 physiotherapists, 1 occupational therapist; mean age 38 years; mean work experience 13.3 years) working in a rehabilitation centre. The surveys were tested for feasibility, legibility, readability and presentation (e.g. perceived statement difficulty, response errors, screen layout, etc.). Testing led to small changes in the phrasing and layout. The survey for informal caregivers was adjusted based on feedback from the other surveys.

4. Statistical analysis

Participants who completed ≥90% of the survey were included in the analysis, and we did not impute for missing values. Analysis of survey data was carried out using Statistical Packages for the Social Sciences (IBM SPSS 22.0 for Windows).

4.1 Participant characteristics

Participant characteristics included socio-demographic data and disease- and work-related characteristics, presented as numbers with percentages or means with standard deviation (SD). Age and sex of responders were compared with those of the stroke population of 2,700 eligible patients in the 2 participating rehabilitation centres, using independent t-test and Wilcoxon-Mann-Whitney test.

4.2 Descriptive analyses

Median scores with interquartile ranges (IQR) were calculated for each of the statement about barriers/facilitators. Based on the median score, the 5 most important statements were reported for each group (patients, informal caregivers and healthcare professionals), and for physicians, physiotherapists and psychologists separately. For statements with a similar median, a more specific ranking (lowest number equals largest influence) was made, based on the mean.

4.3 Association between barriers/facilitators and willingness to use eRehabilitation

The association between a barrier/facilitator and willingness to use eRehabilitation was assessed using logistic regression analysis. The methods were comparable to those used in previous qualitative research about barriers and facilitators to the implementation of innovations in healthcare [25, 26]. This analysis was performed separately for patients, informal caregivers and healthcare professionals, and consisted of 3 steps:

1. All statements about barriers/facilitators were merged into factors, as predefined in the focus group study. The internal consistency of each factor (i.e. group of statements) was calculated using Cronbach's alpha. A Cronbach's alpha of 0.7 was considered acceptable [27] and was determined using a factor analysis with an orthogonal rotation approach, using principal component analysis and varimax rotation [28].

2. Univariate logistic regression analyses were performed to assess whether a factor was significantly associated with willingness to use eRehabilitation. Factors were used instead of statements, to prevent over-fitting of the logistic regression model by including too many variables. The factors were included as the independent

variables, and willingness to use eRehabilitation as the dependent variable. In addition to the factors derived from the focus group study, the characteristics of responders asked for in the first part of the survey, viz. age, discipline (healthcare professionals only) and previous use of eRehabilitation (patients and healthcare professionals only) were also included in the analysis. Odds ratios (OR) with a 95% confidence interval (95% CI) are reported.

3. As individual factors may be related to others, the factors and responder characteristics significantly associated with willingness to use eRehabilitation were included in a multivariate logistic regression analysis using a backward likelihood ratio method. OR values with 95% CI are reported. An OR higher than 1 indicates that a factor was positively associated with willingness to use eRehabilitation, while an OR lower than 1 indicates that a factor was negatively associated with willingness to use eRehabilitation.

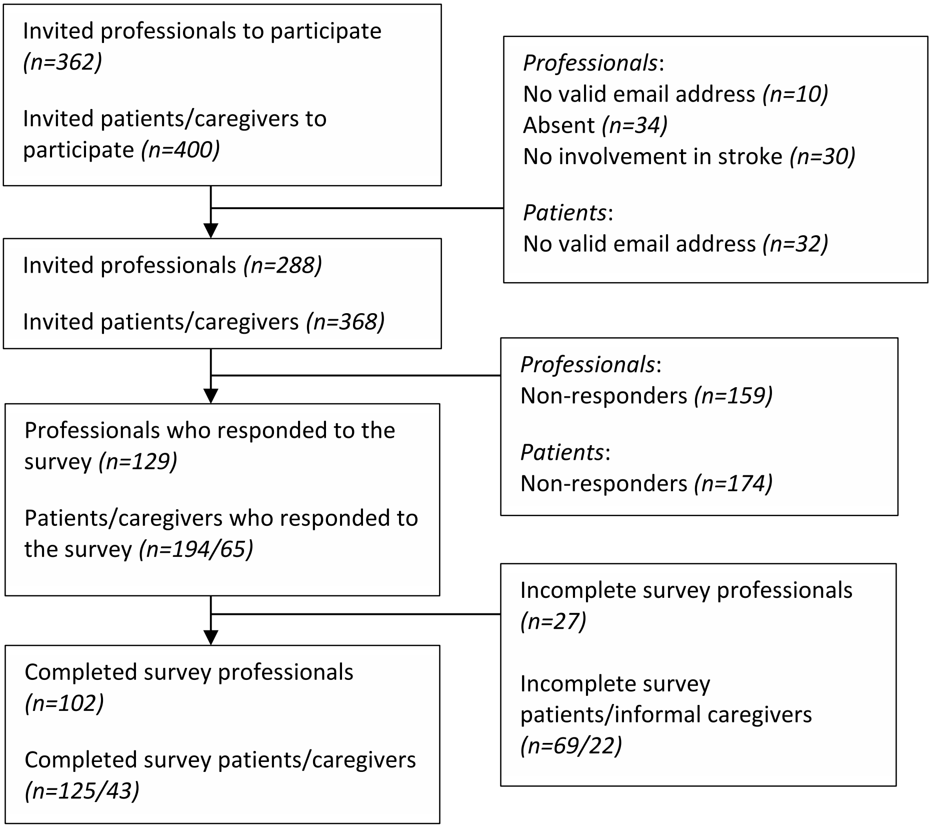

Figure 2. Flow of inclusion

RESULTS

Participant characteristics

The survey was completed by 125 of the 368 (34%) invited patients, 43 informal caregivers (response rate unknown) and 102 of the 288 (37%) invited healthcare professionals (Fig. 2). Reasons for non-response were not verified, except for 30 (10%) healthcare professionals that did not complete the survey because they were not working with stroke patients. Respondent characteristics for the patients, informal caregivers and healthcare professionals were as follows: mean age was 58.2 years (SD 11.4), 58.4 years (SD 12.0) and 41.9 years (SD 10.5), respectively; and 72 (58%), 16 (37%) and 25 (24%), respectively, were male (Table 1). Age and sex did not differ between the responders and the sample of 2,700 patients eligible for this study. Mean time since stroke was 30.6 months (SD 29.2). Most patients (n = 113, 90%) and informal caregivers (n = 41, 95%) used electronic devices such as laptops, tablet or smartphone daily. One-quarter of the patients (n = 30, 24%) and more than one-third of the healthcare professionals (n = 38, 37%) had used eRehabilitation before, and 106 (84%) patients, 38 (88%) informal caregivers and 97 (92%) healthcare professionals reported that they were willing to use eRehabilitation. Of the 102 healthcare professionals, 41 (39%) were physiotherapists, 14 (13%) psychologists and 47 (45%) physicians. Most healthcare professionals (n = 73, 72%) worked in a rehabilitation centre; other settings included primary care (n = 9, 9%) and hospital (n = 34, 32%).

Descriptive statistics

The 5 most important barriers/facilitators influencing willingness to use eRehabilitation are shown in Tables 2. One facilitator appeared in the top 5 highest scoring statements for both patients, informal caregivers and healthcare professionals; “The use of eRehabilitation has a positive influence on the patient’s recovery.” (Table 2a). Other barriers/facilitators in the top 5 for patients and informal caregivers mostly concerned statements belonging to the factors *Advantages of use* (such as the possibilities of online information, online agenda, online survey, etc.) and *Motivation to change*, at the level of individual patients (i.e. benefits of using eRehabilitation for patients, such as reduced travel time and increased motivation). Healthcare professionals mostly endorsed statements belonging to the factor *Feasibility* (such as support from a helpdesk, video instructions or frequently asked questions (FAQs)).

When calculated for each discipline separately, only the facilitator “A helpdesk is available for patients” in the factor *Feasibility* was found in the top 5 for all disciplines (Table 2b). The top 5 for physicians mostly involved statements belonging to the factor *Attractiveness* (such as the content of an eRehabilitation programme), while that for psychologists consisted mostly of statements belonging to the factor *Motivation to change* at the level of individual patients (such as benefits of using of eRehabilitation). Physiotherapists endorsed statements in 5 different factors (*Organization of care, Accessibility, Attractiveness, Advantage of use, and Feasibility*).

Table 1. Characteristics of patients, informal caregivers and healthcare professionals participating in a survey on the use of eRehabilitation

Characteristics	**Patients (n=125)**	**Informal caregivers (n=43)**	**Healthcare professionals (n=102)**
Age, years (mean, SD)	58.2 (11.4)	58.4 (12.0)	41.9 (10.6)
Sex, n male (%)	72 (58)	16 (37)	25 (24)
Time since stroke, months (mean, SD)	30.6 (29.2)	.	.
Living status, n. living alone (%)	22 (18)	5 (12)	
Employment, n. with a paid job (%)	42 (34)	21 (49)	
Self-perceived impairments* (n yes, %)			
Cognitive impairments	81 (65)	.	.
Physical impairments	84 (67)	.	.
Aphasia	48 (38)	.	.
Use of digital devices in daily life (n yes, %)	113 (90)	41 (95)	.
Use of device* (n yes, %)			
Smartphone	85 (68)	33 (77)	.
Tablet	62 (50)	30 (70)	.
Laptop	71 (57)	30 (70)	.
Computer (PC)	54 (43)	20 (47)	.
Previous use of eRehabilitation (n yes, %)	30 (24)	.	38 (37)
Discipline (n, %)			
Physical therapist	.	.	41 (39)
Psychologist	.	.	14 (13)
Physician	.	.	47 (45)
Employed at* (n, %)			
Health centre in primary care[1]	.	.	9 (9)
Rehabilitation centre[1,2]	.	.	73 (72)
General hospital[1,2]	.	.	34 (32)
Work experience, years (mean, SD)	.	.	13.4 (10.0)
Number of new patients per month (mean, SD)			7.95 (8.5)

*Multiple answers possible; 1. Out-patient care; 2. In-patient care

Association between influencing factors and willingness to use eRehabilitation

A confirmatory factor analysis (step 1) showed that the mean Cronbach's alpha of statements merged into factors was 0.82 (range 0.6–0.9), with 1 factor loading below 0.7.

In step 2 (univariate regression analyses), a statistically significant association was found for all end-users between willingness to use eRehabilitation and the factors *Feasibility, Organization of care and Motivation to change* at the level of the individual patient (Table 3). For the patients, the factors *Accessibility, Attractiveness, Advantages of use, Time and Knowledge* were also significantly associated with willingness to use eRehabilitation; for informal caregivers, an association was found for the factors *Accessibility and Advantages of use;* for the healthcare professionals, an association was found for the factors *Time and Motivation not to Change* (at the level of the individual professional). In addition to the factors in the model by Grol (25), we tested the responder characteristics of age, discipline and previous use of eRehabilitation, and these were found not to be significantly associated with willingness to use eRehabilitation (Table 3).

Table 2a. Five highest scoring statements (based on median and mean) for the willingness to use eRehabilitation (range 1-4) among stroke patients, informal caregivers and professionals, as medians (interquartile range)

Statement *I would use eRehabilitation, if…*	**Factor**	**Patients (n=125)**	**Informal caregivers (n=43)**	**Professionals (n=102)**
it has a positive influence on recovery	Motivation to change	4 (4-4)	4 (4-4)	4 (4-4)
it offers an easy way to contact a professional again after discharge	Motivation to change	4 (3-4)	4 (4-4)	.
it offers a way to independently continue treatment after discharge	Motivation to change	4 (3-4)	4 (4-4)	.
exercises for cognitive functioning are available	Attractiveness	4 (3-4)	.	.
decisions that were made during a consultation are documented for patients	Advantage of use	4 (3-4)	.	.
it contains no distracting flashes	Attractiveness	.	4 (4-4)	.
logging in is easy	Accessibility	.	4 (4-4)	4 (4-4)
a helpdesk is available for patients	Feasibility	.	.	4 (4-4)
video instructions on how to use eRehabilitation are available for patients	Feasibility	.	.	4 (4-4)
the patient can read information about stroke	Attractiveness	.	.	4 (4-4)

· = not shown, no part of top 5

Table 2b. Five highest scoring statements (based on median and mean) for the willingness to use eRehabilitation (range 1-4) after stroke, for each individual discipline, as medians (interquartile range)

Statement *I would use eRehabilitation, if…*	**Factor**	**Physicians (n=47)**	**Physiotherapists (n=41)**	**Psychologists (n=14)**
a helpdesk is available for patients	Feasibility	4 (4-4)	4 (4-4)	4 (4-4)
it has a positive influence on patient recovery	Motivation to change	4 (4-4)	.	4 (4-4)
the patient can read information about stroke	Attractiveness	4 (4-4)	.	.
video instructions on how to use eRehabilitation are available for patients	Feasibility	4 (4-4)	.	.
a module about how to deal with stroke (psycho education) is available	Attractiveness	4 (4-4)	.	.
ICT-problems are solved immediately	Organization of care	.	4 (4-4)	.
logging in is easy	Accessibility	.	4 (4-4)	4 (4-4)
physical exercises are avialable	Attractiveness	.	4 (4-4)	.
decisions that were made during a consultation are documented for patients	Advantage of use	.	4 (4-4)	.
a patient wants to use eRehabilitation	Motivation to change	.	.	4 (4-4)
the content of eRehabilitaion can be tailored to the patient's situation	Feasibility	·	.	4 (4-4)

· = not shown, no part of top 5

Table 3. Factor analyses and uni- and multivariate regression analyses for each factor of the model by Grol and for responder characteristics, for patients, informal caregivers and healthcare professionals

		Patients (n=125)			Informal caregivers (n=43)			Healthcare professionals (n=102)		
Level in Grol	**Factor in Grol**	**FA (α)**	**ULR OR (95%CI)**	**MLR OR (95%CI)**	**FA (α)**	**ULR OR (95%CI)**	**MLR OR (95%CI)**	**FA (α)**	**ULR OR (95%CI)**	**MLR OR (95%CI)**
Innovation	Accessibility	0.8	**2.18 (1.39-3.40)**	·	0.9	**9.07 (1.72-47.86)**	·	0.7	1.81(0.83-3.93)	·
	Feasibility	0.8	**1.72 (1.11-2.69)**	·	0.8	**3.59 (1.28-10.06)**	·	0.9	**2.11 (1.14-4.92)**	·
	Attractiveness	0.9	**1.82 (1.02-3.26)**	·	0.9	3.20 (0.94-10.86)	·	0.9	1.63 (0.68-3.85)	·
	Privacy	·	0.99 (0.67-1.46)	·	·	1.34 (0.64-2.79)	·	·	1.81 (0.85-3.86)	·
	Advantages of use	0.9	**2.18 (1.39-3.40)**	·	0.9	**3.24 (1.39-7.52)**	·	0.9	1.41 (0.57-3.44)	·
Organizational context	Organization of care	0.9	**2.74 (1.65-4.56)**	·	0.8	**3.65 (1.10-12.15)**	·	0.8	**2.64 (1.48-7.11)**	·
	Resources	0.8	0.75 (0.48-1.16)	·	0.7	1.86 (0.76-4.57)	·	0.8	0.84 (0.39-1.82)	·
	Time	·	**2.26 (1.37-3.67)**	·	·	1.45 (0.58-3.67)	·	·	**2.81 (1.24-6.36)**	·
Individual patients	**Motivation to change**	0.8	**2.76 (1.61-4.72)**	**2.68 (1.34-5.33)**	0.7	**6.14 (1.14-33.16)**	**8.98 (1.70-47.33)**	0.8	**2.53 (1.42-6.99)**	**6.25 (1.17-10.48)**
	Motivation not to change	0.8	1.20 (0.72-2.03)	·	0.8	1.15 (0.48-2.75)	·	0.6	2.04 (0.79-5.52)	·
	Knowledge	·	**0.66 (0.44-0.99)**	**0.36 (0.17-0.74)**	·	1.12 (0.51-2.47)	·	·	·	·
	Skill	·	0.70 (0.46-1.06)	·	·	1.19 (0.52-2.27)	·	·	·	·
	Stroke-related impairments	0.9	0.81 (0.50-1.30)	·	0.9	0.95 (0.40-2.26)	·	0.8	1.91 (0.65-5.61)	·
Individual professional	Motivation to change	·	·	·	·	·	·	0.8	1.76 (0.72-4.33)	·
	Motivation not to change	·	·	·	·	·	·	0.8	**1.71 (1.17-3.43)**	·
Eco&pol context	Financial arrangements	·	1.01 (0.70-1.46)	·	·	1.21 (0.61-2.39)	·	·	1.08 (0.40-2.48)	·
Responder characteristics										
Age		.	0.97 (0.93-1.02)	.	.	0.92 (0.83-1.03)		.	0.94 (0.87-1.01)	.
Discipline		.	.	.	.	.	.	.	0.72 (0.42-1.23)	.
Previous use of eRehabilitation		.	. 1.13 (0.37-3.44)	.		.	.	.	0.66 (0.12-3.60)	.

FA; Factor analysis, ULR; univariate logistic regression analyses; MLR; multivariate logistic regression analyses OR; Odds ratio, 95%CI; confidence interval, Eco&pol; economic and political context.
Significant values shown in bold

Step 3 (the multivariate logistic regression analysis) showed that the factor *Motivation to change* at the level of the individual patient was positively associated with willingness to use eRehabilitation by patients (OR 2.68; 95% CI 1.34–5.33), informal caregivers (OR 8.98, 95% CI 1.70–47.33) and healthcare professionals (OR 4.08, 95% CI 1.36–12.23). For patients, the factor Knowledge (including the statement “I don’t have sufficient knowledge to use eRehabilitation”) was negatively associated with willingness to use eRehabilitation (OR 0.36 and 95% CI 0.17–0.74).

DISCUSSION

This cross-sectional study among patients, informal caregivers and healthcare professionals has shown that barriers/facilitators influencing willingness to use eRehabilitation are largely similar for patients and caregivers, but are different for healthcare professionals. Whereas its use by patients/caregivers is more associated with the opportunity to improve their health via eRehabilitation, its use by healthcare professionals is more associated with its feasibility. In addition, willingness to use eRehabilitation by patients, informal caregivers and healthcare professionals was positively associated with its expected benefits for stroke patients (e.g. reduced travel time, increased motivation, better health outcomes, increased therapy adherence, etc.). Patients’ willingness to use eRehabilitation was negatively associated with a lack of knowledge regarding its use.

For all end-users, the 5 most important factors found in this study have shown that a “positive influence on patient recovery” is the most important facilitator for willingness to use eRehabilitation. This might sound obvious, but, in fact, many potential barriers/ facilitators for all kinds of healthcare innovations are quite obvious. The logistical regression analyses revealed that other factors that might seem obvious, such as sufficient time for education and proper financial arrangements, are not associated with willingness to use eRehabilitation and should therefore have lower priority in an implementation strategy. In any case, “positive influence on patient recovery” stands out for all stakeholders, so there is an urgent need for more evidence regarding this positive influence. This is one of the most important challenges in eRehabilitation. Although the potential advantages of eRehabilitation seem clear, the lack of currently available evidence hampers its implementation in stroke rehabilitation, therefore more high quality research determining the effectiveness of eRehabilitation interventions is urgently required [6].

In contrast to the above-mentioned similarity, this study has also identified differences between end-users regarding certain factors that are important for willingness to use eRehabilitation. Patients/caregivers were more willing to use eRehabilitation because of its benefits (in this study merged in the factor *Motivation to change*). Many of these benefits were found important in previous studies, viz. the possibility to train at home [29], independent continuation of therapy activities [10] and easy contact with healthcare professionals after discharge or during outpatient therapy [16, 17]. Thus, both personal contacts and a suitable eRehabilitation approach are important. Therefore, eRehabilitation appears to be best offered in a blended intervention in which it is added to conventional rehabilitation [7, 15]. The 2017 Stroke Best Practice Recommendations also concluded that eRehabilitation interventions can only achieve their full potential if integrated in and added to existing stroke services delivery plans [30].

In contrast to the patients, the healthcare professionals considered the factor *Feasibility* to be the most important one. This includes support for patients from a helpdesk, video instructions and FAQ. Support for the healthcare professionals (which was also part of the factor *Feasibility*) was not reported to be important. This shows that healthcare professionals are concerned about sufficient patient support in the use of eRehabilitation during the care process. This is not in line with a previous study among health professionals by Liu et al. [23] about factors influencing the use of eRehabilitation. They reported that performance expectancy ("the degree to which an individual believes that using the system will help to attain gains") was the strongest predictor of the use of new technologies by healthcare professionals. Liu's "performance expectancy" section included 6 questions about patient outcomes, such as accomplishing patient goals quickly, improving daily life and increasing the quality of rehabilitation, and thus closely resembles our factor *Motivation to Change* at the level of the individual patient, which was considered important by patients/ caregivers in the current study.

Our logistic regression analyses have shown that beliefs about potential patient benefits are associated with willingness to use eRehabilitation for patients, informal caregivers and healthcare professionals. The study by Liu et al. [23] already reported that performance expectancy (i.e. the benefits of using a system) is the strongest predictor of the adoption of new technologies by healthcare professionals. The present study suggests that this is also true for patients and their informal caregivers. Another factor associated with willingness among our patients to use eRehabilitation was *Knowledge*: patients have to feel confident about starting to use eRehabilitation. This is in agreement with the results of some previous studies. A review by Pugliese et al. concluded that the most commonly reported patient barrier was that of following instructions about how to use the device [31]. A feasibility study by Palmcrantz et al. [29] found that the majority of stroke patients needed support from a physiotherapist to start using home-based eRehabilitation, and in a focus group study by Saywell & Taylor [32], the participants emphasized that simple, explicit information on how and why to perform is crucial [31]. Educating patients and involving them as partners in the development process was an important prerequisite for the successful use of eRehabilitation in stroke care [16].

Previous research has also shown that the use of technologies such as eRehabilitation is accurately predicted by healthcare professionals' willingness to use new technologies [24]. In the current study, willingness to use eRehabilitation, rather than the actual use of eRehabilitation, was used as the dependent variable. This was done because most of the patients and healthcare professionals invited to participate in the current study were not using eRehabilitation in their daily rehabilitation practice. Since willingness is an accurate predictor of actual use, the factors identified in the current study may not only influence willingness to use eRehabilitation, but also its actual use. In addition, univariate regression analyses showed no associations between willingness to use eRehabilitation and its prior use. In all, this suggests that willingness to use eRehabilitation is a good predictor of its actual use, but is not changed by prior experience with eRehabilitation.

This study had some limitations. First, patients were approached via email, and not all patients had registered an email address. This may have resulted in a response bias, since patients with an email address may have a different perspective on eRehabilitation compared with those without. Secondly, the limited response rate may have affected the generalizability of the results, since those with an interest in eRehabilitation may have been more willing to participate and may have perceived other barriers and facilitators to the use of eRehabilitation compared with those who did not respond. However, the response rate of the current study is comparable with that in other rehabilitation studies [33, 34], and the age and sex of responders did not differ from those of the non-responders. In addition, the age of our responders may seem low, but the Dutch medical specialist rehabilitation setting does not include geriatric rehabilitation care, which explains why the study sample was relatively young. This may have influenced our finding that age was not a significant factor. Thirdly, regression analyses could not be performed separately for the 3 disciplines of healthcare professionals, due to the small number of participants. In addition, occupational and speech therapists were not included in this study, although they do play an important role in stroke rehabilitation. Since these therapists participated in the previous focus group study, their perspectives were included in the survey, but need to be explored in future studies. The differences found between disciplines in the 5 highest scoring barriers/ facilitators also warrant further research, in which occupational and speech therapists should be included.

CONCLUSION

In conclusion, barriers/facilitators and their association with willingness to use eRehabilitation differ among end-users. This implies that during the development and implementation of eRehabilitation, all end-users must be involved to ensure that eRehabilitation suits users' needs and that their willingness to use it is optimized. Important aspects that should be taken into account during both the development and implementation include motivation to change, feasibility and knowledge about using eRehabilitation. Since beneficial outcomes for patients are important factors in willingness to use eRehabilitation, future research should assess the effectiveness of stroke eRehabilitation, preferably in the context of a blended care strategy.

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Appendix 1

Appendix 1: statements in each factor, for the patients, informal caregivers and healthcare professional

Level	Theme	Item	P	IC	HCP
Innovation	Accessibility	How to use eRehabilitation is taught during therapy in the rehabilitation center	x	x	.
		The eRehabilitation program is accessible for a certain period	x	x	x
		Patients' training results are accessible for a healthcare professional	x	x	x
		The eRehabilitation program is accessible without login in every time	x	x	x
		The eRehabilitation program is accessible offline	x	x	x
		The use of eRehabilitation does not result in many screens	x	x	x
		Logging in is easy	x	x	x
		The possibility to use eRehabilitation on all devices, like tablet or smartphone	x	x	x
	Feasibility	Someone visiting the patient at home in case of problems with hard- or software	x	x	x
		Instruction videos explaining how to use eRehabilitation for healthcare professionals	.	.	x
		A menu with frequently asked questions (FAQ)for healthcare professionals	.	.	x
		Helpdesk via telephone or email is available for patients	x	x	x
		Instructions videos explaining how to use eRehabilitation for patients	x	x	x
		A menu with frequently asked questions (FAQ) for patients	x	x	x
		The content of eRehabilitation can be tailored to the patients' situation	x	x	x
	Attractiveness	Use of pictograms instead of text	x	x	.
		A limited amount of text on one page	x	x	.
		A limited amount of options to click on	x	x	.
		No bright colors	x	x	.
		No flashes	x	x	.
		The possibility to listen to written text	x	x	.
		Reminder sounds in case of notifications (for instance a tinkle)	x	x	.
		Adjustable colors	x	x	.
		Adjustable font and font size	x	x	.
		Adjustable layout	x	x	.
		Adjustable background	x	x	.
		Track physical activities (like walking and sitting) with a device	x	x	x
		Insight in the amount of physical activity (including duration) online	x	x	x
		Insight in what is trained online	x	x	x
		Insight in how many is trained online	x	x	x
		Insight in training results online	x	x	x
		Comparing the training results with other stroke patients	x	x	x
		Insights in goals that are achieve	x	x	x
		Tests giving insight in the recovery after stroke	x	x	x
		Speech exercises for patients with aphasia	x	x	x
		Exercises to train cognitive functioning	x	x	x
		Exercises to train physical functioning	x	x	x
		A module about how to deal with stroke (psycho-education)	x	x	x
		Step-by-step explanation of daily activities (e.g. laying the table)	x	x	x
		Keep track of the body weight	x	x	x
		Keep track of heart rate	x	x	x

Level	Theme	Item	P	IC	HCP
Innovation	Attractiveness	The possibility for patients to read information about stroke	x	x	x
		The possibility for patients to read information about patient association	x	x	x
		Links to website with relevant information about stroke for patients	x	x	x
		The possibility to contact other stroke patients	x	x	x
		The possibility for informal caregiver to contact other informal caregivers	x	x	x
		I can find information about stroke	.	x	.
		I can find information about patient associations	.	x	.
		I can find links to websites relevant for stroke patient	.	x	.
	Privacy	Data safety when sending information and training results from the home address to the rehabilitation center	x	x	x
		A safety label for digital rehabilitation programs like eRehabilitation	x	x	x
	Advantages of use	An agenda including reminders for planned appointments and tasks	x	x	x
		The possibility to make videos of performing exercises, so the execution can be assessed by the healthcare professional	x	x	x
		An agenda including time for planned exercises	x	x	x
		An agenda including appointments with the healthcare professionals	x	x	x
		An agenda including the possibility to ask for an appointment with a healthcare professional	x	x	x
		An agenda including the possibility to make and administer an appointment with a healthcare professional	x	x	x
		An agenda including the possibility to plan own tasks	x	x	.
		Decisions made during a consult are documented and visible for patients	x	x	x
		The possibility to reread information that is discussed during a consult	x	x	.
		Insight in the final reports about the rehabilitation results	x	x	x
		Video calling for contact between patient and healthcare professionals (e-consult)	x	x	x
		Completing questionnaires that give insight in the recovery after stroke	x	x	x
Organizational context	Organization of care	Setting up goals of the rehabilitation therapy with the healthcare professionals	x	x	x
		Evaluating goals of the rehabilitation therapy with the healthcare professionals	x	x	x
		Possibility for the healthcare professionals to check if exercises are performed	x	x	x
		The healthcare professional contacts the patients if he/she exercises too little	x	x	x
		The healthcare professional watches video to assess if exercises are perform correctly at home	x	x	x
		Discussing training results with the healthcare professional during a consult	x	x	x
		The use of eRehabilitation is supported by the healthcare professionals	x	x	x
		Support from family members (informal caregivers) in case of problems	x	x	.
		eRehabilitation is used by the entire multidisciplinary team	.	.	x
		I feel supported from within the organization to use eRehabilitation	.	.	x
		The implementation of eRehabilitation coincides with implementation of other ICT-projects	.	.	x
		Ambassadors (forerunners) in the form of direct colleagues who can answer questions about eRehabilitation	.	.	x
		ICT-problems are solved directly	x	x	x

3

Level	Theme	Item	P	IC	HCP
Organizational context	Resources	There is no need to download special programs to use eRehabilitation	x	x	x
		Problems with the internet connection at home	x	x	x
		Problems with the software of eRehabilitation	x	x	x
		Problems with the devices on which eRehabilitation is used	x	x	x
		Not enough free space at home to practice (2x2 meters)	x	x	.
	Time	I have sufficient time to (learn to how to) use eRehabilitation	x	x	x
Individual patient	Motivation to change	eRehabilitation offers variation in exercises	x	x	x
		Exercises in which it is possible to win or get points (serious games)	x	x	x
		eRehabilitation contributes to the therapy adherence	.	.	x
		I/my partner/my patient wants to use eRehabilitation	.	.	x
		Reduced travel time since eRehabilitation offers the possible to exercise at home	x	x	x
		eRehabilitation offers a way to independently continue therapy after discharge	x	x	x
		Training with eRehabilitation has a positive influence on recovery	x	x	x
		I can ask my healthcare professionals questions about my training results online	x	x	x
		eRehabilitation offers an easy way to contact a professional again after discharge	x	x	x
	Motivation not to change	Less contact between patients because they practice at home more often	x	x	x
		Less direct contact (face-to-face) between patients and healthcare professionals	x	x	.
		Less therapy from healthcare professionals in the rehabilitation center	x	x	x
		There is too little evidence that eRehabilitation can promote recovery after a stroke	x	x	x
	Knowledge	I lack knowledge for the use of eRehabilitation	x	x	.
	Skill	I have insufficient skills to use eRehabilitation	x	x	.
	Patient characteristics	The patient is/I am too tired	x	x	x
		The patient has/I have memory problems	x	x	x
		The patient has/I have cognitive problems	x	x	x
		The patient is/I am over-stimulated	x	x	x
		The patient/I cannot read	x	x	x
		The patient experiences/I experience stress	x	x	.
		The patient is/I am paralyzed half-way	x	x	.
		The patient has/I have problems with vision	x	x	.
		The patient has/I have trouble asking for help in case of problems	x	x	.

Level	Theme	Item	P	IC	HCP
Individual Professional	Motivation to change	Possibility to see what activities a patient has done during a day (including time)	.	.	x
		Insight in how much a patient has trained	.	.	x
		Insight in what a patient has trained	.	.	x
		The training results can be viewed by a patient independently	.	.	x
		The results of the patient can be compared with the results of other stroke patients	.	.	x
		Insight in the patient achieving set goals	.	.	x
	Motivation not to change	My therapy is replaced by eRehabilitation	.	.	x
		I have less direct contact (face-to-face) with my patient	.	.	x
		Time for using eRehabilitation is at the expense of therapy time with the patient	.	.	x
Economic and political context	Financial arrangements	The use of eRehabilitation is not reimbursed by the health insurance	x	x	x

P; patient, IC; informal caregiver, HCP; healthcare professional

3

4

Differences in factors influencing the use of eRehabilitation after stroke: a cross-sectional comparison between Brazilian and Dutch healthcare professionals

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ABSTRACT

Background: To improve the use of eRehabilitation after stroke, the identification of barriers and facilitators influencing this use in different healthcare contexts around the world is needed. Therefore, this study aims to investigate differences and similarities in factors influencing the use of eRehabilitation after stroke among Brazilian Healthcare Professionals (BHP) and Dutch Healthcare Professionals (DHP).

Method: A cross-sectional survey study including 88 statements about factors related to the use of eRehabilitation (4-point Likert scale; 1–4; unimportant-important/disagree-agree). The survey was conducted among BHP and DHP (physical therapists, rehabilitating physicians and psychologists). Descriptive statistics were used to analyse differences and similarities in factors influencing the use of eRehabilitation.

Results: Ninety-nine (response rate 30%) BHP and 105 (response rate 37%) DHP participated. Differences were found in the top-10 most influencing statements between BHP and DHP BHP rated the following factors as most important: sufficient support from the organisation (e.g. the rehabilitation centre) concerning resources and time, and potential benefits of the use of eRehabilitation for the patient. DHP rated the feasibility of the use of eRehabilitation for the patient (e.g. a helpdesk and good instructions) as most important for effective uptake. Top- 10 least important statements were mostly similar; both BHP and DHP rated problems caused by stroke (e.g. aphasia or cognitive problems) or problems with resources (e.g. hardware and software) as least important for the uptake of eRehabilitation.

Conclusion: The results indicate that the use of eRehabilitation after stroke by BHP and DHP is influenced by different factors. A tailored implementation strategy for both countries needs to be developed.

BACKGROUND

The rapid growth of digital health technology [1] provides efficient strategies for delivering rehabilitation while maintaining or improving effectiveness [2]. Therefore, it may offer a solution for the increasing need for care, especially in stroke rehabilitation, where incidence, survival rates and healthcare costs are growing [3]. Digital eRehabilitation programs offers an additional way of delivering conventional rehabilitation and can include physical and cognitive exercise programs, serious gaming, education [4–6] and e-consultations [7], delivered via a variety of information and communication technology (ICT) devices such as a computer, tablet and smartphone. eRehabilitation can be seen as an alternative way of providing all aspects of rehabilitation therapy, including intervention, maintenance activities, consultation, education, and training to clients at a remote location [4]. It can include telerehabilitation (e.g. the provision of rehabilitation services to patients at a remote location using ICT), tablet-based therapy, and the use of commercially available devices like the Nintendo Wii [2, 4, 5, 8–11].

Randomized clinical trials and systemic reviews investigated the effects of eRehabilitation and showed multiple benefits of the use of eRehabilitation. eRehabilitation can decrease stroke-related impairments [5, 8, 9], relieve healthcare professionals from manual labour, make rehabilitation accessible to larger number of stroke patients [2], continue therapy-related cognitive and motor activities during and after discharge [4], decrease chronic disability during and after sub-acute rehabilitation, and facilitate home-therapy [10, 11]. Especially in regions with a paucity of socioeconomic resources and limited access to care, regions with the greatest burden of stroke worldwide [12], culturally relevant eRehabilitation interventions are likely to be the most viable strategy to reduce burden [13].

However, the use of eRehabilitation in daily practice lacks worldwide [14] and the uptake of eRehabilitation is hamper by many factors. This included lack of confidence with hardware or software [15, 16], fear of losing social face-to-face contact [17, 18] and lack of meaningful reimbursement [7, 19]. In order to make eRehabilitation feasible, programs need to be tailored to the patients' needs and sufficient support of a helpdesk for ICT is a prerequisite [20]. Studies performed in western countries concluded that eRehabilitation programs are generally considered feasible [5], however, in low- and middle income countries, future trails on the feasibility are needed [13]. Furthermore, it has been shown that eRehabilitation interventions need to address culture-specific issues in order to be effective [21]. However, eRehabilitation interventions for patients are rarely culturally-adapted [22].

To improve the uptake of eRehabilitation after stroke, the identification of barriers and facilitators influencing this use is needed [22]. Most of the abovementioned research about barriers/facilitators in the use of eRehabilitation is performed in western countries (America, Canada, Australia, Europe), and as far as we know, no research is performed on the differences between western countries and other regions. Therefore, the aim of this paper is to describe the differences and similarities in factors influencing the use of eRehabilitation after stroke between Brazil and the Netherlands, countries with different cultures and healthcare systems.

METHODS

To identify differences and similarities in factors influencing the use of eRehabilitation after stroke between Brazilian and Dutch healthcare professionals, cross-sectional study conducted in a medical specialist rehabilitation setting involved a one-time cross-sectional online survey. This survey was developed based on the results of a preceding focus group study [23] and was conducted among Brazilian healthcare professionals (BHP) and Dutch healthcare professionals (DHP) working in stroke rehabilitation. The COREQ guidelines were used for adequate design of the focus groups [24] and STROBE statements were used for adequate sampling, analyses and reporting of the survey [25].

1. Setting

1. 1 Brazil

Brazil has 209 million inhabitants, of which 70% has internet access. Brazil has a population density of 25 inhabitants/ km^2 and gross domestic product of 8.2 US dollar/inhabitant. Data from a national prospective study indicate an annual incidence of 108 cases per 100,000 inhabitants. Stroke Care Guidelines are established involving pre-hospital treatment, intervention in acute stroke, and follow-up at rehabilitation centres [26, 27]. Rehabilitation can take place on an outpatient basis, an inpatient basis, or during hospitalization. In all settings, interventions are delivered by multidisciplinary teams working in an interdisciplinary manner with active patient participation and family inclusion. Specialized professionals include physicians, nurses, social workers, physical therapists, occupational therapists, speech therapists, psychologists, hospital educators, physical education instructors, and nutritionists. The treatment and rehabilitation process are free of charge; the national health budget covers all costs.

1.2 Netherlands

The Netherlands have 17 million inhabitants, of which 95% has internet access. The Netherlands has a population density of 507 inhabitants/km^2 and a gross domestic product of 56.4 US dollar/inhabitant. The annual incidence of stroke in the Netherlands was estimated 107 cases per 100,000 inhabitants [28]. Incidence and mortality rates decline as a result of better and faster treatment [29] and stroke burden in terms of the absolute number of people affected by stroke increase [30]. About 10% of the stroke survivors follow multidisciplinary in or out-patient rehabilitation in a medical specialist rehabilitation setting [31], including physiotherapy, speech therapy, occupational therapy, psychology and a social worker, coordinated by a rehabilitation physician [32]. A rehabilitation plan is made and evaluated during weekly team meetings, and patients and family are involved if needed. Rehabilitation consisted of individual and group exercise [32]. Six months after stroke, on average 60% of the patients are community living again [33]. Most costs are reimbursed by the healthcare insurance provider, with out of pocket costs for the patients of maximum €885,-.

2. Study population

Inclusion criteria for both BHP and DHP were 1) at least 2 years of working experience in a multidisciplinary stroke team and 2) still actively treating stroke patients. Invited BHP included neurologists, physical therapists, occupational therapists, psychologists, nurses, social workers, speech therapists, hospital educators, and physical educators from the SARAH Network of Rehabilitation Hospitals. BHP working with stroke patients were invited via internal communication within SARAH, a network that has nine rehabilitation centres throughout Brazil. Invited DHP included rehabilitation physicians, psychologists and physical therapists. DHP were identified using a Dutch medical address book including contact information of most healthcare professionals in the Netherlands, across the country. Since the participating countries are geographically far apart from each other, it was esteemed unlikely that one person could receive both the Brazilian and Dutch invitation, but this is not impossible. All eligible healthcare professionals (both Brazilian and Dutch) received an invitation email including a link to the online survey, in Dutch to the DHP (June 2016) and in Portuguese to the BHP (October 2017). Non-responders received two reminders, first after 2 weeks and second after 4 weeks that and the survey was available for 5 months.

3. Survey development and content

To develop the survey, eight focus groups were organized with both patients/informal caregivers and healthcare professionals (details about the analysis and results are published elsewhere [23]). Focus groups were used to collect a broad spectrum of possible factors influencing the use of eRehabilitation, including attitudes, experiences and expectations of the healthcare professionals [34]. In this, eRehabilitation is the use of ICT to deliver conventional rehabilitation care and can be used to support therapy related activities, like physical and cognitive exercises, education and communication. Thirteen DHP working in stroke rehabilitation participated, including rehabilitation physicians (n = 4, 31%), physical therapists n = 3, 23%), occupational therapists (n = 3, 23%), psychologists (n = 1, 8%), speech therapists (n = 1, 8%), and managers (n = 1, 8%).

All focus groups were audiotaped and transcribed in full in Dutch. The transcripts were qualitatively analysed using directed content analysis, in which the researchers used a theory or relevant research findings as guidance for initial code [35], in this case the implementation model of Grol and Wensing [36]. This model was chosen because it provides a framework for identifying and categorizing factors that influence the use of innovations in healthcare [36]. A total of 88 barriers/facilitators that impact the use of eRehabilitation were identified. Those were grouped into fourteen factors, divided at five levels of Grol (Table 1); the innovation (e.g. content of eRehabilitation, feasibility, accessibility), the organisational context (e.g. tasks and responsibilities of involved end-users, time and resources), the individual patient (e.g. skills, knowledge, motivation the change and patient characteristics), the individual professional (e.g. skill, knowledge, motivation to change) and the financial arrangements (e.g. insurance).

To prioritize all barriers/facilitators identified in the focus groups, a survey was conducted in the Netherlands and Brazil. The survey included questions about personal characteristics and statements about barriers/facilitators influencing the use of eRehabilitation. The questionnaire (Additional file 1) was specifically developed for an overarching research project to identify factors influencing the use of eRehabilitation. Results of a study concerning only Dutch responses were published elsewhere [20].

3.1 Socio-demographic-, disease- and work-related characteristics

The survey started with the question 'Are you working with stroke patients?' If not, the survey was ended. If 'yes', 12 questions followed regarding age, gender, work setting (primary care/rehabilitation centre/general hospital), years of work experience, number of new stroke patients per month and their current use of eRehabilitation (no, yes; if yes: exercises/games/information).

3.2 Influencing barriers/facilitators

Each potential barrier/facilitator identified in the focus group study was translated into a neutral statement. A total of 88 statements were formulated based on the transcripts of the focus groups. The influence for the use eRehabilitation of each statement was rated on a 4-point Likert scale (1 = unimportant, 2 = somewhat unimportant, 3 = somewhat important, 4 = important or 1 = disagree, 2 = partly disagree, 3 = partly agree, 4 = agree).

Table 1. Results of two focus groups; factors influencing the use of eRehabilitation

Level	Factor	Sub-factor
Innovation	Accessibility	Time frame in which eRehabilitation is accessible
		Devices on which eRehabilitation is accessible
	Feasibility	Helpdesk function
		Tailored to patients' situation
	Attractiveness	Ease of use of eRehabilitation
		Content of eRehabilitation program
	Privacy	Privacy and safety of patient data
	Advantages of use	Added value of innovation offered
Organizational context	Organization of care	Tasks and responsibilities healthcare professional
		Tasks and responsibilities informal caregiver
		Tasks and responsibilities organization
	Resources	Software
		Hardware
	Time	Time
Individual patients	Motivation to change	Reasons to use eRehabilitation for patients
	Motivation not to change	Reasons not to use eRehabilitation for patients
	Patient characteristics	Impairments after stroke
Individual professional	Motivation to change	Reasons to use eRehabilitation
	Motivation not to change	Reasons not to use eRehabilitation
Economic & political context	Financial arrangements	Insurance

The survey was tested in a pilot among three DHP (2 males, 2 physical therapists, 1 occupational therapist, mean age 38 years old, mean working experience 13.3 years). The survey was tested for feasibility, legibility, readability and presentation (e.g., perceived statement difficulty, response errors, etc.). Testing led to small changes in the phrasing and layout.

The survey was based on the results focus groups in the Netherlands and developed in Dutch. For the BHP, the survey was translated by a qualified Portuguese language translator. First, the Dutch version was translated into English by the translation agency *Attached Language* and the translation was discussed in the project team leading to minor changes. Subsequently, the English version was translated into Portuguese and was tested by two Portuguese project members. Differences were discussed and adaptations were made in three rounds until the Portuguese questionnaire was similar to the original Dutch version.

4. Data analysis

Participants who completed >90% of the survey were included in the analysis, which was executed using Statistical Packages for the Social Sciences (IBM SPSS 22.0), and no imputations were done for missing data. Personal characteristics were analysed using descriptive statistics. T-test or Pearson Chi-square test was used to compare age, gender, number of new patients, work experience and the use of eRehabilitation between BHP with DHP.

Based on the median score, all statements influencing the use of eRehabilitation were given a ranking (lowest number equals large influence), separately for the BHP and DHP. For the statements with a similar median, definite ranking was based on the mean. The top-ten most and least influencing statements were noted and differences in ranking were calculated to describe the level of agreement among DHP and BHP. The ranking of all statements for both the DHP and BHP were plotted on a scatterplot, including a 95% confidence interval (CI). Additionally, these analyses were performed with only the disciplines included both in the Netherlands and Brazil (i.e. physical therapists, psychologists and physicians).

5. Ethical issues and approval

All participants gave written informed consent prior to participation. Data were collected and analysed anonymously. This study was approved by the Medical Ethical Review Board of the Leiden University Medical Centre [P15.281] and the Medical Ethics Board of SARAH Network of Rehabilitation Hospitals.

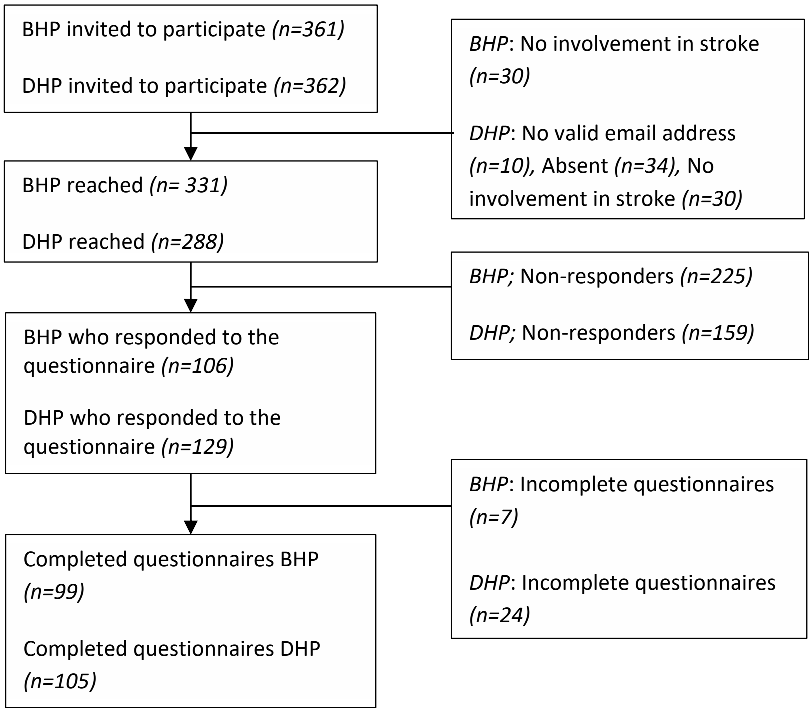

Figure 1. Flowchart

RESULTS

Study population

Of the 361 invited BHP, 331 were reached and 99 responded (response rate 30%); of the 362 invited DHP 288 were reached and 105 responded (response rate 37%). Thirty (8.3%) of the BHP and 30 (10%) DHP did not work with stroke patients and were therefore excluded from the analyses (Figure 1). Table 2 shows that BHP and DHP did not differ significantly in age (40.0 (SD 6.4) and 42.0 (SD 10.5) years old, respectively), gender (n = 21 (21%) and n = 25 (24%) male, respectively), work experience (15.6 (SD6.2) and 14 (SD10) years, respectively) and previous use of eRehabilitation (n = 50 (50%) and n = 40 (38%) respectively). BHP had significantly more new patients each month compared to the DHP (p = 0.00). DHP included physical therapists (n = 41, 39%), psychologists (n = 14, 13%) and physicians (n = 47, 45%), BHP included physical therapists (n = 14, 14%), psychologists (n = 12, 12%), physicians (n = 10, 10%); additionally, nurses (n = 28, 26%), hospital educators (n = 3, 3%), physical education teachers (n = 10, 10%) and neurologists (n = 5, 5%).

Most and least influencing statements

Tables 3 and 4 show the ten most and ten least influencing statements for DHP and BHP to use eRehabilitation after stroke. In the top-10 most influencing factors, four statements were found for both BHP and of DHP, and twelve statements were found in the top-10 of only one group (Table 3). The six statements found for only BHP were related to the factor Patient Motivation to Change (i.e., improved therapy adherence and health outcomes) and the Organization of Care (i.e., sufficient time and support from the organization); the six statements found for only DHP were mostly related to the factor Feasibility of eRehabilitation (like a helpdesk and support).

On the other hand, the statements that BHP and DHP considered not influencing the use of eRehabilitation were comparable, with eight statements found in the top-10 of both BHP and DHP. Factors that did not influence eRehabilitation use were related to the factor Patient characteristics (i.e., cognitive and physical disability or aphasia) and the factor Resources (i.e., problems with the internet connection or hard- and software).

The abovementioned analyses were also performed including only the disciplines that were represented in both countries (i.e. physical therapists, rehabilitation physicians and psychologists), resulting in comparable findings. Only the two statements 'Problems with the devices on which eRehabilitation is used' and 'Problems with the internet connection' were not found in the top-ten least influencing statements of this sub-analysis; the top-ten most influencing statements was fully comparable with the results of the all respondents (Table 3 and Table 4).

Table 2. Characteristics of Brazilian and Dutch healthcare professionals participating in the survey study

Characteristics	BHP (n=99)	DHP (n=105)
Age, years (mean, SD)	40.0 (6.4)	42.0 (10.5)
Sex, (n male, %)	21 (21)	25 (24)
Work experience, years (mean, SD)	15.6 (6.2)	14.0 (10.0)
Number of new patients per month (mean, SD)	**13.5 (9.5)**	**8.0 (8.9)**
Discipline, (n, %)		
Physical therapist	14 (14)	41 (39)
Psychologist	12 (12)	14 (13)
Physician	10 (10)	47 (45)
Nurse	28 (26)	.
Occupational therapist	3 (3)	.
Hospital-based educator	3 (3)	.
Physical education instructor	10 (10)	.
Neurologist	5 (5)	.
Other*	14 (14)	3 (3)
Work setting** (n, %)		
Health centre in primary care	.	10 (10)
Rehabilitation centre	97 (97)	75 (71)
Hospital	4 (4)	34 (32)
Use of digital rehabilitation tools (n yes, %)	50 (50)	40 (38)

BHP; Brazilian healthcare professional, DHP; Dutch healthcare professional
In bold significant differences between BHP and DHP (p-value=0.00)
* Occupational therapist, Speech therapist, Nutritionist, Social worker, **Multiple answers possible

Table 3. Statements with the most influence on the use of eRehabilitation

Statement *I would use eRehabilitation, if…*	Factor	Barrier/ facilitator	Brazil (n=99)		Netherlands (n=105)	
			Median (IQR)	Ranking	Median (IQR)	Ranking
It contributes to the patient's therapy compliance	Patient motivation to change	F	4 (4-4)*	1	4 (4-4)	8
eRehabilitation has a positive influence on recovery	Patient motivation to change	F	4 (4-4)*	2	4 (4-4)	2
I can tailor the content of eRehabilitation to the patient's personal situation	Feasibility	F	4 (4-4)*	3	.	12
I have time to (learn to) use eRehabilitation	Organization of care	F	4 (4-4)*	4	.	21
I feel supported from within the organization to use eRehabilitation	Organization of care	F	4 (4-4)*	5	.	32
eRehabilitation offers a way to independently continue therapy after discharge	Patient motivation to change	F	4 (4-4)*	6	.	15
ICT-problems are solved directly	Organization of care	F	4 (4-4)*	7	4 (4-4)	7
Logging on is easy	Accessibility	F	4 (4-4)*	8	4 (4-4)	3
My patient wants to use eRehabilitation	Patient motivation to change	F	4 (4-4)*	9	.	11
Exercises to train cognitive functioning#	Attractiveness	F	4 (4-4)*	10	.	55
A helpdesk is available for patients	Feasibility	F	.	13	4 (4-4)	1
Video instructions on how to use eRehabilitation are available for patients	Feasibility	F	.	17	4 (4-4)	4
A menu with frequently asked questions (FAQ) for patients	Feasibility	F	.	21	4 (4-4)	5
The patient can read information about stroke	Feasibility	F	.	19	4 (4-4)	6
Decisions made during a consult are documented and visible for patients#	Advantage of Use	F	.	67	4 (4-4)	9
Insights in goals that are achieve	Attractiveness	F	.	24	4 (3-4)	10

· = no part of most influencing statements, B; barrier, F; facilitator, IQR; Interquartile range
*In the top-ten when only physical therapists, rehabilitation physicians and psychologist are included
Outside 95%Confidence interval in scatterplot, see Figure 2

Table 4: Statements with the least influence on the use of eRehabilitation

Statement *I would not use eRehabilitation, if…*	**Factor of Grol**	**Barrier/ facilitator**	**Brazil (n=99)**		**Netherlands (n=105)**	
			Median (IQR)	**Ranking**	**Median (IQR)**	**Ranking**
The patient has too many physical disabilities after stroke	Patient characteristic	B	2 (1-2)*	88	1 (1-2)	88
The patient has too much aphasia after stroke	Patient characteristic	B	2 (1-2)*	87	2 (1-2)	87
I believe that there will be problems with software	Resources	B	2 (1-3)*	86	.	76
There is too little scientific evidence for the effectiveness of eRehabilitation	Professional motivation not to change	B	2 (1-3)*	85	2 (2-3)	82
Implementation of eRehabilitation simultaneously with other ICT projects	Organization of care	B	2 (2-3)*	84	.	74
The patient has too many cognitive disabilities after stroke	Patient characteristic	B	2 (2-3)*	83	2 (2-3)	85
The patient has visual problems	Patient characteristic	B	2 (2-3)*	82	2 (2-3)	80
Problems with the devices on which eRehabilitation is used	Resources	B	3 (1-4)	81	3 (1-3)	79
Problems with the internet connection	Resources	B	3 (1-4)	80	3 (1-3)	81
The patient cannot compare his/her results with the scores of other stroke patients	Attractiveness	F	3 (2-3)*	79	2 (1-3)	86
I cannot compare patients results with the scores of other stroke patients	Attractiveness	F	.	74	2 (2-3)	84
The healthcare professional contacts the patients if he/she exercises too little	Organization of care	F	.	70	2 (2-3)	83

· = no part of least influencing statements, B; barrier, F; facilitator, IQR; Interquartile range
*In the top-ten when only physical therapists, rehabilitation physicians and psychologist are included

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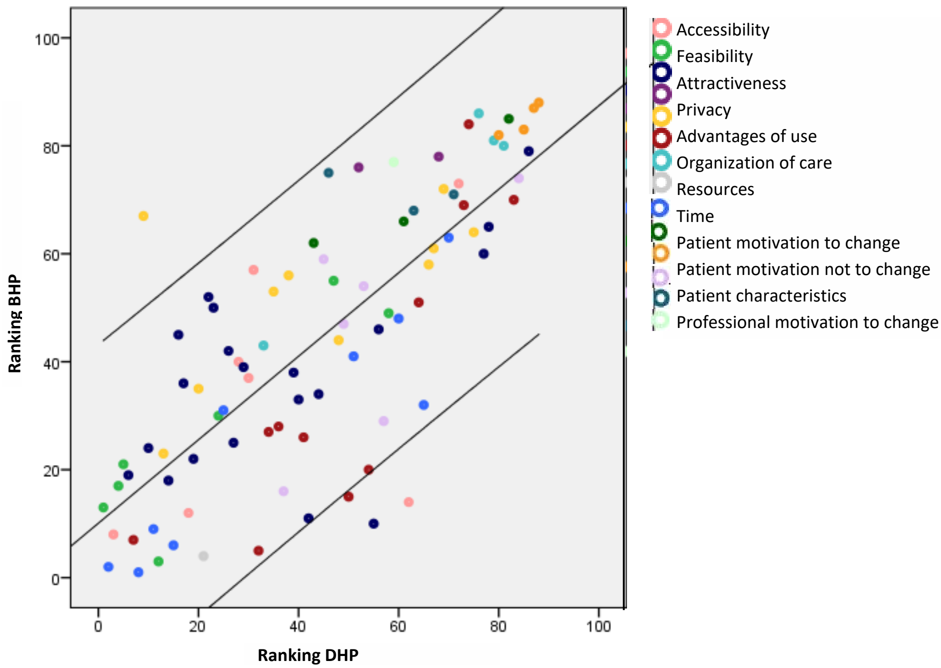

Figure 2. Scatterplot of the ranking of all statements for the Brazilian healthcare professionals (BHP) and Dutch healthcare professionals (DHP); lower values are statements with more influence.

Difference and similarities in ranking

The difference in ranking for the BHP and DHP was calculated for each statement (Additional file 1). The mean absolute difference in ranking between BHP and DHP was 11.2 (SD 15.9, range 0–58). In Fig. 2, the ranking of the Brazilian responses is plotted against the Dutch responses. Four statements were found outside the 95% CI. BHP reported the following statements more frequently as important than DHP: 1) 'The eRehabilitation program is accessible offline', 2) 'Exercises to train cognitive functioning' and 3). 'eRehabilitation is used by the entire multidisciplinary team'. DHP reported the following statement more frequently as important than BHP: 'Decisions made during a consult are documented and visible for patients.' Two of those statements (the second and fourth) were found in the top-10 most influencing statements of respectively BHP and DHP (Table 3).

For the majority of the factors, the statements constituting that factor were spread out on a broad range of the scatterplot, with at least one statement within the 20 most and one statement in the 20 least influencing statements (Additional file 1 and Figure 2). Only the statements constituting the factors Resources, Patient Motivation not to change and Patient characteristics were found only with a low influence.

DISCUSSION

In this study, we investigated differences and similarities in factors influencing the use of eRehabilitation after stroke among healthcare professionals from Brazil and the Netherlands. The statements with the highest influence on the use of eRehabilitation differed between BHP and DHP; BHP agreed more with factors related to the benefits for the patients and organizational constrains, DHP agreed more with factors related to the feasibility of the use of eRehabilitation. The statements with the least influence on the use of eRehabilitation were comparable for BHP and DHP, and were related to patient characteristics and resources. This means that BHP and DHP indicate that the use of eRehabilitation is influenced by different factors and tailored implementation strategies for both countries need to be developed separately [22].

For BHP, and with a lesser frequency for DHP, the factor Motivation to change was important. Benefits of the use of eRehabilitation were found important before, including the possibility to train at home [37], independently continue therapy activities [4] and easily accessible contact with a healthcare professional after discharge or during outpatient therapy [17, 38]. For BHP, time and support for the healthcare professional from the organization is also important. Facilitating conditions, including time, communication and education, was found to be an important facilitating factor in the use of eRehabilitation after stroke before [38, 39]. For DHP, a thorough helpdesk delivering support for patients and healthcare professional is crucial. This is in line with a review of Pugliese (2018) concluding that the most reported patient barrier was following instructions about how to use the device [40].

Concerning the content of the eRehabilitation intervention, for the BHP speech and cognitive exercisers are important, were the DHP focus on physical exercises, and offline accessibility seems important in Brazil but not in the Netherlands. For the DHP it is important that decisions that were made during a consult are incorporated in the eRehabilitation intervention. Therefore it can be concluded that not only the implementation strategy should be adapted to the wishes of the end-users [17], but also the eRehabilitation intervention.

Most factors were constructed of statements that were spread over a broad ranking and included both statements influencing and non-influencing the use of eRehabilitation. So some differences might remain hidden at factor level, since statements within a factor compensate for each other, differences can be found at statement levels. Therefore, it is important to investigate barriers/facilitators for the implementation of eRehabilitation in detail rather than on the level over overarching factors.

Although our study revealed some important differences and similarities among Brazilian and Dutch healthcare professionals, the results have to be interpreted with care due to some limitations. First, only 36% of the BHC were physical therapists, psychologists and rehabilitation physicians; i.e. the disciplines invited in the Netherlands. However, when only the responses of the Brazilian physical therapists, psychologists and rehabilitation physicians were taken into account, the results of the analyses were comparable with the results of all BHPs. Therefore, it seems plausible that differences are caused by the various contexts and not by the specific professional backgrounds of the respondents. Second, the

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response rate of 30–37% in our study may have led to response bias because those who responded to the invitation to participate in the survey were probably more interested in eRehabilitation. As a consequence, the perspective of end-users with less interest in and experience with eRehabilitation might be missing. A third limitation is that the survey statements were based on the results of focus groups performed in the Netherlands. Consequently, we might have missed factors influencing the use of rehabilitation in Brazil that are not present in the Netherlands. However, the developed survey covered all levels of the framework of Grol and showed high amount of saturation (e.g. for two consecutive focus groups, no new factors were found), which reduces the chance of missing potentially important factors. At last, the generalizability of our results beyond the Netherlands and Brazil may be limited. The countries involved differed a lot on important factors (e.g. income and demographics), which is crucial for the development of a successful implementation strategy. It may be assumed that other counties will differ as well, which should be further investigated.

CONCLUSION

Important differences were found in factors influencing the use of eRehabilitation after stroke between BHP and DHP. For BHP, the use of eRehabilitation after stroke was most influenced by support from the rehabilitation organization and the potential benefits of the use of eRehabilitation. For DHP, the feasibility of the use of eRehabilitation for the patient was most influential. Implementation strategies should incorporate those differences, including an eRehabilitation intervention adapted to the wishes of the end-users. Statements with low influence, such as problems caused by patient characteristics after stroke or problems with resources, were comparable for both groups and should have less priority in the implementation strategies. More research about differences between disciplines in Brazil and the generalizability of those results for other countries is needed.

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Appendix 1: Ranking of the importance of the statements based on the median and mean, for Brazilian and Dutch healthcare professionals

Level	Theme	Statement	BHP	DHP	Diff.
Innovation	Accessibility (n=7)	The eRehabilitation program is accessible for a certain period	73	72	1
		Logging in is easy	8	3	5
		The possibility to use eRehabilitation on all devices (i.e.tablet, smartphone)	12	18	6
		Patients' training results are accessible for a healthcare professional	37	30	7
		The use of eRehabilitation does not result in many screens	40	28	12
		The eRehabilitation program is accessible without login in every time	57	31	26
		The eRehabilitation program is accessible offline	14	62	48
	Feasibility (n=7)	A helpdesk via telephone or mail is available for healthcare professionals	30	24	6
		A menu with frequently asked questions (FAQ)for healthcare professionals	55	47	8
		Instruction videos explaining healthcare professionals how to use eRehabilitation	49	58	9
		The content of eRehabilitation can be tailored to the patients' situation	3	12	9
		Helpdesk via telephone or email is available for patients	13	1	12
		Instructions videos explaining how to use eRehabilitation for patients	17	4	13
		A menu with frequently asked questions (FAQ) for patients	21	5	16
	Attractiveness (n=20)	Insight in what is trained online	38	39	1
		Insight in training results online	25	27	2
		A module about how to deal with stroke (psycho-education)	22	19	3
		The possibility for patients to read information about patient association	18	14	4
		Comparing the training results with other stroke patients	79	86	7
		Tests giving insight in the recovery after stroke	33	40	7
		Track physical activities (like walking and sitting) with a device	46	56	10
		Insight in how many is trained online	39	29	10
		Step-by-step explanation of daily activities (e.g. laying the table)	34	44	10
		Keep track of the body weight	65	78	13
		The possibility for patients to read information about stroke	19	6	13
		Insights in goals that are achieve	24	10	14
		Insight in the amount of physical activity (including duration) online	42	26	16
		Keep track of heart rate	60	77	17
		Links to website with relevant information about stroke for patients	36	17	19
		The possibility to contact other stroke patients	50	23	27
		Exercises to train physical functioning	45	16	29
		The possibility for informal caregiver to contact other informal caregivers	52	22	30
		Speech exercises for patients with aphasia	11	42	31
		Exercises to train cognitive functioning	10	55	45
	Privacy (n=2)	Data safety when sending information and training results from the home address to the rehabilitation center	76	52	24
		A safety label for digital rehabilitation programs like eRehabilitation	78	68	10

Level	Theme	Statement	BHP	DHP	Diff.
Innovation	Advantages of use (n=10)	Video calling for contact between patient and healthcare professionals (e-consult)	72	69	3
		An agenda including time for planned exercises	44	48	4
		An agenda including the possibility to ask for an appointment with a healthcare professional	61	67	6
		The possibility to make videos of performing exercises, so the execution can be assessed by the healthcare professional	58	66	8
		An agenda including reminders for planned appointments and tasks	23	13	10
		An agenda including the possibility to make and administer an appointment with a healthcare professional	64	75	11
		An agenda including appointments with the healthcare professionals	35	20	15
		Insight in the final reports about the rehabilitation results	56	38	18
		Completing questionnaires that give insight in the recovery after stroke	53	35	18
		Decisions made during a consult are documented and visible for patients	67	9	58
Organizational context	Organization of care (n=11)	ICT-problems are solved directly	7	7	0
		Possibility for the healthcare professionals to check if exercises are performed	69	73	4
		goals of the rehabilitation therapy with the healthcare professionals	27	34	7
		Evaluating goals of the rehabilitation therapy with the healthcare professionals	28	36	8
		The implementation of eRehabilitation coincides with implementation of other ICT-projects	84	74	10
		The healthcare professional contacts the patients if he/she exercises too little	70	83	13
		The healthcare professional watches video to assess if exercises are perform correctly at home	51	64	13
		Discussing training results with the healthcare professional during a consult	26	41	15
		I feel supported from within the organization to use eRehabilitation	5	32	27
		Ambassadors (forerunners) in the form of direct colleagues who can answer questions about eRehabilitation	20	54	34
		eRehabilitation is used by the entire multidisciplinary team	15	50	35
	Resources (n=4)	There is no need to download special programs to use eRehabilitation	43	33	10
		Problems with the internet connection at home	80	81	1
		Problems with the software of eRehabilitation	86	76	10
		Problems with the devices on which eRehabilitation is used	81	79	2
	Time (n=1)	I have sufficient time to (learn to how to) use eRehabilitation	4	21	17

Level	Theme	Statement	BHP	DHP	Diff.
Individual patient	Motivation to change (n=9)	Training with eRehabilitation has a positive influence on recovery	2	2	0
		My patient wants to use eRehabilitation	9	11	2
		eRehabilitation offers variation in exercises	31	25	6
		eRehabilitation contributes to the therapy adherence	1	8	7
		I can ask my healthcare professionals questions about my training results online	63	70	7
		eRehabilitation offers a way to independently continue therapy after discharge	6	15	9
		Reduced travel time since eRehabilitation offers the possible to exercise at home	41	51	10
		Exercises in which it is possible to win or get points (serious games)	48	60	12
		eRehabilitation offers an easy way to contact a professional again after discharge	32	65	33
	Motivation not to change (n=3)	There is little scientific evidence for the effectiveness of eRehabilitation	85	82	3
		give patients false hope that the continuation of exercising is useful while it is not	66	61	5
		Less contact between patients because they practice at home more often	62	43	19
	Patient characteristics (n=4)	The patient has physical problem	88	88	0
		The patient has aphasia	87	87	0
		The patient has cognitive problems	83	85	2
		The patient has visual problems	82	80	2
Individual Professional	Motivation to Change (n=6)	Possibility to see what activities a patient has done during a day (including time)	59	45	14
		Insight in how much a patient has trained	54	53	1
		Insight in what a patient has trained	29	57	28
		The training results can be viewed by a patient independently	47	49	2
		The results of the patient can be compared with the results of other stroke patients	74	84	10
		Insight in the patient achieving set goals	16	37	21
	Motivation not to change (n=3)	My therapy is replaced by eRehabilitation	68	63	5
		I have less direct contact (face-to-face) with my patient	71	71	0
		Time for using eRehabilitation is at the expense of therapy time with the patient	75	46	29
Eco & pol	Fin. Ar (n=1)	The use of eRehabilitation is not reimbursed by the health insurance	77	59	18

BHP; Brazilian Healthcare Professionals; DHP; Dutch Healthcare professionals; Diff.: Difference Eco & pol; Economical and political context. Fin. Ar.; Financial arrangements

5

The effect of a comprehensive eRehabilitation intervention alongside conventional stroke rehabilitation, on disability and health-related quality of life: a pre-post comparison

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ABSTRACT

Objective: This study compared the effect of conventional rehabilitation (control group; CG) with an individualized, tailored eRehabilitation intervention alongside conventional rehabilitation (Fast@home; intervention group; IG) on disability and quality of life, in people with stroke.

Method: Pre-post design. The intervention comprised cognitive (Braingymmer®) and physical (Telerevalidatie®/Physitrack®) exercises, activity-tracking (Activ8®) and psycho education. Assessments were done at admission (T0) and after 3 (T3) and 6 months (T6). The primary outcome concerned disability (Stroke Impact Scale, SIS) and secondary outcomes measures of health-related quality of life, fatigue, self-management, participation and physical activity. Change scores between T0-T3, T3-T6 and T0-T6 were compared by analysis of variance and linear mixed models.

Results: 153 and 165 people with stroke were included in CG/IG, respectively. In the IG, 82 (50%) people received the intervention, of whom 54 (66%) used it. Between T3-T6, the change scores of the SIS subscales Communication (CG/IG; -1.7/-0.3) and Physical strength (-5.7/3.3) were significantly greater in the total IG (all mean differences < minimally clinically important differences). No significant differences for other SIS subscales or secondary outcomes, nor between T0-T3 and T0-T6 were seen.

Conclusion: eRehabilitation alongside conventional stroke rehabilitation had a small effect on communication and physical strength on the longer term.

INTRODUCTION

Worldwide, about 9 million people experience a stroke each year, in many leading to a broad range of long-term disabilities with a major impact on multiple areas of life [1]. More than half of the people with stroke suffer from physical, mental and/or cognitive impairments six months post-stroke [2,3]. In order to enhance recovery of limitations, people with stroke may be referred to inpatient or outpatient specialized rehabilitation facilities offering multidisciplinary treatment [4]. In the Netherlands, about 10% of the people with stroke are admitted to such facilities, mostly those with severe disability and the potential for recovery [5].

During the last decade there is an increasing interest in the use of digital technologies to deliver rehabilitation, addressed as eRehabilitation, in specialized rehabilitation facilities. Examples of eRehabilitation applications relevant for stroke rehabilitation are virtual reality [6], online communication and consultation [7,8] and applications for the delivery of specific physical or cognitive exercises [9]. A number of systematic reviews on eRehabilitation in stroke, published in the past 10 years, assessed their effectiveness within the first six months after stroke, and concluded that these applications may result in increased access to care [9] and time spent on therapy related activities [6]. Moreover, improved healthcare outcomes, like walking speed, balance and mobility [6], cognition and mood [8] and health-related quality of life [7], were found.

So far, most studies on eRehabilitation in stroke focused on interventions targeting only one domain of rehabilitation treatment [9]. In daily practice however, people with stroke face multiple and distinct problems. Therefore, different applications may be useful at the same time. Yet, making an appropriate selection and handling different ways of access are only two of the many challenges people with stroke and healthcare professionals are facing in the use of eRehabilitation. Integrating a selection of various eRehabilitation applications within one combined intervention would greatly increase their user-friendliness, especially if the selection made appropriately addresses the needs of the individual patient [10].

Evidence on the effectiveness of such comprehensive eRehabilitation interventions, combining eRehabilitation applications covering more than one domain of early rehabilitation treatment, is scarces. Three controlled clinical trials combined multiple applications in one intervention, i.e. online exercise programs with activity tracking or stroke-related education [11-13]. All three studies compared a comprehensive eRehabilitation intervention with conventional rehabilitation, showing equal effect with respect to improvement of motor function and knowledge about stroke [11-13]. However, none of these studies included people with stroke admitted to a specialized rehabilitation facility [14], nor did they explore the effects of eRehabilitation when integrated in conventional rehabilitation service delivery. The latter is striking, as it is suggested that eRehabilitation should preferably be offered alongside conventional stroke rehabilitation to achieve its full potential [15].

Therefore, the present study aimed to compare the effect of a comprehensive eRehabilitation intervention, Fit After STroke @home (Fast@home), consisting of different components offered in addition to conventional stroke rehabilitation in a specialized rehabilitation facility on disability and health-related quality of life.

METHOD

1. Design and setting

This pre-post test controlled pragmatic clinical trial was conducted at two rehabilitation centres, Basalt The Hague/Leiden, The Netherlands. Two groups were compared; the control group (CG; May 2016 – April 2017) receiving only conventional stroke rehabilitation and the intervention group (IG; May 2017 – April 2018) receiving Fast@Home alongside conventional rehabilitation. Data were gathered in an ongoing, observational study, Stroke Cohort Outcomes of REhabilitation (SCORE; Dutch Trial Register no. 4293). Assessments were done at admission (T0), and three (T3) and six months (T6) after admission and the assessors were not blinded.

The SCORE-study was approved by the Medical Ethics Review Committee (protocol NL46531.058.13) of the Leiden University Medical Center. All participants gave written informed consent. Details and results of SCORE are published elsewhere [16-19]. Reporting of the current study was done according to the STROBE Checklist [20], the description of the intervention was done according to the TIDieR Checklist [21].

2. Participants

Inclusion criteria were: age above 18 years and first ever/recurrent stroke less than six months ago. Exclusion criteria were severe psychiatric conditions; unable to communicate in Dutch; concurrent acquired brain injury and/or drug or alcohol abuse. At admission, the treating rehabilitation physician checked the criteria. Eligible people with stroke were informed by the research team within two weeks. All people included in the SCORE-study between May 2016 and April 2018 were considered eligible for the current analysis on the effect of eRehabilitation. From May 2017, the intervention was implemented in conventional rehabilitation. In rare cases, Fast@Home had already started before inclusion in the study was accomplished. People were excluded if they used the intervention seven or more days before T0.

2.1 Conventional Rehabilitation

During the control and intervention periods, people with stroke received conventional rehabilitation according to a national guideline [22]. Treatment was provided by a multidisciplinary team including a rehabilitation physician (RP), physical therapist (PT), occupational therapist (OT), speech therapist, psychologist and social worker. Rehabilitation treatment could focus on improving motor, cognitive/psychological function, speech, or participation. Conditional on the severity of impairments and living situation, inpatient or outpatient rehabilitation was provided [23].

Box 1: The Fast@home intervention

Fast@home is a web-based eRehabilitation intervention developed to support stroke patients, their informal caregivers and healthcare professionals during inpatient and outpatient rehabilitation and after discharge, and is developed in co-creation with patients, informal caregivers and healthcare professionals (10,24). The mobile application was field tested among a small number of patients before the study started, resulting in a small number of practical adaptations.

Fast@home included the following commercially available eRehabiliation applications (see also figure):

- Physical exercise program, offered by Telerevalidatie (Roessingh Research & Development, Enschede, Netherlands, www.telerevalidatie.nl, used in Basalt Leiden) or Physitrack (Physitrack Limited, London, Great Britain, www.physitrack.com, used in Basalt Den Haag). Exercises for all parts of the body were available and aimed to improve strength, balance, coordination, mobility, stability, speech or aerobic capacity. The exercises were explained by videos within the physical exercise program. A tailored day-to-day schedule for each participating patient could be compiled by the treating physical and/or occupational therapist including a selection of one or more exercises.

- Cognitive exercise program, offered by Braingymmer (Dezzel Media, Almere, Netherlands). Every day, each patient could perform three exercises of 300 seconds, on the domains concentration, logic, perception, memory and velocity.

- Physical activity tracker (Activ8 consumer, 2M Engineering, Valkenswaard, Netherlands, www.activ8all.com). This tracker was worn inside a pocket of jeans and measured the time spent on laying, sitting, standing, walking, cycling or running in minutes. Data could be uploaded with a personal login and viewed in the dashboard of Fast@home.

In addition to the applications, a stroke-related information module was accessible (Kennisbank, upper right of figure). This module was based on the information given by the Dutch patient association (www.hersenstichting.nl) and included information about stroke, consequences of stroke and stories of other patients and informal caregiver. Pictograms were used to increase ease of use and understanding.

5

2.2 eRehabilitation Intervention

During the intervention period, all people with stroke had free access to the intervention Fast@home (Box 1), that comprised several commercially available applications for cognitive and physical exercises, activity-tracking and stroke-related psycho education. The intervention was accessible on smartphone, laptop/PC or tablet. Some applications could be used with, some without the support/interference of a healthcare professional.

A tailored strategy, based on barriers and facilitators identified in preceding studies [10,24] was used to implement the intervention. Implementation included among others: structured integration in the healthcare process, providing education and information to healthcare professionals, people with stroke and their caregivers, providing a helpdesk/ support for all users. Implementation activities were mostly executed as planned and supplemented with instructional activities. Of the 49 healthcare professionals who were invited for the instructional session (RPs, OTs and PTs only), 47 (95.9%) attended. Of those professionals trained to deliver the intervention, 75.8% actually delivered it. Main areas for improvement of the implementation of eRehabilitation are found to be related to healthcare professionals' perceptions of the intervention, integration of eRehabilitation into conventional rehabilitation and technical and organizational contextual factors. More information about the implementation strategy, including fidelity and adaptations and details about the training provided for the healthcare professionals, is published elsewhere.

The intervention was delivered as follows:

1. All people with stroke were registered as user in Fast@Home by the research team. Login credentials for people with stroke were logged in the electronic patient record, and forwarded to the patient by email.
    - Every registered patient had access to the psycho education module.
    - The delivery of applications for cognitive exercises, physical exercises and/or the activity tracker was tailored to individual peoples' needs and goals. For the selected applications, treating therapists compiled an individualised program.
2. People with stroke could access the eRehabilitation intervention for 16 weeks. Its precise composition was defined for each individual patient. All people with stroke were encouraged to use it on a regular basis (multiple times per week), with the intended dose depending on the nature of the intervention. For the cognitive exercise program a dose of 300 seconds of use every day was advised, for the physical exercise program the recommended intensity and frequency could vary, depending on the individual patients' situation and nature of exercises (at least 2- 3 days of the week). With every training session people with stroke needed to sign in only once, and were automatically linked to the different applications showing their individualised program. A training session could be performed at any location with enough space and internet access, mostly at home or in the rehabilitation facility. People with stroke could receive reminders to use the intervention by email or text message. An email/telephone helpdesk was available during work hours.
3. Healthcare professionals received reports on the number/repetitions of exercises performed, to support the patient during conventional consultations and/or adapt the program if necessary.

3. Assessments

Stroke and personal characteristics were derived from medical files and health outcomes were collected with questionnaires. Questionnaires were available digitally and on paper, with reminders by telephone after two and four weeks. Use of the intervention was also recorded. Appendix 1 shows an overview of the timing and content of assessments.

3.1 Sociodemographic and clinical characteristics
From the medical records, stroke type (ischemic/haemorrhagic) and localization (right/left/other) were derived, and information on time between stroke and admission to rehabilitation (days), use of inpatient and/or outpatient rehabilitation and length of rehabilitation (days) was retrieved.

The admission questionnaire included living situation (alone or living with spouse/ partner/ children), educational level (low: up to and including lower technical and vocational training; medium: up to and including secondary technical and vocational training; high: up to and including higher technical and vocational training and university) and paid employment before stroke (yes/no). Depression and anxiety were measured by the Hospital Anxiety and Depression Scale (HADS [25]), including 7 items each on anxiety and depression (four-point Likert scale 0–3 points), yielding 2 subscale scores ranging from 0-21 (a higher score indicates a higher level of depression or anxiety).

3.2 Use of the intervention Fast@home
The actual use of the applications was routinely recorded by each application and included: date, starting time and duration per exercise, type of exercise and per exercise the number of repetitions. For the activity tracker, the number of uploads was recorded. For an upload, the patient had to connect the activity tracker to a computer, after which the newly recorded activities were shown. A patient was defined as a user of the intervention if he/she had performed at least one exercise or one upload from the activity tracker. People with stroke who were registered and/or offered the intervention but did not login any of the applications were defined as non-user.

3.3 Primary outcomes
The primary outcome was the Stroke Impact Scale (SIS), which included the following subscales: Physical Strength (4 items, minimal clinical important difference (MCID) 9.2 [26]), Memory (7 items), Feelings & emotion (9 items), Communication (7 items), Activities of Daily Living (ADL, 10 items, MCID 5.9), Mobility (9 items, MCID 4.5) and Meaningful Activities (T3 and T6 only, 8 items). The item scores range from 0 (very difficult) – 5 (not difficult), and the subscale scores from 0-100, with lower scores indicating more impact. The SIS has shown excellent internal consistency and good test-retest reliability [27]. The subscale Hand function was originally included in this study, but because of an error during the collection process, data were only gathered in a subgroup of patient, and were thus omitted from the analyses.

3.4 Secondary outcomes
The EuroQol-5D-3L (EQ5D) measures health-related quality of life (QoL) and consists of five subscales; mobility, self-care, usual activities, pain/discomfort and anxiety/depression [28]. Each dimension had 3 possible answer options: no problems, some problems, extreme problems. Utilities were calculated from the 5 subscales and the VAS scale, using the Dutch tariff [28]. A utility of 1 reflects complete health, -0.239 reflects death.

The 12-item Short-Form Health Survey (SF-12) was used at T3 and T6 to measure mental and physical health. Mental and physical scores can be computed, both scores ranging from 0-100 and higher scores indicating better QoL [29] .

Fatigue was measured using the 9-items Fatigue Severity Scale (FSS), yielding a total score being the mean of the 9 items (item scores and total score range 0-7), with higher scores indicating more fatigue [30]. The FSS has good internal consistency, test re-test reliability and discriminative validity [31].

The Patient Activation Measure Short Form 13 (PAM-13) was used to assess peoples' knowledge, skills and confidence for self-management (item scores 0 (totally disagree) - 5 (totally agree)), yielding a continuous total scale (0-100), higher scores indicating higher levels of patient activation. The shortened 13-item version is found both reliable and valid [32].

Participation was measured with the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-P) [33], consisting of 3 scales (all range 0-100); Frequency of Activities (11 items), Restrictions (11 items), and Satisfaction with participation (10 items). The internal consistency and test-retest reliability in the rehabilitation population were satisfactory [33].

Physical activity was measured with the 7-items International Physical Activity Questionnaire Short Form (IPAQ-SF), about time spent on physical activities and sedentary time (days/hours/minutes) during the last week [34].

4. Analyses

The target sample size was based on the ability to detect a change score of 5 points on the SIS subscale mobility, with a standard deviation of 14 points [35]. With an alpha of 0.05, two-sided testing, power of 80%, and a drop-out rate of 20%, 296 people with stroke in total were needed to detect a significant difference.

Patient characteristics were described using means and SD, median with interquartile range (IQR) or numbers and percentages, depending on type and distribution of the data. Normal distribution was checked by visual inspection and Kolmogorov-Smirnov tests. Characteristics of participants who did and did not complete the study, and characteristics of people with stroke in the CG and IG were compared by means of independent-samples t-tests, Mann-Whitney U tests, or Fisher's exact tests.

Data were analysed on an intention-to-treat basis (ITT), meaning that all participants were included in the analysis. For the IG group, all people with stroke were considered, regardless whether they received and/or used the intervention. In addition, all analyses were repeated comparing all people in the CG with only those people in the IG who actually used the intervention (per-protocol analysis; PP).

Primary and secondary outcomes were compared between T0-T3 and T3-T6 within and between the CG/IG. The periods T0-T3 and T3-T6 were analysed separately, since those periods differ from each other in clinical activity; during the first period, people with stroke receive rehabilitation, where during the second period most people finished rehabilitation. Within group analysis comprised paired t-tests, Wilcoxon Signed Rank tests or McNemar tests, where appropriate.

Change scores between T0-T3 and T3-T6 were compared between the IG and CG by means of Multivariate Analysis of Covariance (MANCOVA), while adjusting for baseline characteristics that significantly differed between the groups (age and type of rehabilitation). For both T0-T3 and T3-T6, two separate MANCOVAs were performed; one with seven subscales of the SIS and one with all secondary outcome measures. Besides, differences in changes scores between ITT and PP were calculated.

To investigate differences over time, Linear Mixed Models (LMM) were estimated for every primary and secondary outcome. These models take into account the correlation structure present in the data due to repeated measures within each patient, while accommodating for missing observations. The primary and secondary outcomes were entered in the model as dependent continuous variables, time as continuous variable and age (continuous) and type of rehabilitation (inpatient/outpatient/both) as control variables. Due to skewed distributions, power (squared) transformation were performed with EQ5D subscales (without VAS-score) and logarithmic (log natural) transformation were performed with IPAQ-scores. A model with a random slope and with unstructured covariance structure was estimated. For the USER-P, a model with only a random intercept was used since a random slope model did not converge. Since not all outcome variables were normally distributed, LMM with bootstrapping was performed to obtain more accurate confidence intervals and to check whether results about significance groups difference and change over time could be confirmed.

Data were entered and stored using Microsoft Access 2016 and analyses were performed using SPSS 25.0. P-values were considered significant if <0.05.

RESULTS

During the study period, in total 568 people with stroke met the inclusion criteria, of whom 318 (55.9%) gave informed consent and returned the baseline questionnaire (Figure 1); 153 people with stroke in the control period and 164 in the intervention period. Of those people, 306 completed the three-month follow-up (96.2% completion rate), 281 completed the six-month follow-up (88.3% completion rate). Participation was similar in the CG and IG. Baseline characteristics of people with stroke who completed the study and those lost to follow-up did not significantly differ (results not shown).

Apart from significant differences with respect to age (mean CG 58.6 (SD12.4); IG 62.6(SD 10.5) years, p=0.020), no significant differences were found in the baseline characteristics nor length of stay between people with stroke in the CG and IG (Table 1). Compared to the CG, people with stroke who used the intervention more often had a combination of inpatient and outpatient rehabilitation (Table 1, CG n=55, 35.9%; Users n=30, 55.6%).

Use of the intervention in the IG

In this pragmatic trail, healthcare professionals delivered the intervention to 82 participants in the IG (50.0%), of whom 54 (65.8%) used it. Of the 54 users, 36 used the physical exercise applications, 19 the cognitive exercise application and 15 the activity tracker. The median number of cognitive exercises performed was 14 (IQR 2-37), the median number of physical exercises was 10 for both applications (IQR Telerehabilitation 4-23, IQR Physitrack 3-51). The median number of uploads of the data of the activity tracker was 4 times (IQR 1-15). Figure 2 shows that most users (85.2%) stopped using the intervention before T3. More details about the amount of use of the applications in the intervention and the influence of several implementation activities on this use is published elsewhere.

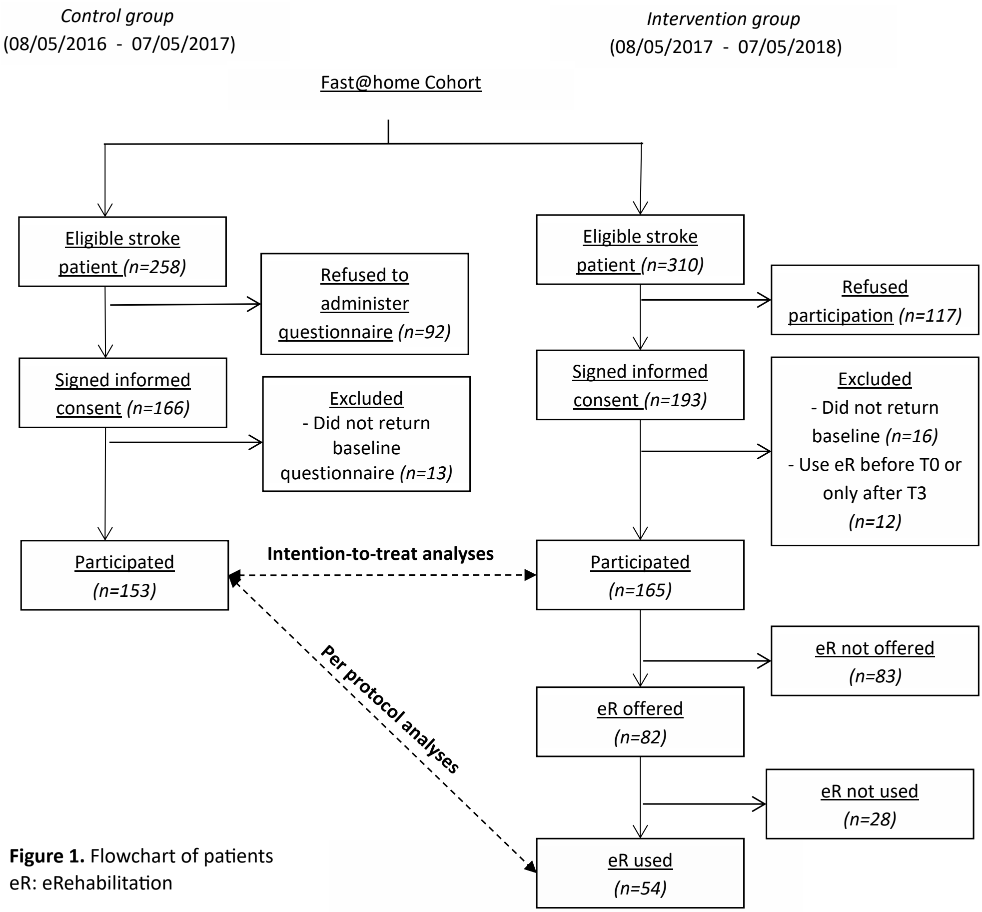

Figure 1. Flowchart of patients
eR: eRehabilitation

Table 1. Characteristics of 318 stroke patients admitted to a rehabilitation centre in a period where conventional rehabilitation was offered (control group) or eRehabilitation was offered in addition (intervention group)

	Control group		**Intervention group**			
	Total (n =153)	**Missing in %**	**Total (n =165)**	**Missing in %**	**Users (n=54)**	**Missing in %**
Age in years, mean (SD)	58.6 (12.4)	0	**62.6 (10.5)**	0	59.2 (10.4)	**0**
Gender, male n (%)	97 (63.4)	0	103 (62.2)	0	34 (62.9)	0
Stroke type, n haemorrhage (%)	31 (20.3)	1.3	24 (14.5)	1.2	9 (16.7)	0
Location of stroke		9.8		14.5		7.4
Hemisphere, n left (%)	59 (38.6)	.	73 (44.2)	.	29 (53.7)	.
Hemisphere, n right (%)	75 (44.8)	.	64 (38.8)	.	19 (35.2)	.
Other, n (%)	4 (2.6)	.	4 (2.4)	.	2 (3.7)	.
Living status, n living alone (%)	43 (28.1)	1.3	45 (27.3)	2.4	12 (22.2)	3.7
Education level		3.6		3.6		5.6
Low, n (%)	60 (39.2)	.	67 (40.6)	.	17 (31.5)	.
Middle, n (%)	47 (30.7)	.	44 (26.7)	.	19 (35.2)	.
High, n (%)	44 (28.8)	.	48 (29.1)	.	15 (27.8)	.
Employment, n. paid job age <65 (%)	83 (80.6)	0	59 (69.4)	3.6	24 (68.6)	3.7
HADS-A (0-21, low-high depression), mean (SD)	5.1 (3.8)	9.2	4.7 (3.8)	10.3	4.6 (3.9)	7.4
HADS-D (0-21, low-high anxiety), mean (SD)	5.2 (3.9)	9.2	5.2 (3.5)	9.7	4.8 (3.5)	5.6
Time between stroke and start rehabilitation, median, (IQR)	13 (8-30)	0	11 (7.27)	0	11 (7.14)	0
Type of rehabilitation		0		0		0
Inpatient, n (%)	**52 (33.9)**	**.**	**60 (36.4)**	**.**	**18 (33.3)**	**.**
Outpatient, n (%)	**46 (30.1)**	**.**	**37 (22.4)**	**.**	**6 (11.1)**	**.**
In and outpatient, n (%)	**55 (35.9)**	**.**	**68 (41.2)**	**.**	**30 (55.6)**	**.**
Days of inpatient rehabilitation, median, (IQR)	42 (29-77)	5.7	34 (24-47)	11.6	36 (24-47)	0
Days of outpatient rehabilitation, mean (SD)	84 (44-124)	2.1	106 (56-175)	5.4	123 (70-159)	16.6
Days of in- plus outpatient rehabilitation, median, (IQR)	178 (99-244)	5.4	135 (83-196)	13.2	131 (97-181)	13.3
Time between stroke and start rehabilitation, median, (IQR)	13 (8-30)	0	11 (7-27)	0	11 (7-14)	0

In Bold, significant difference with control group ($p<0.05$)
SD; standard deviation, Educational level; low: up to and including lower technical and vocational training/ medium: up to and including secondary technical and vocational training/ high: up to and including higher technical and vocational training and university, HADS-A; Hospital Anxiety and Depression Scale – Anxiety, HADS-D; Hospital Anxiety and Depression Scale – Depression, IQR; Inter quartile range.

Effect on primary outcomes

Regarding the changes within groups, the largest improvements occurred between start of rehabilitation and T3, both for the CG and IG (Table 2a). Between T0-T3, significant improvements of the SIS subscales, except for Feelings & emotion, were seen within both groups. Between T3-T6, significant improvements were only seen within the IG, (SIS subscales Memory and Meaningful activities). All mean changes score between T0-T3 of both the IG and CG were below MCID.

Regarding groups differences, no significant differences between the IG and CG were seen between T0-T3. However, between T3-T6, the improvements were significantly greater in the IG than the CG for the SIS subscales Communication and Physical strength. Taking into account all time points, no significant differences were seen between CG and IG. All mean changes score between T3-T6 of both the IG and CG were below MCID.

Effect on secondary outcomes

Within groups, between T0-T3, the EQ5D total score improved and the USER-P deteriorated significantly and the FSS improved significantly in the IG only (Table 2a). All other secondary outcomes showed no significant within group changes. Between T3-T6 only the USER-P Restriction and Satisfaction scores improved significantly within both groups. None of the between group differences reached significance between T0-T3, nor T3-T6 or T0-T6.

Per-protocol analysis

The PP-analysis overall yielded in similar results as the ITT-analysis (Table 2b). No group differences were found between T0-T3. Between T3-T6, significantly greater improvements on the SIS subscales Communication and Physical strength were seen in the IG as compared to the CG. In addition, differences in the changes scores of the SIS subscales Memory and Meaningful activities reached significance as well. All mean changes score of the PP-analyses, of both IG and CG and between T0-T3 and T3-T6, were below MCID.

To compare the results of the ITT-analyses with the PP-analyses, differences in change scores between ITT and PP were calculated (Appendix 2). The magnitude of improvements over time was larger for the users group (PP) as compared to the total IG (ITT), both between T0-T3 (for 8 of the 12 outcome measures) as well as between T3-T6 (for 13 of the 17 outcome measures).

DISCUSSION

This quasi-experimental pragmatic clinical study found that with a comprehensive eRehabilitation intervention combining multiple applications, offered alongside conventional stroke rehabilitation, some improvements were better maintained on the longer term than with conventional rehabilitation only. Whereas people with stroke in both the control and intervention groups improved significantly during the first three months after admission on various domains of health, no significant differences between the groups were seen. In the second three-month period however, although further improvements within the groups were small, significant differences in favour of the intervention group were found in some of the outcome measures. These differences were even more pronounced if only the people with stroke actually using the intervention were taken into account, suggesting that the longer term differences may be attributed to the intervention.

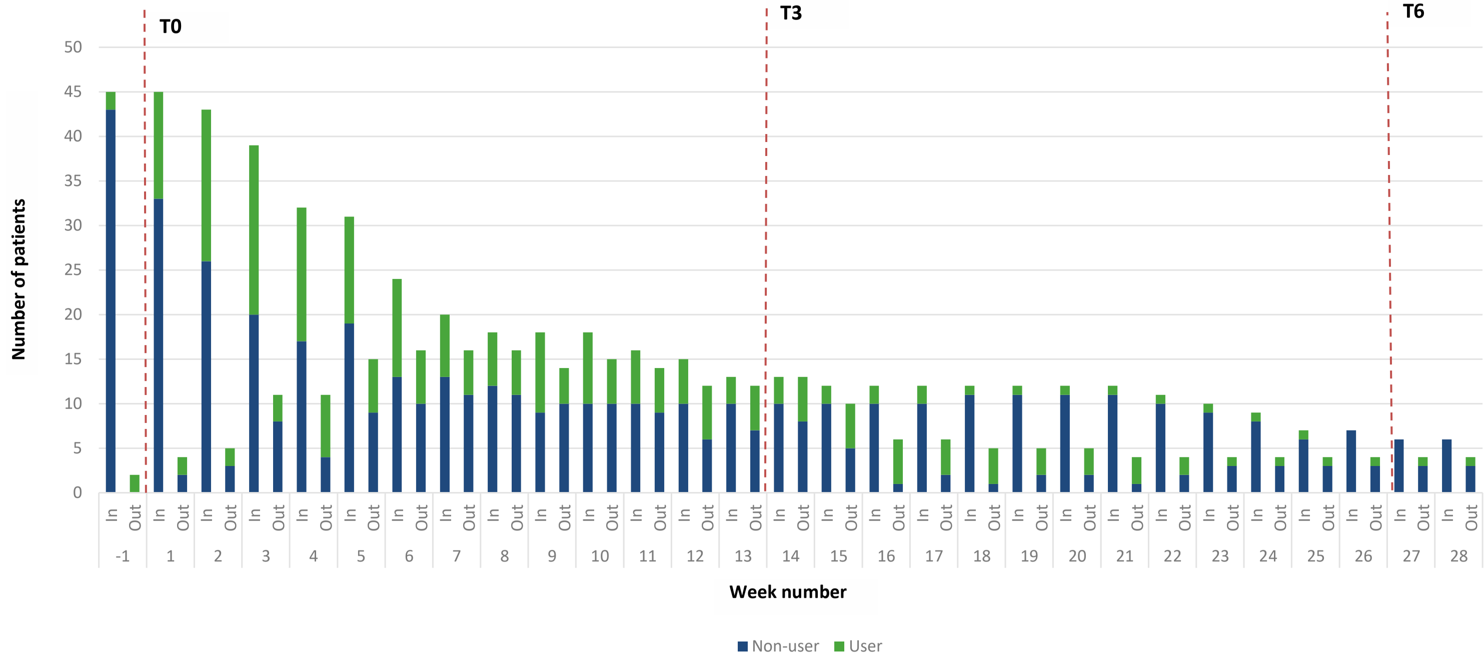

Figure 2. Use of Fast@home over time, for both in patients (in) and out patients (out). Number of non-users (blue) and users (green) of Fast@home over time, with measurement moments at T0 (start of rehabilitation), T3 (3 months after admissions) and T6 (six months after admission)

5

Table 2a. Intention to treat analysis, comparing the control group (n=153) with the intervention group (n=165). Baseline scores and change score in mean difference (SD) for T0-T3 and T3-T6 and Linear mixed models (LMM) for the whole period (T0-T6)

	T0 baseline		T0-T3 change scores			T3-T6 change scores			LMM (T0-T6)
			Within group		Between groups	Within group		Between groups	Between groups
	Control group	Interven-tion group	Control group	Interven-tion group	p	Control group	Interven-tion group	p	p (95%CI)
SIS (0-100, high-low impact)									
Communication	85.6 (16.1)	85.7 (15.5)	3.5 (13.4)*	2.5 (11.8)*	.13	-1.7 (8.9)	-0.3 (10.5)	**.026**	0.70 (-1.9 - 1.3)
Memory	78.9 (19.0)	80.4 (19.9)	4.5 (14.6)*	3.6 (14.9*	.30	-1.3 (10.3)	2.1 (9.9)*	.65	0.97 (-2.0 - 1.9)
Mobility	72.6 (29.3)	75.5 (24.3)	12.2 (20.0)*	9.4 (19.3)*	.23	-0.8 (10.8)	1.1 (7.9)	.11	0.80 (-2.9 - 2.3)
Feelings & emotion	75.7 (15.8)	75.8 (14.6)	0.6 (14.2)	-1.2 (15.4)	.47	0.5 (11.4)	0.4 (11.2)	.88	0.17 (-3.3 - 0.5)
Activity of Daily Living	75.0 (23.9)	74.8 (21.1)	9.6 (14.5)*	8.8 (18.1)*	.062	0.2 (9.8)	0.7 (6.5)	.30	0.96 (-2.2 - 2.2)
Physical Strength	58.0 (27.6)	55.8 (25.2)	15.3 (33.9)*	9.3 (25.4)*	.066	-5.7 (22.4)	3.3 (11.7)	**.010**	0.48 (-3.2 - 6.8)
Meaningful activities	.	.	.	.	.	1.6 (19.2)	9.1 (18.0)*	.12	.
EQ5D (0-1, low-high HRQoL)	0.71 (0.3)	0.69 (0.2)	0.07 (0.2)*	0.07 (0.2)*	.19	-0.01 (0.2)	0.01 (0.2)	.38	0.50 (0.0 - 0.1)
FSS (0-7, low-high fatigue)	4.5 (1.52)	4.3 (1.5)	.0.1 (1.5)	0.3 (1.5)*	.059	0.2 (1.29)	-0.2 (1.1)*	.11	0.33 (-0.1 - 0.3)
PAM(0-100, low-high self-management)	58.3 (13.9)	60.3 (14.9)	3.2 (16.0)	0.8 (17.4)	.064	2.2 (16.7)	1.3 (14.9)	.47	0.05 (-4.8 - 0.0)
SF-12 (0-100, low-high HRQoL)									
Physical	.	.	.	.	.	1.1 (8.7)	1.1 (6.3)	.98	.
Mental	.	.	.	.	.	0.6 (7.0)	1.7 (7.8)	.48	.
USER-P (0-100, low-high participation)									
Frequency**	35.4 (13.3)	35.0 (12.5)	.5.5 (14.8)*	.6.6 (11.9)*	.41	-4.4 (11.6)	1.9 (10.1)	.46	0.81 (-1.7 - 1.4)
Restriction	.	.	.	.	.	6.4 (18.5)*	5.4 (14.6)*	.24	.
Satisfaction	.	.	.	.	.	3.6 (16.7)*	5.5 (12.0)*	.088	.
IPAQ-SF (minutes physical activity)	754 (1132)	757 (1015)	154 (1620)	102 (1271)	.27	2.8 (674)	60 (666)	.77	0.53 (-0.2 - 0.1)

* Significant within group difference (p<0.05), in bold significant between group difference (p<0.05), LMM; linear mixed models with random slope model, **LMM with random intercept model; HRQoL; Health-related quality of life
Paired t-test for within group comparison, MANCOVA and Linear Mixed Models for between group comparison. Within group differences unadjusted, between group difference and LMM adjusted for age and type of rehabilitation

Table 2b. Per-protocol analyses, comparing the control group (n=153) with the users of eRehabilitation (n=54). Baseline score and change score in mean difference (SD) for T0-T3 and T3-T6 and Linear mixed models (LMM) for the whole period (T0-T6)

	T0 baseline		T0-T3 change scores			T3-T6 change scores			LMM (T0-T6)
			Within group		Between groups	Within group		Between groups	Between groups
	Control group	Interven-tion group	Control group	Interven-tion group	p	Control group	Interven-tion group	p	P (95%CI)
SIS (0-100, high-low impact)									
Communication	85.6 (16.1)	85.7 (17.6)	3.5 (13.4)	0.6 (11.1)	.41	-1.7 (8.9)	2.6 (12.1)	**.019**	.47 (-1.4 - 3.1)
Memory	78.9 (19.0)	79.8 (21.6)	4.5 (14.6)*	3.7 (14.1)	.87	-1.3 (10.3)	4.2 (11.5)*	**.031**	.42 (-1.7 – 4.0)
Mobility	72.6 (29.3)	71.8 (25.5)	12.2 (20.0)*	11.4 (19.5)*	.46	-0.8 (10.8)	1.7 (6.4)	.33	.36 (-2.1 - 5.9)
Feelings & emotion	75.7 (15.8)	75.2 (14.9)	0.6 (14.2)	1.1 (12.5)	.82	0.5 (11.4)	-0.3 (12.1)	.95	.63 (-3.2 - 2.0)
Activity of Daily Living	75.0 (23.9)	70.1 (20.8)	9.6 (14.5)*	11.4 (16.7)*	.053	0.2 (9.8)	3.1 (6.1)*	.20	.06 (-0.1 - 6.3)
Physical Strength	58.0 (27.6)	52.6 (26.0)	15.3 (33.9)*	10.6 (23.3)*	.087	-5.7 (22.4)	6.0 (10.4)*	**.008**	.05 (-0.1 - 13.0)
Meaningful activities	.	.	.	.	.	1.6 (19.2)	16.2 (17.2)*	**.040**	.
EQ5D (0-1, low-high HRQoL)	0.71 (0.3)	0.69 (0.22)	0.06 (0.25)*	0.07 (0.20)*	.21	0.00 (0.2)	0.00 (0.18)	.32	.32 (0.0 - 0.1)
FSS (0-7, low-high fatigue)	4.5 (1.52)	4.6 (1.4)	-0.1 (1.5)	0.0 (1.74)	.31	0.2 (1.29)	-0.3 (1.0)	.13	.50 (-0.4 - 0.2)
PAM (0-100, low-high self-management)	58.3 (13.9)	60.6 (14.2)	3.2 (16.0)	-1.6 (12.2)	.071	2.2 (16.7)	3.6 (10.3)*	.87	.09 (-5.5 - 0.4)
SF-12 (0-100, low – high HRQoL)									
Physical	.	.	.	.	.	1.1 (8.7)	4.1 (.4)	.75	.
Mental	.	.	.	.	.	0.6 (7.0)	-0.2 (9.0)	.41	.
USER-P (0-100, low – high participation)									
Frequency**	35.4 (13.3)	35.1 (12.1)	-5.5 (14.8)*	-6.0 (11.8)*	.88	-4.4 (11.6)	-4.3 (10.0)*	.65	.68 (.1.7 . 2.7)
Restriction	.	.	.	.	.	6.4 (18.5)*	8.2 (15.9)*	.42	.
Satisfaction	.	.	.	.	.	3.6 (16.7)	8.9 (12.5)*	.57	.
IPAQ-SF (minutes physical activity)	754 (1132)	670 (775)	154 (1620)	270 (874)	.67	2.8 (674)	141 (864)	.43	.90 (-0.2 - 0.3)

* Significant within group difference (p<0.05), In bold significant values (p<0.05), CG; control group, IG; intervention group, LMM; linear mixed models with random slope model, **LMM with random intercept model; HRQoL; Health-related quality of life
Paired t-test for within group comparison, MANCOVA and Linear Mixed Models for between group comparison, Within group differences unadjusted, between group difference and LMM adjusted for age and type of rehabilitation

5

The absence of an effect of eRehabilitation in the first three months after stroke is in line with the results of previous studies [11,13], concluding that those who received eRehabilitation reported additional exercise practice, but this did not directly translate into significant difference in the primary outcomes. The lack of short-term effect is probably related to the intensity of conventional rehabilitation in the first phase after stroke, with limited opportunities for further optimization of care. Moreover, irrespective of the treatment offered, in people with stroke the largest improvements are seen during the first three months following stroke [3,36]. Thus, the added value of the intervention might be under the threshold for clinical significance in that period.

In contrast to other studies, we also collected data during a follow-up period until six months after stroke, when institutional rehabilitation was finished for most people with stroke. Although improvements between three and six months were smaller compared to the first three months in both groups, there appeared to be an overall benefit of the intervention. This is striking, given the disappointingly low rates of participants being offered and using the intervention. Yet, as the differences were greater when only participants actually using the intervention were taken into account, it is not unlikely that the effect was indeed related to the eRehabilitation intervention. Although most participants stopped with the use of the applications after discharge, they were probably more likely to continue doing exercises at home and thereby maintaining or slightly improving the functional gains of the first three months. Although on the longer term some statistically significant differences were seen between the intervention and control groups, their clinical relevance remains uncertain. Overall, the mean change scores were relatively small. For the Physical Strength subscale, the one subscale with significant between group differences and of which an MCID is known, the observed statistically significant difference did not exceed the MCID.

The overall improvements of people with stroke over time and the observed differences between the control and intervention groups were mainly seen for the SIS. The SIS appears to be a valuable instrument, reflecting the heterogeneity of the consequences of stroke on the individual patient. Nevertheless, problems of people with stroke vary widely and evaluating cognitive, physical and mental health in all of them independent of the presence of such problem, may probably dilute the differences between patient groups. Future research should therefore probably also include patient specific outcome measures such as the COPM [37]. Moreover, since the consequences of a stroke are so heterogeneous, more detailed analyses to evaluate changes in relevant domains (e.g. cognitive, motor, aphasia) for a specific subgroup of people with stroke are recommended. Unfortunately the different subgroups in the current study would be too small for such investigations.

The relatively low proportion of people with stroke who received the intervention suggests that although the implementation activities were employed as intended, this may not have led to the change that was predicted. A process evaluation, investigating which components of the implementation strategy actually worked and why with the implementation of the eRehabilitation intervention is currently underway. In this, we found that healthcare professionals did not deliver the eRehabilitation intervention to all patients, most likely due to physical, mental or cognitive limitations of the patients hampering engagement. Moreover, not all patients who received the intervention proceeded. This could be possibly explained by the fact that those patients did not see added value of continuation of usage after rehabilitation was finished because they had already sufficiently recovered. Although the relatively low use can be seen as an important drawback of the study, our study reflects the situation in usual care, and in that respect the rates of people with stroke who were actively offered the intervention may not be considered that unfavourable.

Although this study suggests the potential of eRehabilitation offered alongside conventional rehabilitation, the results must be interpreted with care, as it has several limitations. First, this study did not have a randomised, controlled design and people with stroke nor healthcare professionals were blinded regarding whether or not they had access to the intervention. Therefore, it cannot be ruled out that their awareness influenced the results, or that other, unknown developments in the rehabilitation centre occurring over time had an impact on the findings. Second, as mentioned previously, the numbers of people with stroke that were offered and actually used eRehabilitation were relatively low. Although the total number of people with stroke included met de requirements of the sample size calculation, this was not true if in the intervention group only people with stroke actually using the intervention were considered. Future studies investigating the effect of the use of eRehabilitation should develop a clear decision algorithm underling the clinical decisions whether or not to deliver the intervention to a patient. Besides, reasons for (non-) use of patient should be registered as well as what (both applications as exercises within an application) is prescribed and performed, which is necessary to calculate adherence. Third, due to data collection errors, we could not use the data of the SIS hand function. However, this study was performed in the clinical setting, reflecting the situation in which eRehabilitation will be used most.

CONCLUSION

In conclusion, this study indicates that a comprehensive eRehabilitation intervention combing multiple applications and offered alongside conventional stroke rehabilitation is beneficial regarding the maintenance of some of the improvements obtained directly after stroke. Future studies need to investigate the effect of a comprehensive eRehabilitation intervention using a parallel group design, and a better monitoring of the delivery and use of the intervention. It would also be of interest to study partial replacement of conventional stroke rehabilitation by eRehabilitation applications instead of offering it on top.

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Appendix 1

Table 1. Time points of assessments

Domain	Outcome	Short	T0	T3	T6
Sociodemographic and clinical characteristics					
Sociodemographic	Sociodemographic characteristics	-	x	.	.
Clinical	Stroke characteristics	-	x	.	.
Depression and anxiety	Hospital Anxiety and Depression Scale	HADS	x	x	x
Primary and secondary outcomes					
Disease impact	Stroke Impact scale	SIS	x	x	x
Generic health	EuroQoL-5D	EQ5D-3L	x	x	x
Fatigue	Fatigue Severity Scale	FSS	x	x	x
Self-management	Patient Activation Measure	PAM-13	x	x	x
Quality of life	Short Form 12	SF-12	.	x	x
Participation	Utrechtse Schaal voor Evaluatie van Revalidatie	USER-P	x	x	x
Physical activity	International Physical Activity Questionnaires	IPAQ-SF	x	x	x

T0; admission, T3; three months after admission, T6; 6 months after admission

Appendix 2

Table 1. Comparison between intention-to-treat (ITT) and per-protocol (PP) analyses; mean change scores for control group (CG, n=153), complete intervention group (IG total, n=164) and users (IG users, n=53) and the mean differences in change scores between the ITT and the PP

	T0-T3				T3-T6			
	ΔCG	**ΔIG Total**	**ΔIG Users**	**Difference IG Total/ IG Users**	**ΔCG**	**ΔIG Total**	**ΔIG User**	**Difference IG Total/ IG Users**
SIS (0-100, high – low impact)								
Communication	3.5	2.5	0.6	-1.9	-1.7	**-0.3**	**2.6**	2.9
Memory	4.5	3.6	3.7	0.1	-1.3	2.1	**4.2**	2.1
Mobility	12.2	9.4	11.4	2.0	-0.8	1.1	1.7	0.6
Feelings & emotion	0.6	-1.2	1.1	2.3	0.5	0.4	-0.3	-0.7
Activity of Daily Living	9.6	8.8	11.4	2.6	0.2	0.7	3.1	2.4
Physical Strength	15.3	9.3	10.6	1.3	-5.7	**3.3**	**6**	2.7
Meaningful activities	-	-	-	-	1.6	9.1	**16.2**	7.1
EQ5D (0-1, low-high HRQoL)	0.07	0.07	0.07	0.0	-0.01	0.01	0.0	-0.01
FSS (0-7, low – high fatigue)	-0.1	0.3	0.0	-0.3	0.2	-0.2	-0.3	.01
PAM-13 (0 – 100, low- high self-management)	3.2	0.8	-1.6	-2.4	2.2	1.3	3.6	2.0
SF-12 (0-100, low-high HRQoL)								
Physical	-	-	-	-	1.1	1.1	4.1	3.0
Mental	-	-	-	-	0.6	1.7	-0.2	-1.9
USER-P (0-100, low – high participation)								
Frequency	-5.5	-6.6	-6.0	-0.6	-4.4	1.9	-4.3	-6.2
Restriction	-	-	-	-	6.4	5.4	8.2	2.8
Satisfaction	-	-	-	-	3.6	5.5	8.9	3.4
IPAQ-SF (minutes physical activity)	154	102	270	168	2.8	60	141	81

In bold; differs significant from control group (p<0.05), HRQoL; Health-related quality of life

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What works and why in the implementation of eRehabilitation after stroke: a process evaluation

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ABSTRACT

Background: The implementation of an eRehabilitation intervention (consisting of cognitive and physical exercise applications, activity-tracking and psycho education) in stroke rehabilitation resulted in small health-related improvements. This process evaluation aimed to understand what worked and why in the implementation and to identify areas for improvement for future implementations by 1) evaluating implementation activities, 2) exploring mechanisms of impact and 3) and identifying contextual factors influencing the implementation.

Methods: Predefined implementation activities (including information provision for healthcare professionals and patients, integration of the intervention into conventional rehabilitation, instruction, practical support and motivation of professionals directly involved) were carried out over a 14-months period in a specialized rehabilitation facility. Mixed-methods were used, guided by the Medical Research Council framework for process evaluations. Implementation activities were evaluated by field notes, surveys and user data; mechanisms of impact by surveys; contextual factors by field notes and interviews. Field notes were made during the implementation. Interviews were held with 11 professionals. Surveys on satisfaction with the implementation activities, intervention and factors potentially influencing the implementation were conducted among 51 professionals and 73 patients. User data were extracted from the eRehabilitation applications.

Results: Implementation activities were mostly executed as planned and supplemented with instructional activities. From the professionals trained to deliver the intervention (33 of 51 professionals included in the survey), 25 (75.8%) delivered it. From the 165 patients, 82 (49.7%) received the intervention, with 54 (65.8%) using it. Concerning the mechanisms of impact, professionals and patients were equally satisfied with implementation activities (median score 7.0 (IQR 6.0-7.75) versus 7.0 (6.0-7.5), respectively), but patients were more satisfied with the intervention (8.0 (IQR 7.0-8.0) versus 5.5 (4.0-7.0)). The rating of impact on the implementation showed highest scores for, amongst others, personal guidance by professionals (patients), and the support of ambassadors and time given for training (professionals). Professionals rated the integration into conventional rehabilitation as insufficient. Contextual factors hampered the implementation, including unexpected financial cutbacks and technical setbacks.

Conclusion: Main areas for improvement of the implementation of eRehabilitation appear to be related to healthcare professionals' perceptions on the intervention, actual integration of eRehabilitation into conventional rehabilitation, as well as contextual, mostly technical and organizational, factors.

INTRODUCTION

Over the last decades, the availability and quality of digital health technology in rehabilitation (eRehabilitation) increased [1,2]. eRehabilitation may include various modalities such as online physical or cognitive exercise programs, serious gaming, education or e-consultations [3-6] and has the potential to improve the quality and frequency of rehabilitation therapy [7,8]. A major target population in medical specialist rehabilitation are stroke patients. As the incidence of stroke and survival rates increase in our ageing society [9], eRehabilitation may provide a solution for the growing demand for stroke rehabilitation and healthcare-related costs. Recent systematic reviews concluded that eRehabilitation after stroke might lead to better health-related outcomes [10-12], improved access to care [4], reduced healthcare costs [8] and improved self-management of patients [13]. However, it is hard to draw conclusions about the effectiveness of stroke eRehabilitation in general, since the characteristics of interventions and outcomes measured varied greatly across studies and most studies were not adequately powered [8].

An important observation regarding eRehabilitation is that its usage by patients and healthcare professionals in clinical practice is, despite implementation efforts, generally limited [14]. This finding highlights the need for studies that provide insight into why eRehabilitation interventions work or fail, and in particular how interventions and implementation strategies can be improved [15]. The implementation of eRehabilitation may be influenced not only by the eRehabilitation intervention itself, but also by the implementation strategy and the context in which it is executed, the latter often varying from one intervention, organisation or country to another [15,16]. Therefore, comprehensive, systematic evaluations taking into account all of these aspects are very important [8,15]. The Medical Research Council (MRC) framework is frequently used to structure such comprehensive evaluations of the implementation of interventions [16]. Their results make it possible to better interpret findings of effectiveness studies, and may contribute to the evidence base for recommendations for the design and execution of future implementation projects [17].

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Despite the importance of comprehensive process evaluations, to our knowledge, only one process evaluation is published in the field of eRehabilitation after stroke. That study was performed in Uganda, and concerned a mobile phone-supported rehabilitation intervention [18]. Terio et al. investigated the user experiences and contextual factors influencing the implementation. It was concluded that the implementation strategy was partially delivered as planned and that barriers, including technical setbacks, and facilitators, including motivated participants, influenced the implementation. However, that study did not follow the MRC guidelines [19], and did not describe details of the implementation strategy nor evaluated the mechanisms through which the intervention and implementation strategy might have worked.

Recently, an observational effect study was performed, which aimed to evaluate an eRehabilitation intervention, integrated into conventional stroke rehabilitation (Fit After Stroke @Home, Fast@Home, Box 1). As compared to conventional stroke rehabilitation alone, patients treated in the period where the eRehabilitation intervention was offered to all admitted stroke patients, showed a greater improvement on the Stroke Impact Scale domains communication, memory, meaningful activities and physical strength, three to six months after admission. However from admission until three months thereafter no statistically significant differences were found [20].

The aim of the current process evaluation was to describe and evaluate the implementation of the Fast@home eRehabilitation intervention in a medical specialist rehabilitation facility. More specific, the objective was to understand what worked and why in the implementation of the Fast@home eRehabilitation intervention into conventional rehabilitation and to identify areas for improvement in future implementations. This was done with the guidance of the MRC framework for 1. describing and evaluating the implementation activities (dose, fidelity, adaptations, reach); 2. exploring mechanisms of impact (patients and healthcare professionals responses and interaction with the intervention and implementation strategy); and 3. identifying contextual factors that influenced the implementation of the eRehabilitation intervention.

METHOD

1. Setting

The Fast@home eRehabilitation intervention was implemented at two locations of a specialized rehabilitation facility in the Netherlands (Basalt The Hague, Basalt Leiden). In the Netherlands, approximately 10% of the stroke patients receive inpatient and/or outpatient rehabilitation treatment. Rehabilitation treatment is provided in accordance to a national guideline [21], delivered by a multidisciplinary team including a rehabilitation physician (RP), physical therapist (PT), occupational therapist (OT), speech therapist, psychologist and social worker. Stroke rehabilitation treatment generally focuses on improving motor, cognitive or psychological function, speech, and/or daily activities and participation. The average duration of treatment varies, from 44 days for inpatient rehabilitation, to 119 days for outpatient rehabilitation [22].

2. Study design

In this mixed methods study, the MRC guidelines for process evaluation of complex interventions were followed [19]. The three domains of evaluation recommended by the guidance were explored, namely implementation, mechanisms of impact, and contextual factors (Figure 1).

Box 1: The Fast@home effect study

Aim: Compare the effects of a multidisciplinary eRehabilitation intervention offered alongside conventional stroke rehabilitation, with conventional stroke rehabilitation.

Design: Pre-test post-test comparison in two rehabilitation centres in the Netherlands (Basalt The Hague and Leiden), with 12 months control period and 12 months intervention period, with both inpatients and outpatients.

Intervention: Fast@home is an eRehabilitation intervention consisting multiple already existing applications;

- physical exercise program, named Physitrack which was used in The Hague (Physitrack Limited, London, Great Britain) and Telerehabilitation, used in Leiden (Roessingh Research & Development, Enschede, Netherlands)
- cognitive exercise program named Braingymmer (Dezzel Media, Almere, Netherlands),
- activity-tracker named Activ8 (Activ8 consumer, 2M Engineering, Valkenswaard, Netherlands)
- psycho education based on the Dutch patients association (www.hersenstiching.nl)

Each patient was offered access to the psycho education. For the patients who would benefit from it, additional applications were offered. In this eRehabilitation intervention, healthcare professionals compiled an exercise program tailored to each patient personal goals and monitored the results and adherence of the patients. Fast@home is a web-based intervention and can be used on each smartphone, laptop, pc or tablet.
Professionals where provided with objective data including time of use in each application, number of attempted and successful repetitions, in order to better support the patient and/or adapt the programme if required.

Methods: Questionnaires at admission (T0), three months (T3) and six months (T6) after admission, and administration of the use of the intervention by the application developers. Primary outcome was the Stroke Impact Scale (SIS), secondary outcomes were health-related quality of life, measured with the EuroQoL-5D (EQ5D) and the 12-item Short-Form Health Survey (SF-12); fatigue, measured with the Fatigue Severity Scale (FSS); Self-management measured with The Patient Activation Measure Shorted form 13 (PAM-13) and participation measured with the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-P) and the International Physical Activity Questionnaire Short Form (IPAQ-SF).

Outcome: A positive significant effect was found between three and six months in the SIS domains Communication, Memory, Physical Strength and Meaningful activities. Users of eRehabilitation showed a trend toward greater improvements compared to the whole intervention group including those who did not use eRehabilitation. However, Fast@home did not result in any clinically relevant difference or effect over the entire six-month period.

1. The implementation domain explores which elements of the implementation strategy are actually delivered (dose), how delivery is achieved (fidelity and adaptations) and whether the intended target group comes into contact with the intervention (reach). It covers Objective 1 of this study, i.e. describing the implementation strategy.
2. The mechanisms of impact domain identifies the process through which the intervention and implementation activities produce changes (Objective 2, to explore participants responses and interaction with the intervention).
3. The contextual factor domain explores the contextual elements that positively or negatively affect the implementation and outcomes (Objective 3, to identify contextual factors influencing the implementation).

The study was approved by the Medical Ethics Review Committee (protocol P18.038) of the Leiden University Medical Center and all participants gave written informed consent.

3. Implementation strategy

The implementation strategy used in this study was developed to target barriers and facilitators in the implementation of the eRehabilitation intervention, as identified in preceding focus group and survey studies [23,24]. The implementation strategy included activities that focused on the following four domains: Information provision, Integration, Instruction & support and Motivation. The implementation activities targeted almost all healthcare professionals working in stroke teams within the two rehabilitation facilities, with a specific focus on the RPs, PTs and OTs who are primarily involved in delivering eRehabilitation to the patients. Several activities also targeted patients and their informal caregivers. An overview of the activities of the implementation strategy is given in Table 1.

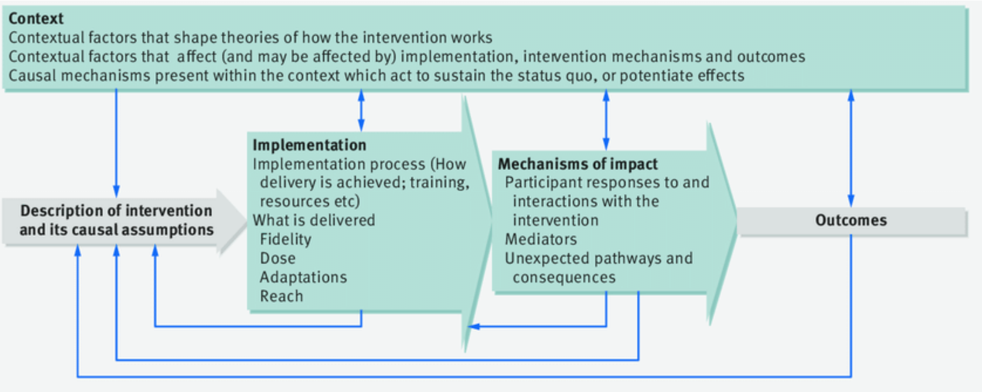

Figure 1. MRC framework for evaluations of the implementation processes [16]

An overview of the timing of the phases of the Fast@home project is given in Figure 2. First, before the control period, focus group and survey studies identified expected barriers and facilitators regarding the delivery and use of eRehabilitation among patients, informal caregivers and healthcare professionals (December 2016 – June 2016). Second, during the control period, patients received conventional rehabilitation without eRehabilitation (May 2016 – April 2017) and simultaneously, the intervention and implementation strategy were designed (July 2017 – February 2017), based on the results of the preceding studies. During the last three months of the control period, healthcare professionals were already informed about the eRehabilitation intervention, but without the possibility to use it. During the intervention period (May 2017- April 2018) the eRehabilitation intervention was integrated into conventional stroke rehabilitation and data for the current process evaluation were collected. During the whole intervention period, implementation activities were performed (March 2017 – April 2018).

Table 1. Implementation strategy of the Fast@home eRehabilitation intervention

Element of strategy; Aim of element	**Description**	**Timing**	**Frequency**	**Pat**	**Prof**
Information provision; Informing end-users about the existence and potentials of eR	- News items via internal & external communication	3 months before until start of inter-vention	Variable, ± once per month	x	x
	- Presentation about potential eRehabilitation		Once	.	x
	- Promotional activities (banners, flyers, treats, etc.)		Continuous	x	x
Integration; Actions for integrating eRehabilitation into the conventional rehabilitation process	- Discuss benefits of applications for the patient during multidisciplinary team conferences	Start until end of interven-tion	Continuous	.	x
	- Login credentials in electronic patient registries		Continuous	.	x
	- Administering patient email address		Continuous	x	.
	- Email with login credential send to patient		Continuous	x	
	- Use of eRehabilitation discussed during consultation with PT, OT or RP		Continuous	x	x
Instruction & support; Increase ease of use and offering support in case of problems	- Joined instruction for RP, OT, PT (2 hours)	Start until end of interven-tion	Once per prof	.	x
	- Helpdesk by telephone and email		Continuous	x	x
	- Students available for support		Continuous	x	x
	- Ambassador* available for support (2 h/ week)		Continuous	.	x
	- Manuals for patients and professional		Continuous	x	x
	- Information folder for each patient		Continuous	x	
Motivation; Keeping end-users involved and motivated	- Recurrent presentation about use and potential of eRehabilitation	Start until end of interven-tion	Once per 4 months	.	x
	- Motivation from management**		Continuous	.	x
	- Video with patient using eRehabilitation		Once	.	x
	- Promotional activities (banners, flyers, treats, etc.)		Continuous	x	x

Pat; patients, Prof; healthcare professionals, eR; eRehabilitation, RP; rehabilitation physicians, PT; physical therapist, OT; occupational therapist, *Ambassador; physical therapist with extra time and knowledge to support colleagues; **Management; executive board, managers and rehabilitation physicians

3.1 Information provision

All potential end-users (patients and their informal caregivers if applicable and healthcare professionals) were informed about the availability and potential advantages of the eRehabilitation intervention Fast@home, prior to the start of the intervention period and by means of internal and external communication, presentations and promotion materials (banners, flyers, etc.).

3.2 Integration

For the integration of the intervention within regular care, the conventional stroke rehabilitation process was first described. Next, a meeting was organized with representatives of the different professionals involved in each step of this rehabilitation process (e.g. OT/PT, RP, nurse, administrative assistant). In that meeting, the integration of the intervention into conventional stroke rehabilitation was discussed. The results were included in practical guidelines for each location, that prescribed in detail which actions should be taken by whom within each phase of the rehabilitation process.

3.3 Instruction & support

RPs, PTs and OTs who were directly involved in the rehabilitation of stroke patients were instructed in the delivery of the eRehabilitation intervention and the developed practical guidelines. This was done during joined instruction sessions (3 sessions, 2 hours per session, one session per healthcare professional) prior to the start of the intervention period of the effect study. Other stroke team professionals (i.e., psychologist, social worker, etc.) were informed during presentations and via internal communication. During the intervention period, support was given to healthcare professionals and patients by a helpdesk (both telephone and email), manuals and specifically trained movement technology students. For the healthcare professionals, additional support was provided by an ambassador. This ambassador was a PT who was skilled in and motivated for the delivery of eRehabilitation. Each ambassador (one per rehabilitation facility) was available for two hours per week to support colleagues in using the eRehabilitation intervention and to pass on questions and feedback to the research team.

Figure 2. Timing of the investigation of barriers and facilitators (23,24), the development of an implementation strategy and an eRehabilitation intervention, the implementation period and evaluation by the current process evaluation. In light blue the effect study with a control and intervention period.

3.4 Motivation

During the intervention period, all users were motivated by presentations, support from their managers and a video of a patient while using Fast@home.

4. Participants and data collection

Data collection methods for each domain of the MRC framework are summarized in Table 2. Both quantitative and qualitative data were collected using a mixed-methods approach. For the evaluation of the implementation (Objective 1), data were collected using field notes, a survey among patients and a survey among healthcare professionals and user data of the Fast@home eRehabilitation intervention. To explore the mechanism of impact (Objective 2), data from the aforementioned surveys were used. For identification of the contextual factors (Objective 3), data were collected using individual in-depth interviews with healthcare professionals and field notes.

All stroke patients admitted during the intervention period of the effect study could receive the Fast@home intervention, which was decided by the treating healthcare professional (see box 1 as well). Patients admitted during this period could participate in the effect study and/or the process evaluation. All healthcare professionals that provided stroke rehabilitation during the intervention period were invited to participate in this process evaluation.

Table 2. Sources and data collection methods in the three domains of the MRC framework

Aim	Content; measurement outcome	Data collection method
1. Implementation; How the implementation is delivered		
1.1 Fidelity	Whether the intervention was delivered as intended; n participants at (online) instruction, n presentations, etc.	Field notes (Ql)
1.2 Adaptations	Changes in implementation strategy	Field notes (Ql)
1.3 Dose	The quantity of intervention implemented; n participants noticed elements of implementation	Survey patients and professionals (Qt)
1.4 Reach	Whether the intended audience comes into contact with the intervention; n participants using Fast@home	Survey patients and professionals (Qt), user data of patients (Qt)
2. Mechanism of impact; Responses of participants	Satisfaction about implementation (information provision, motivation, instruction & support, integration) and eRehabilitation/Fast@home	Survey patients and professionals (Qt),
F3. Context; factors associated with use	Factors influencing the implementation and perceived impact of eRehabilitation	Interviews professionals and field notes (Ql)

Qt; quantitative data, Ql; qualitative data

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4. 1 In-depth interviews

All OTs and PTs who were instructed in the delivery of the eRehabilitation intervention and still worked in one of the rehabilitation facilities after the end of the intervention period (n=35) were invited to participate in the in-depth interviews regarding the delivery and barriers and facilitators for the delivery of the eRehabilitation intervention. RPs were not invited because in practice only PTs and OTs delivered the eRehabilitation intervention. RPs were only involved in the prescription of the intervention to stroke patients. We continued interviews with OTs and PTs until data saturation was reached. Data saturation was reached when no novel concepts emerged during three consecutive interviews [26]. The interview guide was based on the results of the preceding focus group study and survey study [23,24]. Questions included were: 'What is your experience (feasibility, added value compared to conventional methods, integration) with the eRehabilitation intervention?', 'Why did you (not) deliver the eRehabilitation intervention?' and 'How can we improve your experience with eRehabilitation?' Prompts (i.e. the content, ease of use, lay-out and accessibility) were included to encourage the participants to reflect on possible improvements. The duration of the in-depth interviews varied from 20 to 40 minutes and were conducted by two researchers (SH, BB).

4.2 Field notes

Throughout the implementation and intervention period of the effect study, field notes were made by the primary researcher and the Fast@home-ambassadors. These field notes concerned contextual factors influencing the implementation, perceptions of users of the intervention and number of healthcare professionals attending instructional activities. Field notes were tagged with date and rehabilitation facility location where the field note was taken.

4.3 Surveys

Two separate surveys were developed, one for patients and one for healthcare professionals. This was done by two researchers involved in the development and execution of the implementation strategy (BB, LvB). The surveys included questions concerning the previously identified barriers and facilitators [23,24] and the activities of the implementation strategy. Both surveys were pilot tested on readability, content and length by two patients and five professionals (SH, SB, JM, IK, AM).

The survey for the patients included baseline characteristics (gender and age) and questions regarding the possession of digital technology including smartphone, laptop, tablet, PC (yes/no). The survey also included questions to evaluate whether patients received (yes/no) and used (yes/no) the eRehabilitation intervention. If patients had not used the intervention at all, the survey was ended. If patients had used the eRehabilitation intervention, they were asked to complete the following items: use of the five applications that were part of the eRehabilitation intervention (5 items, yes/no), satisfaction about these five applications if used (5 items, range 0-10), awareness of the implementation activities (7 items, yes/no), the contribution of those activities to the use of the eRehabilitation intervention (range 0-10), the perceived barriers/facilitators in the context (7 items, range 0-10), satisfaction with the implementation in general and the eRehabilitation intervention in general (range 0-10), willingness to use Fast@home and eRehabilitation in the future (both yes/no), and whether patients performed exercises prescribed in the eRehabilitation intervention without login in (yes/no).

The survey for the healthcare professionals included the following items: professional discipline, delivery of the five applications that were part of the eRehabilitation intervention (5 items, yes/no), satisfaction about these five applications if delivered (5 items, range 0-10), awareness of implementation activities (9 items, yes/no), the contribution of these activities to the delivery of eRehabilitation (range 0-10), perceived barriers/facilitators in the context (11 items, range 0-10), satisfaction with the implementation in general and the eRehabilitation intervention in general (range 0-10), and willingness to deliver the Fast@home intervention and eRehabilitation in the future (both yes/no).

The patient survey was sent out in May 2019 to 210 patients admitted during the intervention period of the effect study (both patients who participated and patients who did not participate in the effect study), by email (n=160) and on paper (n=50) if no email address was available. Reminders were sent after two and four weeks. Thereafter, non-responders were phoned by the research team (maximum two times). If a patient responded to the phone call, the survey was administered by telephone if the patients was willing to complete it in that way. The survey for healthcare professionals (all member of the multidisciplinary team, n=80) was conducted in January 2019, individually during the weekly team conferences, to include as many as possible responders. To those who were not present at the team meetings, a personal email was sent to ask them to participate in the survey.

4.4 User data

The inclusion of patients in the effect study was done in cooperation with the ongoing, observational study Stroke Cohort Outcomes of REhabilitation (SCORE; Dutch Trial Register no. 4293 [22,25]). Inclusion criteria for patients were: being 18 years or older and time since first or recurrent stroke less than six months. Exclusion criteria were severe psychiatric conditions, inability to communicate in Dutch, concurrent acquired brain injury and/or drug or alcohol abuse. For patients included in the intervention group of the effect study, it was recorded whether they received and used the eRehabilitation intervention. For each patient who used the intervention, the number of exercises performed in the individual applications of the intervention were recorded, and how long the intervention was used (days between the first and last exercise). Details about this data collection are published elsewhere [20].

5. Data analyses

5.1 In-depth interviews and field notes

In-depth interviews were audio-taped and transcribed in full. Both in-depth interviews and field notes were analysed with initial line-by-line open coding. The codes were discussed between the two researchers (BB and LvBV) and categorized according to the levels of the implementation model of Grol and Wensing; i.e. the innovation, the organisational context, the individual patient, the individual professional, the financial context and the social context [27].

5.2 Survey and user data
Survey and user data were described using means and standard deviations (SD), median and inter quartile ranges (IQR), or numbers and percentages. Participants who completed <90% of the survey were excluded. Analyses were performed using Statistical Packages for the Social Sciences (IBM SPSS 25.0 for Windows). STARI guidelines were used for adequate data collection, analyses and reporting [28].

RESULTS

Participant response & characteristics
In-depth interviews
Of the 35 healthcare professionals invited, 11 participated (response rate 31.4%). Three of them were male (27.2%), three were OT and eight were PT.

Surveys
Of the 210 patients who were included in the intervention period of the effect study, 65 were not eligible to participate in the survey; four were deceased, of four there was no valid email or post address available and 57 patients refused participation. So finally, 145 patients were invited for the current process evaluation, of whom 73 participated (response rate 50.4%), with a mean age of 62.9 (SD 13.2) years, 43 males (58.9%) and the majority (n=68, 93.2%) possessing one or more digital devices to use eRehabilitation. Of the 73 patients who participated, 41 (56.1%) were offered the eRehabilitation intervention and 22 of those 41 patients (53.7%) actually used it.

In total, 80 healthcare professionals were invited and 51 participated in the survey (response rate 63.8%); 14 OTs (27.5%), 12 PTs (23.5%), 7 RPs (13.7%), 5 speech therapists (9.8%), 4 psychologists (7.8%), 3 social workers (5.8%) and 6 others (11.7%). Forty-six healthcare professionals who were instructed in the delivery of eRehabilitation (i.e. PT, OT, RP) were invited to participate in the survey, of whom 33 participated (response rate 73,9%), and 25 (73,5%) delivered Fast@home.

User data
165 patients were included in the effect study (details about the inclusion of participants will be published elsewhere [20]. Mean age of those patients was 62.6 (SD 10.5) years, and 103 (62.8%) were male. Of those 165 patients, 82 (49.7%) received Fast@home and 54 (65.9%, 32.7% of total group) used it.

Implementation
The implementation of the eRehabilitation intervention was evaluated regarding the following aspects of the MRC framework: fidelity, adaptations, dose and reach of the implementation strategy.

Fidelity
The implementation activities in the domains Information provision, Motivation and Instruction & support (Table 1) were delivered as planned. However, from the field notes it appeared that regarding the domain 'integration' only one out of the three teams in Basalt The Hague discussed the delivery of eRehabilitation during all weekly multidisciplinary team conferences. Furthermore, it appeared that in the second half of the implementation period promotional activities (banners, flyers, etc.) were less frequently prepared and disseminated by the research team than the intended frequency of once per month.

Adaptations
Table 3 shows activities that were executed in addition to the planned implementation activities, as recorded in the field notes. These activities were performed when the delivery of the eRehabilitation intervention fell behind. It included, amongst others, 1) extra instructional sessions for PTs and OTs, and the provision of more time for PTs and OTs to get familiar with the delivery of eRehabilitation and 2) instruction for all members of the multidisciplinary teams other than RPs, PTs or OTs (i.e. speech therapist, psychologist, social workers, movement agogist, nurses); all healthcare professionals were offered an eLearning about Fast@home, and for the movement agogist and nurses the ambassador introduced Fast@home face-to-face. The aim of the extra training for PTs and OTs was to increase confidence of PTs and OTs in delivering the eRehabilitation intervention. The extra instruction for all healthcare professionals aimed to fulfil their need to increase knowledge about the eRehabilitation intervention. Moreover, nurses and movement agogists were trained in response to PTs' and OTs' observation that they had insufficient time during regular consultations to support patients to start using the intervention.

Table 3. Adaptations made to implementation strategy, as reported in field notes

	Target group	
Domain	**Pat.**	**Prof.**
Motivation		
Extra presentations, one for each multidisciplinary stroke team	.	x
Instruction & support		
Extra instruction time (0.5-2 hours) for physical therapists and occupational therapists	.	x
Extra support from helpdesk (pro-actively offering support)	.	x
Other disciplines (nurses, movement agogist, social workers) instructed in using eRehabilitation	.	x
Integration		
Nurses playing an active role in encouraging patient to use eRehabilitation	x	x
Movement agogist supporting patients in the first time use of eRehabilitation	x	x

Pat; patients, Prof; healthcare professionals

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Table 4: Dose of the implementation, based on survey with patient and healthcare professionals using Fast@home, n patients/healthcare professionals noticed activities of the implementation strategy, in n (%)

Domain	Patients (n=22)	Healthcare professionals* (n=25)
Information provision		
Presentations	.	21 (84.0%)
Promotional activities	18 (81.8%)	22 (88.0%)
Integration		
Email with login credentials	15 (68.2%)	.
eRehabilitation discussed with OT/PT	20 (90.9%)	.
eRehabilitation discussed with RP	14 (63.6%)	.
Instruction & support		
Information folder for patient	16 (72.7%)	20 (80.0%)
Helpdesk (telephone and email)	11 (50.0%)	19 (76.0%)
Manual for patients and professionals	10 (45.5%)	18 (72.0%)
Ambassador	.	19 (76.0%)
ELearning	.	15 (60.0%)
Students available for support	.	14 (56.0%)
Motivation		
Video with patient using Fast@home	.	12 (48.0%)

* Only occupational therapist (OT), physical therapist (PT) and rehabilitation physician (RP)

Dose

Table 4 shows the awareness of the implementation activities (dose) as reported in the surveys by patients and healthcare professionals. On average, each activity of the implementation strategy was noticed by 60.7% (range 45.5%-90.9%) of the 22 patients using eRehabilitation, and 71.1% (range 48%-88%) of the 25 healthcare professionals delivering eRehabilitation. Of all implementation activities, patients who used eRehabilitation most frequently noticed the integration activity 'discussing the use of the eRehabilitation intervention with the PT/OT' (n= 90.9%); healthcare professionals reported that they most frequently noticed the 'promotional activities like banners, flyers, internal and external communication' (n= 88%).

In the field notes it was reported that of the 47 (95.9%) out of 49 healthcare professionals who were invited for the instructional session (RPs, OTs and PTs only) did attend.

Table 5: Reach of patients; use of applications within Fast@home by patients, based on the user data

Use of eRehabilitation (total/used)	Cognitive exercises (n=165/20)	Physical exercises (TR, n=65/20)	Physical exercises (PhT, n=100/16)	Activity-tracker (n=165/15)
Number of exercises, median (IQR, min-max)	14 (2-37, 1-308)	9.5 (4-23, 1-66)	9.5 (3-51, 1-548)	4 (1-15, 1-110)
Period of use, mean days (median, IQR)	26 (9.5-150.5)	25 (16.5-62.5)	9 (1-21)	-*

TR; Telerehabilitation, used in Leiden, PhT; Physitrack, used in The Hague, * Information for Activ8 not available

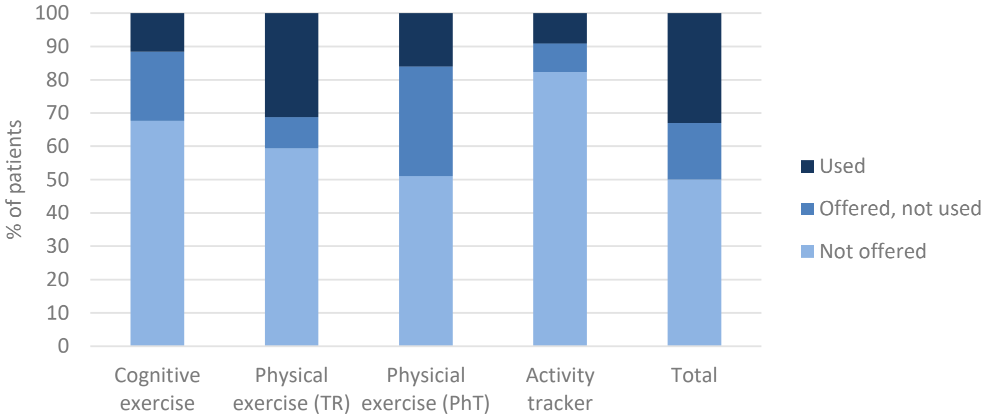

Figure 3. Reach of patients, by the number of patients receiving and using Fast@home. TR; Telerehabilitation, PhT; Physitrack

Reach

Figure 3 shows that 50% (n=82) of the 165 patients with an account for the eRehabilitation intervention had access to at least one application. Subsequently, 65.6% of those who received the intervention (n=54, 29 in The Hague and 25 in Leiden) actually used of one or more of those applications. The cognitive exercise application was used by 20 (24.4%) patients, the physical exercise application Telerehabilitation (Leiden only) by 20 of the 25 patients (80.0%), Physitrack (the Hague only) by 16 of the 29 patients (55.1%) and the activity-tracker by 15 (18.2%) patients.

In Table 5, the median use of the applications is shown, also based on the user data. The cognitive exercise application was most frequently used (median 14 exercise sessions, IQR 2-37) and for the longest period (median number of days 26, IQR 9.5-150.5). The number of exercises performed with the two physical exercise applications were comparable (Telerehabilitation; median 9.5 exercise sessions, IQR 4-23; Physitrack; median 9.5 exercises sessions, IQR 3-51). However, Telerehabilitation was used on average for 25 days (IQR 16.5-62.5) and Physitrack for 9 days (IQR 1-21). The data of the activity-tracker was on average uploaded four times (IQR 1-15). The majority of the patients participating in the survey (n=19, 86.5%) reported that they performed exercises prescribed in the eRehabilitation intervention without logging on since they know the exercises by heart.

Figure 4 shows that 8 of the 14 OTs (57.1%), 12 of the 12 PTs (100%) and 5 of the 7 RPs (71.4%) reported to have delivered at least one application of the eRehabilitation intervention (i.e. physical exercise program, cognitive exercise program or activity-tracker). Since additional instruction was offered to the remaining disciplines, also 2 of the 5 (40%) speech therapists delivered the eRehabilitation intervention, as well as 2 of the 6 (33%) other disciplines (a dietician and movement agogist).

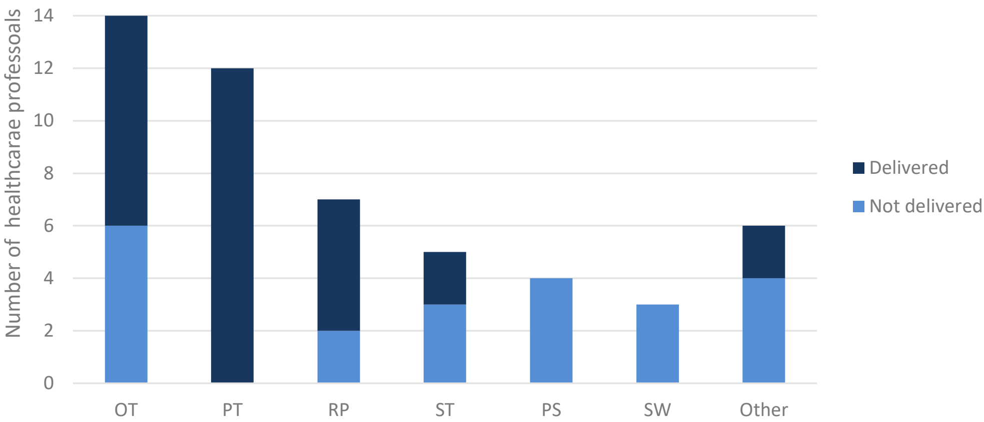

Figure 4. Reach of professionals, by the number of professionals that delivered Fast@home to stroke patients OT; occupational therapist, PT; physical therapist, RP; rehabilitation physician, ST; speech therapist, PS; psychologist, SW; social worker

Mechanisms of impact

The mechanisms of impact are defined as the extent to which the implementation activities contributed to the delivery and use of the eRehabilitation intervention. The results that describe the mechanisms of impact are shown in Table 6, as measured with the surveys among patients and healthcare professionals.

Interaction with implementation strategy

The satisfaction regarding the implementation activities of healthcare professionals (n=25) and patients (n=22) who respectively delivered and used the eRehabilitation intervention was comparable (median 7.0 (IQR 6.0-7.5) and 7.0 (IQR 6.0-7.75)). Healthcare professionals reported that the support of the ambassadors (domain instruction & support, median 7.0, IQR 6.0-8.0) and the time they were given to learn how to deliver intervention (domain integration, median 7.0, IQR 6.0-8.0) had the greatest impact of all implementation activities. On the contrary, activities in the domain integration hampered the delivery of the eRehabilitation intervention, according to healthcare professionals. This included insufficient integration of Fast@home into conventional stroke rehabilitation (median 4.0, IQR 2.0- 6.0) and insufficient time to apply eRehabilitation in daily rehabilitation practice including the discussion of benefits, explaining how to use the eRehabilitation intervention and to adapt the exercises in the physical exercise applications if needed (median 5.0, IQR 3.0-7.0). Multiple activities of the implementation strategy facilitated the use of the eRehabilitation intervention according to patients. For patients, the implementation activity with the highest impact was individual guidance by PTs and OTs (domain integration, median 7.0, IQR 7.0-8.0),

Table 6. Mechanisms of impact. Interaction with the implementation strategy and intervention, based on survey with patient and healthcare professionals using the eRehabilitation intervention

	Satisfaction/agree	
	Patient (n=22)	**Professionals* (n=25)**
Interaction with the implementation		
Overall satisfaction about implementation strategy activities (0-10), median (IQR)	7.0 (6.0-7.75)	7.0 (6.0-7.5)
Satisfaction about implementation strategy activities (0-10), median (IQR)		
Information provision; Presentation	.	6.0 (5.5-7.0)
Information provision; Promotional activities	6.0 (6.0-7.0)	7.0 (5.75-7.25)
Integration; Fast@home discussed with OT/PT (personal guidance)	7.0 (7.0-8.0)	.
Integration; Fast@home discussed with RP (personal guidance)	7.0 (5.75-7.25)	.
Integration; Email with login credentials	6.0 (5.0-7.0)	.
Instruction & support; Joint education	.	7.0 (6.25-8.0)
Instruction & support; Sufficient time to learn how to use		7.0 (6.0-7.0)
Instruction & support; Helpdesk (telephone and email)	6.0 (6.0-8.0)	6.0 (5.0-7.0)
Instruction & support; Manual	7.0 (6.0-7.25)	6.5 (5.0-7.25)
Instruction & support; Information folder	6.0 (4.5-7.75)	7.0 (5.0-7.75)
Instruction & support; Ambassador	.	7.0 (6.0-8.0)
Instruction & support; ELearning	.	6.0 (4.0-7.0)
Instruction & support; Students available for support	.	6.0 (3.75-8.0)
Motivation; Sufficiently supported by the Executive Board	.	6.0 (5.0-7.0)
Motivation; Sufficiently supported by managers	.	6.0 (5.0-7.0)
Motivation; Sufficiently supported by rehabilitation physicians	.	6.0 (4.75-8.0)
Barriers/facilitators in the implementation (0-10; disagree-agree), median (IQR)		
I had sufficient time to use eRehabilitation	.	5.0 (3.0-7.0)
Is sufficiently integrated into the conventional rehabilitation	.	4.0 (2.0-6.0)
Interaction with the intervention		
Overall satisfaction about the Fast@home intervention (0-10), median (IQR)	8.0 (7.0-8.0)	5.5 (4.0-7.0)
Satisfaction about applications within Fast@home (0-10), median (IQR)		
Psycho education	7.0 (7.0-8.0)	7.0 (6.0-7.0)
Activity-tracker	8.0 (6.0-8.0)	6.0 (3.0-8.0)
Physical exercise application (Telerehabilitaion)	7.0 (6.0-8.0)	7.0 (7.0-8.0)
Physical exercise application (Physitrack)	7.0 (6.0-8.0)	7.0 (5.75-8.0)
Cognitive exercise application	7.0 (6.0-8.0)	6.0 (3.0-8.0)
Barriers/facilitators related to the intervention (0-10; disagree-agree), median (IQR)		
Contributed to recovery of the patient	7.0 (5.75-8.0)	6.5 (5.0-7.0)
Has added value for my work as professional	.	6.0 (4.5-7.0)
Is applicable in addition to convention therapy	7.0 (6.0-8.0)	6.0 (3.0-8.0)
Is feasible despite disabilities after stroke	7.0 (2.5-10.0)	5.0 (4.0-7.0)
Is user-friendly	7.0 (6.0-7.25)	5.0 (3.0-7.0)
Recommend future use, n (%)		
Recommend Fast@home to others	20 (90.0%)	14 (56%)
Use Fast@home in the future	19 (86.4%)	.
Use eRehabilitation in the future	.	22 (88%)

* Only occupational therapist (OT), physical therapist (PT) and rehabilitation physician (RP)

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Interaction with the intervention
Healthcare professionals who delivered the eRehabilitation intervention reported to be less satisfied with the Fast@home intervention as a whole than patients who used the eRehabilitation intervention (median 5.5 (IQR 4.0-7.0) and 8.0 (IQR 7.0-8.0) respectively). However, healthcare professionals reported to be satisfied about the physical exercise applications (Telerehabilitation median 7.0, IQR 7.0-8.0 and Physitrack median 7.0, IQR 5.57-8.0) and the psycho education (median 7.0, IQR 6.0-7.0), but less about the activity-tracker and the cognitive exercise application (both median 6.0, IQR 3.0-8.0). Patients were relatively satisfied about all five applications in Fast@home; psycho education (median 7.0, IQR 7.0-8.0), two physical exercise application (Telerehabilitation median 7.0, IQR 6.0-8.0; Physitrack median 7.0, IQR 6.0-8.0), cognitive exercise application (median 7.0, IQR 6.0-8.0)) and the activity-tracker (median 8.0, IQR 6.0-8.0). Furthermore, patients reported that the feasibility of the eRehabilitation intervention was high, despite stroke-related impairments (median 7.0, IQR 2.5-10.0), healthcare professionals were more negative (median 5.0, IQR 4.0-7.0). The same difference between patients and healthcare professionals was found concerning the user-friendliness of the eRehabilitation intervention (professional median 5.0 (IQR 3.0-7.0), patient median 7.9 (IQR 6.0-7.25)).

Of the 25 healthcare professionals, 14 (56.0%) would recommend Fast@home to others and 22 (88.0%) wanted to deliver eRehabilitation in the future. When accounted for all responses of healthcare professionals (also those who did not deliver eRehabilitation), a similar proportion of 88.0% (n=45) was found regarding the wish to deliver eRehabilitation in the future. In total, 20 of the 22 (90.9%) patients taking part in survey and used the eRehabilitation intervention would recommend Fast@home to others and 19 (86.4%) were planning to keep using eRehabilitation in the future.

Contextual factors
Table 7 shows the contextual factors influencing the implementation of eRehabilitation, based on the in-depth interviews with 11 healthcare professionals and field notes taken during the intervention period.

Six factors concerned the innovation, of which four reported both as barrier and facilitator and two reported only as barrier. These factors included eRehabilitation being evidence-based (barrier and facilitator), the content of exercise applications being useful to attain the specific rehabilitation goals of the individual patients (barrier and facilitator) and the number of patients per healthcare professional being too small to deliver eRehabilitation regularly and efficiently (barrier only).

Twelve factors, mostly barriers, were identified concerning the organisational context. These factors included insufficient integration of the eRehabilitation intervention into conventional stroke rehabilitation, resulting in healthcare professionals forgetting to deliver eRehabilitation. Insufficient time was also reported, both to learn how to deliver the eRehabilitation intervention and to deliver the eRehabilitation intervention in conventional stroke rehabilitation. Especially ‘playing time’, in which healthcare professionals can get acquainted with the new intervention was reported as important. Financial cutbacks during the intervention period resulted in less time for the healthcare professionals to properly incorporate eRehabilitation into their daily routine. Moreover, stroke patients were no longer merely admitted to stroke units, therefore some patients were treated by healthcare professionals who were not instructed how to deliver Fast@home. Another important barrier was the experience of technical setbacks including problems delivering the intervention on an Apple device and uploading data from the activity-tracker. A facilitator at the level of the organisational context was the presence of the ambassadors.

Four factors were identified at the level of the individual patient and three factors at the level of the individual healthcare professional. For both the patients and healthcare professionals, skills and knowledge about how to use and deliver the eRehabilitation intervention were reported as sufficient (facilitator) as well as insufficient (barrier). According to the professionals, insight in daily activities and exercises activities is an important reason for patients to start using the eRehabilitation intervention. For healthcare professionals a motivation to deliver eRehabilitation is that it facilitates the cooperation between PTs and OTs and multidisciplinary work. According to the healthcare professionals, a reason for patients not to use eRehabilitation was that there is no added value of logging in if the patient knew the exercises by heart. The motivation to deliver eRehabilitation for the healthcare professionals was hampered by the feeling of doing double work by prescribing exercises in one of the exercise applications and reporting in the treatment plans.

Concerning the social context, two factors were identified hampering the implementation of the eRehabilitation intervention: the beliefs of the healthcare professional about the effectiveness of eRehabilitation, and the relatively low priority for the implementation of eRehabilitation among managers and RPs.

DISCUSSION

This process evaluation aimed to understand what worked and why in the implementation of an eRehabilitation intervention integrated into conventional rehabilitation for stroke patients, and to identify areas of improvement for future implementations. The implementation strategy was mostly executed as planned and supplemented with additional instructional activities, resulting in the delivery of intervention by three-quarters of the healthcare professionals and in actual usage by two-thirds of the patients who received it. Regarding the mechanisms of impact, it was found that professionals and patients were equally satisfied with the implementation activities, but patients were more satisfied with the intervention. The implementation activities with the highest impact were, amongst others, personal guidance by PTs, OTs and RPs (for the patients) and the support of ambassadors, joint education and time given for learning to deliver eRehabilitation (for the healthcare professionals). However, at the end, professionals reported that eRehabilitation was insufficiently integrated into conventional rehabilitation, despite all implementation activities. Contextual factors that hampered the implementation, including unexpected financial cutbacks, technical setbacks and low priority of the implementation of eRehabilitation among managers and RPs.

Table 7. Contextual factors influencing the implementation, reported in interviews with professionals and field notes, categorized among the levels of Grol

	Factor	Sub-factor	B,F	Quote interviews	Field notes
Innovation	Feasibi-lity	Helpdesk function	B,F	SH (F); *'I think there was a lot of support for us [therapists] in using eRehabilitation. For example, a helpdesk that was reasonably accessible.'* AO (B): *No, it [the use of eRehabilitation] was complicated because things didn't work or patients did not have login credentials.'*	.
	Attrac-tiveness	Ease of use	B,F	SB (B); *'Less clicks and actions would improve the ease of use of the eRehabilitation intervention. It must be simpler.'* BM (F); *'For the patients I thought it [the eRehabilitation intervention] was convenient, it is very clear how you go through to use the different applications."*	.
		Content of eRehabilitation	B,F	MB (B); *'It is better to learn explicitly instead of learning implicitly, so the exercises needs to have something functional. For example, get up from the chair instead of making squats. Now, there are only implicit exercises available.'* LH (F); *'There are plenty of options for different exercises within the eRehabilitation intervention. That makes me happy.'*	Request from healthcare professional for task-oriented arm/hand exercises, which are not standard but can be developed.
	Advan-tage of use	Innovation offering advantage	B,F	EP (F); *'We have less and less time for treatment per patient. This [Fast@home] is particularly a very good solution to compensate for that problem.'* SH (B); *'Since there is some doubt about the added value of this eRehabilitation intervention compared to the conventional treatment, they are not willing to make the investment to learn working with the eRehabilitation intervention.'*	A healthcare professional mentioned that patients ask for Fast@home during treatment. Patient see the added value and want to try it.
		Proven effects	B	IS; *'Especially for Braingymmer [cognitive training], it is actually not scientifically proven that that would help.'*	In Leiden, professionals are not keen on using the cognitive exercise program because of the lack of scientific evidence.
	Applica-bility	Few patient suitable for eR	B	BM; *'There are times that you use eRehabilitation a lot, but sometimes there a periods in which you are working with patients for whom it is not feasible to use it in their rehabilitation. In those periods, you use it just too little to keep up your skills regarding the use of the eRehabilitation intervention in rehabilitation.'*	"Speech therapist and social workers are trained in the use of FAST@HOME and are enthusiastic, but currently they do not see patient to practice it with".
Organisational context (1)	Organi-sation of care	Conflict with other projects	B	BM; *'We are now very busy with the entire CARAS arm-hand training. Immediately, you notice that FAST@HOME shows a decrease in use because there is limited time to implement new things in addition to the already busy schedules.'*	.
		Ambassador useful	F	EW; *'The ambassador does a great job. She sends regular emails and she makes sure there is very frequent time to work with eRehabilitation. So in that sense it is really facilitated and supported.'*	Ambassadors help colleagues with first time use of intervention and report that this is helpful.
		Problems administering accounts	B	AO; *'There were problems with the patient administered in Fast@home. It turned out the patient was not registered in Fast@home, which should be done automatically at the start.'*	.
	Resour-ces	Hardware	B	ET; *'We do not have a computer in our department where patients can use Fast@ home.'*	Healthcare professional reporting: "Also, not all patients have their own device."

	Factor	Sub-factor	B,F	Quote interviews	Field notes
Organisational context (2)		Software	B	BM; *'Here in the clinical departments there were sometimes complaints about the failing internet connections, which caused problems in using eRehabilitation for patients.'*	Due to an update of the internet firewall, exercises of Braingymmer are not accessible anymore. The Activ8 [activity-tracker] accidentally ended up in the washing machine, and now the activity data is lost.
	Time	Time to learn	B	ET; *'I think the recommendation for future projects would be to make sure you have instruction at the beginning, but also 'playing time'. That healthcare professionals can get to know the eRehabilitation program.'*	A healthcare professional was positive but felt that she did not yet master the program, she said she felt insecure. She would like to have 2 hours each week for 5 weeks to learn how to work with eRehabilitation.
		Time to use	B	SH; *'Everyone already has a full schedule and extra something [the use of eRehabilitation] is added. Therapists simply do not have the time to also tailor an exercise program for each patient.'*	Healthcare professionals are willing to try to discuss Fast@home more during conventional therapy, but indicates that there is already little time for each patient.
	Changes context and conven-tional rehabili-tation	Financial cutbacks	B	.	This week [December 2017] major budget cuts were announced including redundancy, which gives a noticeable changed in atmosphere within the organization in The Hague.
		Increasing patient related time	B	.	Financial situation is less positive than expected. Guidelines are published to increase production, resulting in less time for additional activities [like innovation projects].
		Patient admitted to all units	B	.	To occupy as many beds as possible, stroke patients are now admitted in all units, including units not instructed in the use of eRehabilitation.
	Imple-menta-tion in conven-tional care	Implementation in usual rehabilitation	B, F	SB; *'I think it [the use of the eRehabilitation intervention] is not implemented enough in our conventional rehabilitation processes. I forget to use it, because it is something new and you don't get reminders during team meetings.'*	Movement agogist are instructed in the use of eRehabilitation. They are motivated to support patients during their first time use and unburden healthcare professional who had to do this during therapy time.
		Temporary, flex worker	B	ET; *'I set up an exercise program for a patient. I didn't evaluate whether she used it or not, it wasn't for one of my patients.'*	In the summer months, there are several flex workers to compensate for healthcare professional on holiday. Must they be instructed, for e.g. via e-learning?

6

Table 7 continued

	Factor	Sub-factor	B,F	Quote interviews	Field notes
Individual patient	ICT-skills		B,F	BM (B); *'For the older patients who do not have a feeling with computers, I will not use Fast@home, it is so unfamiliar for them that it is not going to work.'* CB (F): *'To be honest, patients have been using computers for 15 years now. I had a 70-year-old patient with a smartphone, so I think it will be become less an issue.'*	.
	Motiva-tion to change		B,F	EP (B); *'Patients don't really use the videos. They only see which exercise they have to do and think 'I have to make a squat', for example, and then they will do that, instead of always watching the videos.'* AO (F); *'I think that the concept of registering and tracking activity and exercise, is very attractive, and also patients are interested in it. They appreciate it as well.'*	.
Individual professional	Know-ledge		B,F	EP (F); *'Patients are very enthusiastic, they realize that they can do more independently. I think that people are also well informed about how to do this.'* SH (B); *'Patients do not use it because they do not understand how to use it.'*	.
	Patient charac-teristics		B	LH; *'Very often patients starting [with rehabilitation therapy] have limited mental capacity and get easily over stimulated.'*	A healthcare professional mentioned: "My patients are too old or do not have a laptop or something."
	Motiva-tion to change		B,F	EP (B): *'I think that healthcare professionals have the feeling of doing double work at the beginning. They already report an exercise in the electronic patient registries, and then they also have to prepare the exercise in the eRehabilitation program.'* IS (F); *'I think that the multidisciplinary team is aware of using eRehabilitation, so occupational therapist and physical therapist can cooperate together really easy.'*	.
	Know-ledge		B,F	**SB (F);** *'And for example, healthcare professionals have now made a step-by-step plan containing a really clear overview of all the steps to set up an exercise program, and I have the idea that this gives a bit of insight and an extra manual to keep the overview.'* **SB (B);** *'After the joined instruction at the start, I felt insecure working with it.'*	A healthcare professional mentioned: "I got all flyers on my desk, but the person who brought them said that other worlds knew what to do with them. I don't"
	Skill		B	AO; *'Logging in with my credentials, it was a terrible hassle. It will be my age as well.'*	.
Social context	Culture in team		B	ET; *'At a certain point I stopped doing that [motivating colleagues to use Fast@home], if I don't hear anyone anymore.'*	Managers say Fast@home has become a goal in itself, as many patients as possible in the study and not so much improvement in care.
	Leader-ship	No priority management	B	ET; *'It all depends on time and, indeed, also on priority. But it [the use of eRehabilitation] has no priority now. You can't change a lot unless the managers say 'we have to do this'.*	The board says Fast@home needs to be used by default, but the professional feel they did not have the opportunity to really invest time and don't master the program.

B; barrier, F; facilitator

The current process evaluation enabled us to identify what worked and why, and thus to reflect on how the implementation may have influenced outcomes and to highlight lessons for future implementation. Previous implementation studies only investigated potential barriers and facilitators for the implementation of eRehabilitation [29-31] or the feasibility or acceptability when implemented [32-34]. Below, areas of improvement for future implementations will be discussed for each of the three domains of the MRC framework.

Regarding the implementation strategy, on first sight the use of the eRehabilitation intervention by patients may seem quite low. A usage rate of 66% among those who received the intervention is, however, in line with previously published studies that reported proportions of patients using eRehabilitation interventions at least once (66-100%, [35-39]). The number of days that the intervention was used (median 19 days) was higher than found in a previous study that reported a median of 5 days [40]. Moreover, in the design of the Fast@home study, all patients admitted to conventional stroke rehabilitation were assumed to be eligible for eRehabilitation. This has probably resulted in a number of patients included in this study who were actually not able to use eRehabilitation. This could well be a reason for healthcare professionals not to offer the intervention to some patients, thereby increasing the percentage of non-users of the total group of patients. Therefore, it is important to gain insights in and better define which patients would be eligible and who would benefit most from eRehabilitation [8].

Regarding the mechanisms of impact, the delivery and use of the eRehabilitation intervention could probably have been improved as we succeeded 1) to integrate the eRehabilitation better in the conventional rehabilitation and 2) to increase the healthcare professionals' satisfaction with the eRehabilitation intervention. To enhance the integration, additional instructions and time to get familiar with the delivery of the eRehabilitation were offered to PTs and OTs, as well as to the whole multidisciplinary team. As a consequence of the involvement of the whole multidisciplinary team, the workload of PTs and OTs delivering the eRehabilitation intervention to patients was reduced and better manageable. Previous literature showed that starting to use an eRehabilitation intervention by patients required the support of a healthcare professions for on average 41 minutes [40]. This support is found to be the most important for patients, in this study and before [32]. However, despite the implementation activities, healthcare professionals were still not satisfied about the integration. Previously, it is already indicated that proper integration of eRehabilitation might be the largest challenge in the maturation of eRehabilitation [6,41] and that successful integration of eRehabilitation in conventional rehabilitation can probably only be achieved when all parts of the conventional rehabilitation are redesigned [6]. To increase healthcare professionals' satisfaction, it is important to address healthcare professionals' lack of belief in the effectiveness of some of the applications within the eRehabilitation intervention. According to the healthcare professionals, the effectiveness of some of the applications within the eRehabilitation intervention was questionable, which influenced their motivation to deliver the eRehabilitation intervention. This confirms findings from previous literature, in which was stated that belief in the effectiveness of an eRehabilitation intervention is crucial for successful delivery [23].

With respect to contextual factors, a prompt and better response to some observations in the present study could also have led to better results. In our study it appeared that healthcare professionals experienced additional barriers during the intervention period as to the ones they expected on beforehand. These included financial cutbacks that forced healthcare professionals to focus on production instead of novelties like eRehabilitation, low priority given to the delivery of the intervention by managers and rehabilitation physicians, and technical setbacks that made it more difficult for healthcare professionals to deliver the eRehabilitation intervention. This latter barrier was also found in previous studies [6,18], and thus it is an important point of attention for future implementation initiatives.

Based on all of the abovementioned findings, it is recommended for future eRehabilitation initiatives to increase delivery of eRehabilitation by healthcare professionals. This can be achieved by sufficient integration in conventional rehabilitation, increased satisfaction with the intervention and resolve barriers in the context. Therefore, it is important to redesign conventional rehabilitation in such a way that the interventions become an indispensable part of the rehabilitation process. For example, by setting treatment goals for patients that can only be met and measured using eRehabilitation. Such a redesign of the rehabilitation process should be done in co-creation with patients, healthcare professionals and the research team [36]. Moreover, the results indicate that a flexible approach towards the implementation process is needed to be able to give a better response to unexpected barriers for the implementation, such as unexpected financial cutbacks. Regarding the research methodology, we recommend to use techniques developed by experts in action research, which allow adaptation of the intervention and implementation strategy to counteract unexpected barriers [19].

Although this study provides some new insights in the implementation process of eRehabilitation in stoke care, some limitations should be discussed. First, this study focussed on the users of the eRehabilitation intervention more than on non-users. Thus, insight into non-users perceptions of why eRehabilitation was not used and what would have motivated them is limited. Second, the majority (86.5%) of patients reported to use the eRehabilitation intervention without logging in since they knew the exercises by heart. This underlines the challenges of accurately measuring the use of eRehabilitation applications. In our case, the actual use of the eRehabilitation intervention may probably have been higher than reported. Future effect studies and process evaluations should be able to monitor the usage of eRehabilitation interventions better, by giving the patients more incentives to log in to the eRehabilitation applications. Third, the delivery of eRehabilitation intervention by healthcare professionals as part of the conventional rehabilitation was voluntary, resulting in some OTs/PTs barely providing the eRehabilitation intervention to patients. Although there may have been good reasons for this, such as patients being non-eligible for the intervention, making eRehabilitation a fixed part of the conventional rehabilitation would maybe have resolved possible ignorance.

CONCLUSION

In conclusion, the main areas for improvement of an implementation process of eRehabilitation appear to be related to the perceptions of healthcare professionals on the intervention, the actual integration of eRehabilitation in conventional rehabilitation, as well as contextual, mostly technical and organizational, factors.

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7

Summary & General Discussion

SUMMARY

Aim of this thesis

Stroke is a relatively common condition with a large impact on patients' lives. Rehabilitation treatment aims to support patients in coping with the physical, mental and cognitive consequences of stroke. Although technologies are increasingly available for rehabilitation purposes, the actual use of eRehabilitation in clinical practice after stroke can be improved.

The main aim of this thesis was to gain insight in the interplay between the effectiveness, the implementation, and the context in which eRehabilitation after stroke will be used, as delivered in a specialised rehabilitation facility. To study this interplay, the sub aims were:

1. Identify the (most important) barriers and facilitators of patients, informal caregivers and healthcare professionals regarding the use of eRehabilitation after stroke;
2. Investigate the effectiveness of a multidisciplinary eRehabilitation intervention embedded in conventional stroke rehabilitation, using a hybrid implementation and effectiveness study design;
3. Investigate what works and why in the implementation of a multidisciplinary eRehabilitation intervention in conventional stroke rehabilitation, by using a hybrid implementation and effectiveness study design.

Main findings

*In Chapters 2, 3 and 4, the barriers and facilitators perceived by patients, informal caregivers and healthcare professionals for the use of eRehabilitation after stroke were identified and prioritized **(Aim 1)**.*

Chapter 2 concerned a qualitative focus group study aiming to identify expected barriers and facilitators for the use of eRehabilitation after stroke. Expected barriers/facilitators were investigated by means of eight focus groups; six focus groups with in total 32 stroke patients and 15 informal caregivers, and two focus groups with in total 13 healthcare professionals (rehabilitation physicians, physiotherapists, occupational therapists, psychologists and managers) involved in stroke rehabilitation. Focus groups were audiotaped, transcribed in full and analysed by direct content analysis according to the implementation model of Grol. A total of 14 influencing factors were found, which were classified to five of the six levels of the implementation model: Innovation, Organizational context, Individual patient, Individual professional, Economic & political context. Most quotes from patients, informal caregivers and healthcare professionals were comparable and classified to the level of the Innovation (e.g. content, attractiveness and feasibility of an eRehabilitation intervention). In addition, patients' responses were relatively often classified at the level of the Individual patient (e.g. patients characteristics as fatigue and the inability to understand ICT devices). For the healthcare professionals, relatively many quotes were classified to the level of the Organizational context (e.g. having sufficient time and the shift in tasks and responsibilities in conventional rehabilitation). It was concluded that there was considerable overlap in reported factors between patients/informal caregivers and healthcare professionals regarding the level of innovation. However, patients/informal caregivers put particular emphasis on factors related to the Individual patient whereas healthcare professionals emphasized the importance of factors related to the Organizational context.

In **Chapter 3**, a large scaled national cross-sectional survey study is described, that aimed to investigate which expected barriers and facilitators that were identified in Chapter 2 are most important in the use of eRehabilitation. Based on the outcomes of the qualitative study, 88 statements about barriers and facilitators potentially influencing the intention to use eRehabilitation were scored on their importance for using eRehabilitation (1-4; unimportant-important). Besides, the survey included one statement about the willingness to use eRehabilitation in the future (yes/no). A one-time online survey was conducted among 125 stroke patients, 43 informal caregivers and 103 healthcare professionals (physicians, physiotherapists, psychologists). The 88 statements were allocated to and grouped into 16 factors of the implementation model of Grol using factor analyses. Next, univariate logistic regression analyses were used to assess the association between the 16 factors (the independent variables) and the intention to use eRehabilitation (the dependent variable). All factors that were positively associated with the intention to use eRehabilitation in the univariate analyses were entered simultaneously in a multivariable logistic regression analysis. This multivariable analysis showed that the intention to use eRehabilitation was positively influenced by perceived benefits for patients (i.e. reduced travel time, increased motivation, increased health-related outcomes), for patients (OR 2.68, 95%CI 1.34-5.33), informal caregivers (OR 8.98, 95%CI1.70-47.33) and healthcare professionals (OR 3.87, 95%CI 1.41-10.64). However, insufficient knowledge about the use of eRehabilitation was associated with a decrease in intention to use eRehabilitation for patients (OR 0.36, 95%CI 0.17-0.74). It was concluded that although differences were found between patients/informal caregivers and healthcare professionals, perceived benefits of the use of eRehabilitation facilitated willingness to use eRehabilitation for patients, informal caregivers and healthcare professionals.

Contextual factors not only concern the local context but also national or cultural aspects. To get more insight in the impact of international and intercultural aspects, in **Chapter 4**, an international comparison between Brazilian and Dutch healthcare professionals (BHP and DHP) regarding factors influencing the use of eRehabilitation was made. The survey used in Chapter 3 was translated into Portuguese and administered to 99 BHPs (physical therapists, rehabilitating physicians and psychologists, nurses, hospital educators, physical education teachers and neurologists). To compare the responses of the BHPs with the DHPs, a top-10 most and a top-10 least important statements for Brazil and The Netherlands was composed by calculating the median importance score of each of the 88 statements in the survey. In the top-10 most influencing statements, four statements were found in both top-10's of the BHPs and DHPs, the other six statements differed. Overlap concerned the ease of use and better health-related outcomes after the use eRehabilitation. Concerning the disagreeing statements of the top-10, most important for BHPs were sufficient support from the rehabilitation centre with respect to resources and time. DHPs rated the feasibility of the use of eRehabilitation for the patient (i.e. a helpdesk and good instructions) as most important for effective use. Top-10 least important statements were mainly similar; eight statements were found in both the top-10's of BHPs and DHPs, related to problems caused by stroke (i.e. aphasia or cognitive problems) or problems with resources (i.e. hardware and software). Therefore, it was concluded that the use of eRehabilitation after stroke by BHPs and DHPs is partly influenced by different factors but there is also a considerable overlap in less important factors. To develop an effective implementation strategy, barriers and facilitators specific for each county needs be taken into account.

*Using the knowledge of the studies described in the Chapters 2, 3 and 4, an eRehabilitation intervention and accompanying implementation strategy was developed and carried out at two locations of a specialized rehabilitation facility. In Chapter 5, the effectiveness of this multidisciplinary eRehabilitation intervention implemented in clinical stroke rehabilitation was investigated **(Aim 2)**. In Chapter 6, the accompanying implementation strategy was evaluated **(Aim 3)**.*

Chapter 5 concerned an observational study with a clinical pre-post design, comparing outcomes of stroke patients admitted in a period where only conventional rehabilitation was offered (control group, n=153) with patients admitted in a period where stroke rehabilitation was combined with eRehabilitation (intervention group, n=165). This multidisciplinary eRehabilitation intervention, named Fit After Stroke @Home (Fast@home), comprised one digital environment with possibilities for cognitive and physical exercise programs, wearable activity-tracking devices and online psycho education, and was delivered alongside conventional rehabilitation. All patients in the intervention group were given access to the psycho education and if beneficial, one or more of the other applications was offered by the treating healthcare professional. Primary outcomes included seven domains of the Stroke Impact Scale (SIS; hand function excluded because of an administration error) and secondary outcomes included measures of health-related quality of life, fatigue, self-management, participation and physical activity. Measurements were done at admission (T0), and three and six months thereafter (T3, T6). Change scores between T0-T3, T3-T6 and T0-T6 were compared between the intervention and control groups by means of analysis of variance and linear mixed models, adjusted for potential confounders including age and type of rehabilitation (inpatient or outpatient). In the intervention group, 82 (50%) patients received the intervention, of whom 54 (66%) used one or more applications. In the first three months of rehabilitation, no differences between the total intervention and control groups were found. Between three and six months, a favourable effect of the intervention was found for the SIS domains Communication (p=0.026) and Physical strength (p=0.010), although the mean change scores were all below the minimally clinically significant difference. No significant differences were found for other outcome measures, between T0-T3, T3-T6 or over all time points. When only those who used the intervention were compared with the control group (per protocol analysis) the favourable effect on the SIS domains Communication (p=0.019) and Physical strength (p=0.008) was confirmed, supplemented with a favourable difference in the domains Memory (p=0.031) and Meaningful activities (p=0.040). The conclusion of this study is that a comprehensive eRehabilitation intervention combining multiple applications, offered alongside conventional stroke rehabilitation, is beneficial regarding the maintenance of some of the improvements obtained directly after stroke. This was based on small, yet statistically significantly greater improvements of communication and physical strength in the intervention group between three and six months after starting rehabilitation.

In **Chapter 6**, the implementation strategy was evaluated according to the Medical Research Council framework. The objectives were 1) to describe the implementation process of Fast@home (dose, fidelity, adaptations and reach), 2) to explore the mechanisms of impact (participants' responses and interaction with Fast@home) and 3) to identify contextual factors influencing the implementation. The predefined implementation activities included information provision for healthcare professionals and patients, integration of the intervention into conventional rehabilitation, instruction, practical support and motivation of professionals directly involved. Implementation activities were carried out over a 14-month period in a specialized rehabilitation facility. A mixed-methods design was used; qualitative data included field notes made during the implementation and in-depth interviews were conducted after the intervention period was ended with 11 healthcare professionals involved in Fast@home. Quantitative data included the user data of the applications in Fast@home and surveys conducted among 73 patients and 51 healthcare professionals. The surveys comprised questions regarding the use of and satisfaction with the intervention (5 items, range 0-10), the awareness and influence of the implementation activities (7 items for patients, 9 for healthcare professionals, range 0-10) and contextual factors influencing the use of the intervention (9 items for patients, 11 for healthcare professionals, range 0-10). Descriptive statistics were used for quantitative data, thematic analyses for qualitative data. Implementation activities were evaluated by field notes, surveys and user data; mechanisms of impact by surveys; contextual factors by field notes and interviews. All planned activities were delivered, although some less frequently then planned (fidelity), whereas some additional supporting activities were delivered to enhance the implementation in a changing context (adaptations). Of the 51 professionals included in the survey, 31 were trained to deliver the intervention and 25 (75.8%) of those 31 delivered it. Of the 165 patients included in the effect evaluation, 82 (49.7%) received the intervention, of which 54 (65.8%) used it. Concerning the mechanisms of impact, professionals and patients were equally satisfied with the implementation activities (median score 7.0 (IQR 6.0-7.75) versus 7.0 (6.0-7.5)), but patients were more satisfied with the intervention (8.0 (IQR 7.0-8.0) versus 5.5 (4.0-7.0)). The rating of impact on the implementation showed highest scores for, amongst others, personal guidance by professionals (patients) and use of ambassadors and time given for training (professionals). Professionals rated the integration into conventional rehabilitation as insufficient. Contextual factors hampered the implementation, including unexpected financial cutbacks and technical setbacks. It was concluded that main areas for improvement of the implementation of eRehabilitation appear to be related to healthcare professionals' perceptions on the intervention, actual integration of eRehabilitation into conventional rehabilitation, as well as contextual, mostly technical and organizational factors.

GENERAL DISCUSSION

The effectiveness of eRehabilitation is not only influenced by the intervention itself, but also by the implementation strategy and the context in which the intervention is implemented. These latter two aspects often vary from one intervention, organisation or country to the other [1,2]. This complex interplay between the effectiveness, the implementation and the context of an eRehabilitation intervention in stroke care constitutes the focus of the present thesis.

The Fit After Stroke @Home (Fast@home) project is the central study in this thesis. It consisted of the following phases (Figure 1): 1. a thorough and structured investigation of the anticipated barriers/facilitators in the context of the specialised rehabilitation facility. With this information, an eRehabilitation intervention and a tailored implementation strategy were developed, simultaneously with the control period of the effect study. After this, 2. the effectiveness; and 3. the implementation strategy of the eRehabilitation intervention was evaluated. Studying these three different phases in the same clinical setting enabled us to interpret the effect of the intervention in the context in which it was used and evaluated the extent to which the implementation and context influenced the effects.

Considering the results of the studies, this thesis leads to a deeper understanding of how and why eRehabilitation works, compared to merely studying the effectiveness of an eRehabilitation intervention as independent tool. Apart from the relevance of the results for patients and healthcare professionals, the outcomes can be used to inform other stakeholders, including directors, managers and policymakers regarding the future implementation and upscaling of eRehabilitation [3]. This chapter discusses the interplay between the multiple phases of the research projects (the effectiveness, the implementation and the context). Besides, recommendations for future research and clinical practice are given.

Figure 1. Interplay between studies included in this thesis, concerning the context (green, Chapters 2-4), the effectiveness of the intervention (orange, Chapter 5) and the implementation (blue, Chapter 6)

7

Part 1: The interplay between the effectiveness, implementation and context

1.1 Barriers and facilitators in the context of eRehabilitation

Several studies in this thesis (**Chapters 2-4 and 6**) describe barriers and facilitators regarding the use of eRehabilitation among multiple groups of end-users (patients, informal caregivers and healthcare professionals) at multiple time-points (before and after implementation) in a specialised rehabilitation facility. Up to now, most studies investigating barriers and facilitators for the implementation of eRehabilitation included only one group of end-users and were performed only before [4-6] or during/after [7-11] the use of an eRehabilitation intervention.

1.1.1 Multiple perspectives

By investigating multiple end-users, it was shown that the expected barriers and facilitators for the use of eRehabilitation among different groups of end-users were only similar to a limited extent. All groups of end-users expected that a specific eRehabilitation intervention, the Fast@home intervention, would add value to conventional stroke rehabilitation (e.g. by possibilities for additional online training or information provision). On the other hand, end-users also reported barriers and facilitators that were specific to their personal situation. Patients mainly reported barriers and facilitators related to their personal situation, including reasons to use eRehabilitation (i.e. the potential to reduce travel time and possibilities to continue treatment after discharge) and hampering characteristics related to their stroke (e.g. fatigue and lack of understanding of ICT devices). Healthcare professionals, on the other hand, reported barriers related to the organisation of eRehabilitation and defined some organizational requirements (e.g. tasks and responsibilities of both rehabilitation centre and healthcare professionals, and resources like hardware).

Although differences in expected barriers and facilitators between groups of end-users might seem obvious, more attention for these different perspectives in research and clinical practice is necessary. Only one other study was found to investigate barriers and facilitators for stroke eRehabilitation among more than one group of end-users [12]. In line with our study, differences in barriers and facilitators between end-users were observed. Based on the findings of this and our study, it can thus be concluded that important information will be missed when the perspective of only one group of end-users is taken into account. As a result, not acting on unidentified barriers is likely to lead to a less effective implementation strategy. After all, a proper fit between the implementation strategy and barriers and facilitators as perceived by *all* end-users is crucial for an optimal use of eRehabilitation interventions [13].

1.1.2 Expected versus experienced factors

Next to the exploration of *anticipated* barriers and facilitators prior to the implementation of eRehabilitation (**Chapters 2 and 3**), we investigated which barriers and facilitators were *actually experienced* by healthcare professionals (**Chapter 6**), resulting in interesting differences. Prior to the implementation, healthcare professionals mainly had concerns about the organisation of the eRehabilitation intervention, as discussed above. During the implementation, healthcare professionals experienced barriers regarding the integration of eRehabilitation into conventional care pathways and the actual delivery of eRehabilitation. These barriers pertained to the eRehabilitation intervention (e.g. lack of proven effectiveness), the implementation process (e.g. insufficient time to become familiar and to use the eRehabilitation intervention during conventional therapy, and insufficient integration in conventional rehabilitation) and the context in which healthcare professionals had to use the eRehabilitation intervention (e.g. financial cutbacks, low priority for the implementation among managers and rehabilitation physicians).

To counteract the additional barriers that were not anticipated, it is recommended to monitor barriers and facilitators at multiple time-points during the implementation phase and act on them directly if needed. Indeed, additional implementation activities were undertaken when new barriers were noticed; e.g. insufficient time to learn how to use the eRehabilitation intervention was solved by additional instructions and more time to get familiar with eRehabilitation. However, these adjustments were done ad hoc and were not formally evaluated at predefined time points. The use and subsequent effect of the eRehabilitation intervention in our study may have been larger if we monitored the use of the eRehabilitation intervention better, performed additional analyses of barriers, and had systematically undertaken actions to improve the use, including an evaluation of the effects of those actions. Although interim adjustments of the implementation strategy are recommended in literature, hardly any study has so far planned or conducted these [14].

1.2 Effect of eRehabilitation

In **Chapter 5**, the effects of the eRehabilitation intervention are evaluated. This evaluation did not show significantly better health-related outcomes in stroke patients for the Fast@home intervention group as compared to those in the control group during the first three months of rehabilitation. Possibly, the additional effect of the Fast@home intervention was not large enough to detect significant differences during the first three months of treatment. This hypothesis is supported by the experience that most progress in stroke rehabilitation is established during the first three months [15,16]. Neither randomized controlled trials [17-22] nor several systematic reviews [23-25] that investigated the effects of adjuvant eRehabilitation among stroke patients reported better outcomes in favour of the intervention groups during the first three months of rehabilitation treatment.

7

In contrast with the first three months, between three and six months some statistically significantly greater improvements in the intervention group as compared to the control group were observed. The observed mean differences were, however, relatively small, and, if available, did not exceed the minimally clinically important difference. The improvements between three and six months became somewhat larger if only the users of the intervention were compared to the control group. This delayed effect may be explained by a larger contrast between intervention and control group; with the rehabilitation trajectories mostly finished, the effect of doing more exercises at home will be more pronounced. Two studies evaluating the effects of eRehabilitation intervention were identified with a follow-up of six months [19,20]. These studies did no show differences between the intervention and control group at six months. A possible explanation for the lack of effect is that both studies used mixed-model analyses, meaning that they compared the intervention group and control group over the total period of six months. In our study, the results of the total period of six months were also non-significant. A separate analysis between three and six months was not performed in the two previous studies. However, since eRehabilitation may have more pronounced effects after the first three months, it is recommended for future research to perform separate analyses for the first three months and the period between three and six months.

1.2.1 Use of eRehabilitation

The relatively small proportion of stroke patients using the eRehabilitation intervention in the clinical effect study (64% of the patients who received the intervention; 32% of total intervention group) is partially consistent with literature [7,11,17,20,21,26-29]. Comparisons with previous studies are hampered by the fact that some of these studies did not explicitly report details about adherence. Studies that did mention details, reported the percentage of patients that used the eRehabilitation intervention at least once (range between 66-100% [20,21,26,28,29]) or those who used it for the entire intended period (10%-93%, [7,11,27]). Others reported the duration (on average 12-20 min per day, 1190 minutes in total or for a total of 5 days [7,11,26,27]). Compared to those studies, indeed the percentage of patients using the intervention in our study might be relatively low, but the duration of use (median 19 days) was better than the previously reported average of 5 days [26].

Chapter 6 showed several explanations why relatively few patients used the intervention. This included the attitude of healthcare professionals towards the intervention, extent of integration in the conventional stroke rehabilitation and financial and technical setbacks. Most of the previous studies did not report reasons for non-use. For the few studies where those reasons were given, explanations were partly comparable. This included barriers related to the intervention (e.g. technical errors) and lack of support from the healthcare professionals [21,27,28]. In contrast to other studies, we did not encounter any practical issues with the delivery of the intervention in our study (e.g. patients not attending sessions due to scheduling conflicts or no-shows) or problems with the level of difficulty of the therapy [21,27,28].

To evaluate the effect of the eRehabilitation intervention in this thesis, a pre-test post-test comparison was made. This design allowed the use of data that was already collected. However, traditional study designs where control and intervention conditions as well as assessments are to a large extent predetermined, are not always ideal to study the effectiveness of innovations like eRehabilitation. Designs with a shorter duration are needed, since eRehabilitation technology develops rapidly and may be outdated before the study is finished [30]. The study design used in this study was, despite a limited duration, still relatively rigid and did not allow for interim improvements. Alternative designs that are particularly suitable to evaluate eRehabilitation will be discussed in part 2 of this paragraph 'Implications for future research & clinical practice'.

1.3 Implementation in the clinical context

The Fast@home study was performed in a real-life setting (i.e. in clinical stroke rehabilitation). This means that multidisciplinary teams of healthcare professionals involved in the rehabilitation of a stroke patient jointly decided whether or not to offer the eRehabilitation intervention to a patient. Subsequently, a designated healthcare professional (mostly a physical therapist or occupational therapist) was responsible for the delivery of the intervention. **Chapter 6** showed that a more intensive and better monitored implementation strategy, adapted to emerging needs, could probably have resulted in more stroke patients being offered and using the eRehabilitation intervention. Since the user of the intervention showed greater gains in health–related outcomes compared to the intervention group as a whole (**Chapter 5**), more intensive use of eRehabilitation as a consequence of a better adapted implementation strategy will probably lead to greater effects on health-related outcomes, as is supported by previous research [24].

Previous studies concerning stroke eRehabilitation with a randomized controlled design did not face problems with the implementation of eRehabilitation. The interventions in those studies were offered not fully embedded into conventional rehabilitation; for example, by setting a fixed number of digital consultations next to the conventional consultations [18,31], or by delivering eRehabilitation without the involvement of a healthcare professional [20,21,26,29]. Despite the obvious drawbacks of an evaluation in a real-life setting, the results of our effect study are better transferable to clinical practice.

Despite all the internal efforts to increase the use and implementation of eRehabilitation, external contextual factors may have had a major impact. A strong example is the situation arising during the COVID-19 pandemic starting in the spring of 2020. During this pandemic, it was impossible to deliver conventional face-to-face rehabilitation. The absence of an alternative [38] may have motivated healthcare professionals to use eRehabilitation and resulted in a forced substitution of physical consultations by remote care [39]. Although eRehabilitation was offered as an alternative to conventional stroke rehabilitation and not as a blended approach, it was shown that urgency can support to overcome barriers. The increased use of eRehabilitation during COVID-19 [40] provides the possibility to embrace the positive experiences and increasing competency of the users, focussing on optimal integration of eRehabilitation to prevent healthcare professionals relapse into old habits.

1.3.1 Integration in conventional rehabilitation

The largest challenge in the implementation of eRehabilitation in the clinical setting was found to be the integration of eRehabilitation into conventional rehabilitation. This observation is in line with previous literature [32,33]. Although difficult, it is crucial to offer eRehabilitation integrated into conventional stroke rehabilitation instead of offering it as a full alternative or next to conventional rehabilitation. Some studies even concluded that eRehabilitation can only achieve its full potential when integrated in conventional stroke rehabilitation [32,34]. However, real integration requires conventional care pathways being "redesigned", meaning that tasks and responsibilities must be reallocated [33,34]. Healthcare professionals have to learn new routines, including prescribing exercises embedded in the personal eRehabilitation program of the patient, discussing the use and results of digital treatment modalities with patients and collaborate in this use with colleagues of the multidisciplinary team.

For patients, a major benefit of integration is that eRehabilitation is delivered with the support of a healthcare professional. Patients reported to only be interested in eRehabilitation when it would not replace conventional rehabilitation treatment (**Chapters 2 and 3**) and that guidance by their healthcare professional motivated them most to use it (**Chapter 6**). The support of a healthcare professional to explain benefits, guide the first-time use and tailor an exercise program to individual needs was previously found to be essential for effective use of eRehabilitation [11,27,34-37]**.**

For healthcare professionals, the integrated approach results in the possibility to offer treatment modalities in the conventional way to patients who are not capable of using eRehabilitation. To support the integration, the role of the specialized ambassadors within the teams were highly appreciated by healthcare professionals (**Chapter 6**). Moreover, the integration could be improved by instructing professionals other than physical therapist and occupations therapist (i.e. speech therapists, social workers, nurses) in the use of eRehabilitation. The delivery of eRehabilitation was found too extensive for one physical or occupational therapist alone. By involvement of the whole multidisciplinary team, healthcare professionals can support and remind each other about the use of eRehabilitation.

Part 2: Implications for future research & clinical practise

The significant interplay between the effectiveness, the implementation and the context leads to an extensive overlap between the implications for future research and clinical practice, which are therefore described in a single paragraph and visualized in Figure 2.

2.1 Evaluation & designs

Traditional study designs (e.g. randomized controlled trials or a pre-test post-test comparison) are not always most appropriate to evaluate eRehabilitation in a clinical setting, as was mentioned before. In the rapidly developing field of eHealth, in which the context is also subject to change, research designs that have a shorter time frame and allow iterations during the study period are probably more suitable [41,42]. Iterations facilitate the quality, usefulness and relevance for clinical practice [43], whereas shorter studies could decrease the time between research findings and larger scale uptake in clinical practice [41,42]. An overview of 75 study designs to assess the effects of eHealth has recently been published [42]. The results were aggregated into an online “eHealth methodology guide” to support researchers in the field of eHealth to identify the appropriate evaluation approach suitable for a particular study [44].

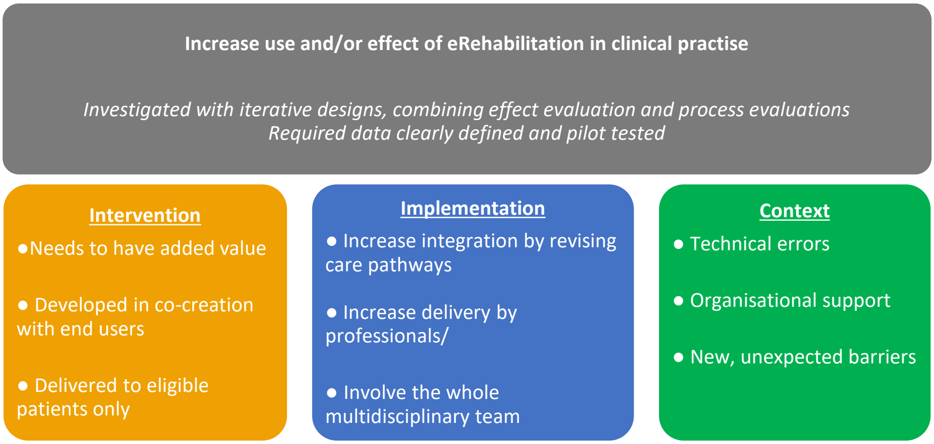

Figure 2. Lessons learned for future use and evaluations of eRehabilitation in the clinical setting

A useful methodology with respect to the iterative process of the development, evaluation and implementation of eHealth interventions, is the roadmap of the Centre for eHealth Research and Disease Management (CeHRes [45]). The CeHRes roadmap can be used as a guideline for eHealth development, implementation and evaluation. In this, each consecutive phase is related to previous phases and active participation of the community (e.g. patients, healthcare professionals, managers) is required to articulate the problem and participate in the problem-solving process. Although not explicitly defined in the study protocol, some aspects from the CeHRes roadmap have been included in our study, such as the use of information of the first stages (**Chapters 2-4**) in the development of the intervention and implementation strategy and the close involvement of end-users throughout the study.

In this thesis, a *hybrid implementation and effect study* was combined with an exploration of the barriers and facilitators in the context in which it is used. This means that the effectiveness of eRehabilitation was investigated together with the implementation strategy, and an exploration of the context in which it is used. Hybrid design increase the usefulness and relevance for clinical practice [43] and offers the possibility to evaluated an eRehabilitation intervention together with the infrastructure and organisation of delivery [46]. This resulted in a more valid assessment of the effectiveness in clinical practice [47]. Besides, insight in the implementation and context is important to interpret the outcomes of the effect evaluation and use of the intervention. We showed that the relatively small effects of eRehabilitation in addition to conventional rehabilitation could be improved by a better adapted implementation strategy which will probably lead to more intensive use of eRehabilitation.

2.2 Clinical use of eRehabilitation

An important aspect that must be considered in future use of eRehabilitation concerns the eligibility of patients. In this project, it was expected that most patients would receive and use the intervention, whereas a small proportion would have cognitive, emotional or motor impairments hampering its use. Taking the health situation of the patient into account, it was left to the discretion of the treating healthcare professionals to either deliver the intervention or not. In future projects, a clear decision algorithm should underlie such clinical decisions, to obtain insight in the reasons why (not) to deliver the intervention. By means of such information, the process of identifying the patients for whom the eRehabilitation is not feasible or useful can be further refined. An example of a promising tool is the 'Quick scan for your patient's digital skills' [48]. This quick scan enables a healthcare professional to identify whether a patient is capable of using eHealth. In addition, disease specific tools are needed to assess the capability of patients for using eHealth.

Apart from the patients' perspective, improving the commitment of healthcare professionals is important to increase the use of eRehabilitation. This can be achieved by making eRehabilitation an integral part of the rehabilitation treatment, which requires a comprehensive revision of the current care pathways. Support and leadership of the organisation and the rehabilitation teams is needed for such a revision [49,50]. Sufficient integration also includes the continuous monitoring of the use of eRehabilitation, both by the healthcare professionals and patients, in order to act upon non-users and registering the exercises and adherence in electronic medical records.

To monitor the use of eRehabilitation in the clinical setting, a minimal set of data to quantify the use of eRehabilitation is needed. However, the collection of such a set will not be easy, as applications vary widely with respect to their nature [23] and data stored, as well as the ease of extracting data from applications. It is recommended to at least be sure of a good definition and operationalization of the terms 'delivery' and 'use'. For instance, is a patient a user if he/she logged in at least once, if he/she has started a minimum number of sessions, or when the prescribed protocol was fully completed? For each exercise session, a time stamp including date and time is needed of both start and finish. If applicable, this should also include the intensity, number of sets and repetitions, and experiences during and after the exercises, such as pain or exertion scores. To calculate the adherence, a link between what is prescribed and performed is necessary. It is recommended to actually analyse the user data in a pilot phase and determine whether it is sufficient to calculate the delivery, use and adherence. Collaboration with application developers is a prerequisite for successful monitoring the use of eRehabilitation interventions in clinical practise. It should also be considered that once exercises have been repeated many times and can be done without digital support, it does not necessarily mean that the patients is not exercising any more. Depending on the nature of an intervention, abandonment may also mean that digital support is simply no longer necessary.

2.3 Future projects

The lessons learned from the Fast@home study are incorporated in a follow-up project "Ikoefenzelf" (funded by Stimuleringsregeling Ehealth Thuis, [*I exercise by myself*, funded by eHealth at Home Incentive, grand number 1900002]). In this project, an improved version of the Fast@home intervention including more applications and smaller chance of technical errors is used. It is widely implemented in multiple specialized rehabilitation facility, including the multidisciplinary team as a whole. The use of this intervention can be continued in primary care, for instance by a physical therapist working in primary care. In this follow-up project, a healthcare insurance company is involved, to explore how the use of eRehabilitation as part of the regular therapy can be reimbursed in the near future.

CONCLUSION

This thesis gained insight in the interplay between the effectiveness, the implementation and the context of eRehabilitation after stroke. An eRehabilitation intervention and accompanying implementation strategy were developed based on anticipated barriers and facilitators identified in the context of the specialised rehabilitation facility. The use of the eRehabilitation intervention led to small but significantly greater improvements in the intervention group on the long term. These improvements were even more pronounced if only the users of the intervention were compared with the control group. However, between admission and three months, no between group differences were seen, only a limited number of patients used the intervention and all change scores were below minimal clinical important difference.

Reasons for the limited use were found in the lack of implementation and contextual factors. Especially the full integration of Fast@home in clinical care pathways appeared challenging. To increase the delivery of eRehabilitation, it should be an integral part of the rehabilitation care pathways, which requires a comprehensive revision of the current care pathways, including the electronic medical records.

To gain better insight in the clinical effectiveness of eRehabilitation, effect evaluations should be combined with process evaluations investigating the implementation strategy. It is recommended to include the organisation of care delivery and barriers and facilitators in the context rather than investigating eRehabilitation as an independent intervention. Besides, iterative designs allowing adaptations of both the intervention and implementation strategy and a minimum set of data in order to perform proper analyses of the use of eRehabilitation, are important. Future project should include these recommendations, to increase the use and effectiveness of eRehabilitation.

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8

Nederlandse Samenvatting & Algemene Discussie

NEDERLANDSE SAMENVATTING

Doel van het proefschrift

Een cerebro vasculair accident (CVA) of beroerte is een relatief veel voorkomende aandoening met een grote impact op het leven van de patiënt en zijn of haar naasten. De revalidatie na een CVA is bedoeld om patiënten te ondersteunen bij het omgaan met de fysieke, mentale en cognitieve gevolgen van een CVA.

Hoewel digitale technologieën in de gezondheidszorg (eHealth) in toenemende mate beschikbaar zijn, kan het daadwerkelijke gebruik van eHealth in de CVA-revalidatie worden verbeterd. Om dit gebruik te optimaliseren, heeft dit proefschrift als doel inzicht te verschaffen in de samenhang tussen de effectiviteit van eHealth interventies, de gebruikte implementatiestrategie en de context waarin eHealth na een CVA wordt gebruikt. Om deze samenhang te bestuderen, zijn de volgende subdoelen gedefinieerd:

1. Inventariseren van de (belangrijkste) belemmerende en bevorderende factoren in de context waarin eHealth gebruikt wordt, zoals ervaren door patiënten, mantelzorgers en zorgverleners;
2. Onderzoeken van de effectiviteit van een multidisciplinaire eHealth interventie, aangeboden als onderdeel van de reguliere CVA revalidatie, met behulp van een hybride implementatie- en effectiviteitsonderzoek;
3. Onderzoeken wat er werkt en waarom bij het implementeren van een multidisciplinaire eHealth interventie in de reguliere CVA revalidatie, met behulp van een hybride implementatie- en effectiviteitsonderzoek.

Deze drie subdoelen zijn bestudeerd gedurende het Fit After Stroke @Home (Fast@home)-onderzoek, dat is uitgevoerd bij het grootste revalidatiecentrum in Nederland (Basalt).

Bevindingen

In de hoofdstukken 2, 3 en 4 zijn de belemmerende en bevorderende factoren voor het gebruik van eHealth in de context van de CVA-revalidatie in kaart gebracht en geprioriteerd, onder patiënten, mantelzorgers en zorgverleners ***(doel 1)****.*

Hoofdstuk 2 beschrijft een kwalitatief onderzoek dat factoren identificeerde (zowel belemmerende en bevorderende factoren) die van invloed zijn op het gebruik van eHealth na een CVA. Hiertoe zijn acht focusgroepen georganiseerd; zes focusgroepen met in totaal 32 CVA-patiënten en 15 mantelzorgers, en twee focusgroepen met in totaal 13 zorgverleners: revalidatieartsen, fysiotherapeuten, ergotherapeuten, psychologen en managers betrokken bij revalidatie na een CVA. De focusgroepen werden opgenomen, volledig uitgeschreven en citaten werden geanalyseerd met behulp van het implementatiemodel van Grol. Er werden in totaal 14 beïnvloedende factoren gevonden, gegroepeerd in vijf van de zes niveaus van het implementatiemodel: de innovatie, de organisatorische context, de individuele patiënt, de individuele professional en de economische & politieke context. De meeste citaten van patiënten, mantelzorgers en zorgverleners hadden betrekking op de innovatie (bijv. de inhoud van eHealth, de toegankelijkheid en meerwaarde, zoals verminderen van reistijd). Daarnaast gingen citaten van patiënten en mantelzorgers relatief vaak over de individuele patiënt (bijv. patiëntkenmerken als vermoeidheid en het onvermogen om ICT-apparaten te gebruiken). Citaten van zorgverleners hadden relatief vaak betrekking op de organisatie (bijvoorbeeld voldoende tijd hebben om eHealth te gebruiken gedurende de reguliere behandeling en dat eHealth moet aansluiten bij bestaande werkprocessen in de zorg). Er werd geconcludeerd dat er een aanzienlijke overlap in gerapporteerde factoren was tussen patiënten, mantelzorgers en zorgverleners als het gaat om eHealth in de CVA-revalidatie. Echter, patiënten/mantelzorgers en zorgverleners legden ook nadruk op factoren die specifiek zijn voor hun eigen situatie en deze verschillen zijn van belang voor het gedegen implementeren van eHealth na CVA.

In **Hoofdstuk 3** wordt een grootschalige, landelijke vragenlijst-studie beschreven waarin werd onderzocht welke van de factoren die in Hoofdstuk 2 zijn geïdentificeerd het belangrijkst zijn bij het gebruik van eHealth. Op basis van de uitkomsten van het focusgroep-onderzoek werden 88 stellingen over mogelijke factoren ondergebracht in een vragenlijst. Deze stellingen werden gescoord op hun belang voor het gebruik van eHealth (1-4; onbelangrijk-belangrijk). Bovendien bevatte de vragenlijst een vraag over de bereidheid om in de toekomst eHealth te gebruiken (ja/nee). De eenmalige online vragenlijst is afgenomen onder 125 CVA-patiënten, 43 mantelzorgers en 103 zorgverleners (artsen, fysiotherapeuten, psychologen). De 88 stellingen zijn met factoranalyses gegroepeerd in 16 factoren, op basis van het implementatiemodel van Grol. Vervolgens werd middels univariate logistische regressieanalyse de associatie tussen de 16 factoren (de onafhankelijke variabele) en de intentie om eHealth te gebruiken (de afhankelijke variabele) in kaart gebracht. Alle factoren die in de univariate analyses statistisch significant geassocieerd waren met de intentie om eHealth te gebruiken werden gelijktijdig ingevoerd in een multivariabele logistische regressieanalyse. Deze multivariabele analyse toonde aan dat de intentie om eHealth te gebruiken volgens zowel patiënten, mantelzorgers als zorgverleners positief werd beïnvloed door voordelen voor patiënten (bijv. kortere reistijd, verhoogde motivatie, grotere gezondheidswinst). Anderzijds was alleen bij patiënten onvoldoende kennis over het gebruik van eHealth geassocieerd met een afname van de intentie om eHealth te gebruiken. Geconcludeerd werd dat de verwachte voordelen van het gebruik van eHealth het draagvlak om eHealth daadwerkelijk te gaan gebruiken voor alle groepen vergroot, zolang er voldoende kennis is over het gebruik.

Om meer inzicht te krijgen in de invloed van internationale en interculturele aspecten op het gebruik van eHealth, is in **Hoofdstuk 4** een internationale vergelijking gemaakt tussen Braziliaanse en Nederlandse zorgverleners werkzaam in de revalidatie. De vragenlijst uit hoofdstuk 3 is vertaald in het Portugees en afgenomen bij 99 Braziliaanse zorgverleners (fysiotherapeuten, revalidatieartsen en psychologen, verpleegkundigen en neurologen). Om de antwoorden van de Braziliaanse en Nederlandse zorgverleners te vergelijken, is een top-10 van de meest en een top-10 van de minst belangrijke factoren voor Brazilië en Nederland samengesteld. Dit is gedaan op basis van de gemiddelde mate van invloed op het gebruik (door de professionals gescoord op een schaal van 1-4; onbelangrijk-belangrijk) van elk van de 88 factoren in de vragenlijst. Voor de top-10 van de meest belangrijke factoren werden vier overeenkomstige stellingen gevonden tussen de Braziliaanse en de Nederlandse zorgverleners; de overige zes hoogste gescoorde factoren verschilden. De overlap betrof het gebruiksgemak en betere gezondheidsuitkomsten na het gebruik van eHealth. De factoren die verschilden betroffen voldoende steun van de organisatie voor de Braziliaanse zorgverleners en de haalbaarheid van het gebruik van eHealth voor de patiënt voor Nederlandse zorgverleners. De top-10 van de minst belangrijke factoren was grotendeels vergelijkbaar: voor zowel Braziliaanse als Nederlandse zorgverleners werden acht stellingen die betrekking hadden op problemen veroorzaakt door een CVA (bijvoorbeeld afasie of cognitieve problemen) of problemen met benodigde middelen (bijvoorbeeld hardware en software) het minst belangrijkst gevonden. Daarom werd geconcludeerd dat het gebruik van eHealth na CVA door Braziliaanse en Nederlandse zorgverleners deels werd beïnvloed door verschillende, als belangrijk gescoorde, factoren, maar dat er een aanzienlijke overlap was in vooral de minder belangrijke factoren. Om een effectieve implementatiestrategie te ontwikkelen moet rekening worden gehouden met de factoren die specifiek zijn voor de behoeften van de gebruikers in een specifiek land.

Met de kennis uit de onderzoeken beschreven in de hoofdstukken 2, 3 en 4 zijn een eHealth interventie en een bijbehorende implementatiestrategie ontwikkeld. In Hoofdstuk 5 werd de effectiviteit van deze multidisciplinaire eHealth interventie, geïntegreerd in de klinische revalidatie na een CVA, onderzocht ***(doel 2)****. In Hoofdstuk 6 is de implementatiestrategie geëvalueerd* ***(doel 3)****.*

Hoofdstuk 5 betreft een observationele klinische studie, waarbij de uitkomsten van een groep patiënten die alleen reguliere CVA-revalidatie aangeboden kregen (controlegroep, n=153) werd vergeleken met die van een groep patiënten die de reguliere revalidatie aangeboden kreeg gecombineerd met eHealth (interventiegroep, n=165). Het onderzoek werd uitgevoerd op twee locaties van revalidatiecentrum Basalt. De multidisciplinaire eHealth interventie die werd aangeboden (Fast@Home) bestond uit één digitale omgeving met cognitieve en fysieke oefenprogramma's, activiteiten-monitoring en psycho-educatie. Deze interventie werd aangeboden als onderdeel van de reguliere revalidatie. Alle patiënten in de interventiegroep kregen toegang tot de pyscho-educatie en indien relevant, werden één of meer van de andere applicaties aangeboden door de betrokken zorgverleners (revalidatieartsen, fysiotherapeuten, ergotherapeuten en psychologen). Primaire uitkomstmaten waren zeven domeinen van de Stroke Impact Scale (SIS) en secundaire uitkomstmaten waren verschillende meetinstrumenten voor kwaliteit van leven, vermoeidheid, zelfmanagement en participatie. Metingen werden gedaan bij opname (T0) en drie en zes maanden daarna (T3, T6). Verschilscores tussen T0-T3, T3-T6 en T0-T6 werden vergeleken tussen de interventie- en controlegroep door middel van variantieanalyse en lineaire regressie modellen. In de interventiegroep kregen 82 van de 165 (50%) patiënten één of meerdere applicaties aangeboden door de zorgverleners. Van deze 82 patiënten hebben 54 (66%) daadwerkelijk gebruik gemaakt van de applicaties. In de eerste drie maanden na start revalidatie werden geen verschillen gevonden tussen de interventie- en controlegroep. Tussen drie en zes maanden werd een positief effect gevonden voor de SIS domeinen communicatie ($p = 0.026$) en fysieke kracht ($p = 0.010$). Er werden geen significante verschillen gevonden voor andere uitkomstmaten, tussen T0-T3, T3-T6 of T0-T6. Wanneer alleen de 54 gebruikers van de interventie werden vergeleken met de controlegroep werd het effect van de interventie op de SIS-domeinen communicatie (p = 0.019) en fysieke kracht (p = 0.008) bevestigd en aangevuld met de domeinen geheugen (p = 0.031) en waardevolle activiteiten (p = 0.040). De conclusie van deze studie was dat het gebruik van eHealth bij CVA-patiënten gepaard gaat met verbeteringen van communicatie en fysieke kracht tussen drie en zes maanden na start van de CVA-revalidatie.

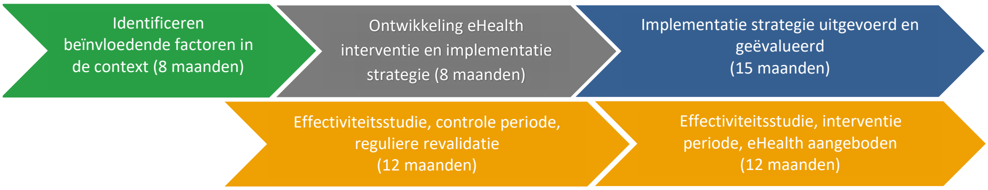
In **Hoofdstuk 6** is de implementatiestrategie, zoals uitgevoerd in de klinische studie beschreven in hoofdstuk 5, geëvalueerd volgens het Medical Research Council (MRC) framework. De doelstellingen waren om: a. het implementatieproces van de Fast@home interventie te beschrijven; b. de mechanismen van impact te onderzoeken (d.w.z. reacties van deelnemers en interactie met Fast@home); en c. contextuele factoren te identificeren die de implementatie beïnvloedden. De vooraf gedefinieerde implementatieactiviteiten waren gericht op de informatievoorziening voor patiënten en zorgverleners, het motiveren van patiënten en zorgverleners (o.a. door de inzet van ambassadeurs), instructie en ondersteuning van gebruikers en de integratie Fast@home in bestaande zorgprocessen. Deze activiteiten werden gedurende een periode van 14 maanden uitgevoerd. Om de implementatie te evalueren werden kwalitatieve en kwantitatieve data verzameld. Kwalitatieve data betroffen notities gemaakt door de onderzoekers gedurende de implementatie en diepte-interviews met 11 zorgverleners die bij Fast@home betrokken waren. Kwantitatieve data omvatten de mate van gebruik van de applicaties in Fast@home en vragenlijsten afgenomen bij 73 patiënten en 51 zorgverleners. De vragenlijsten bestonden uit vragen over de tevredenheid en invloed van meerdere factoren op het gebruik van Fast@home. Beschrijvende statistiek werd gebruikt voor kwantitatieve gegevens, thematische analyses voor kwalitatieve gegevens. Alle geplande implementatieactiviteiten waren uitgevoerd, hoewel sommige minder vaak dan gepland, terwijl ook nog aanvullende ondersteunende activiteiten werden aangeboden om de implementatie verder te bevorderen. Van de zorgverleners die geschoold zijn in het aanbieden van Fast@home (33 van de 51 zorgverleners die in de vragenlijst hebben ingevuld), hebben 25 (75,8%) deze daadwerkelijk geleverd. Wat betreft de mechanismen van impact waren zorgverleners en patiënten in gelijke mate tevreden over implementatieactiviteiten, maar patiënten waren meer tevreden over de Fast@home-interventie zelf. Van alle implementatie activiteiten werd door patiënten de persoonlijke begeleiding van zorgverleners het best beoordeeld. Door zorgverleners werd de inzet van ambassadeurs en tijd voor training het hoogst gescoord. Zorgverleners beoordeelden de integratie in reguliere revalidatie als onvoldoende. Contextuele factoren belemmerden de implementatie, waaronder onverwachte bezuinigingen en technische problemen. Geconcludeerd werd dat voor een verbetering van de implementatie van eHealth het belangrijk is om te focussen op de eHealth percepties van zorgverleners, de integratie van eHealth in reguliere revalidatieprocessen en technische en organisatorische contextuele factoren.

ALGEMENE DISCUSSIE

Het effect van eHealth in de CVA-revalidatie wordt, naast de eHealth interventie zelf, ook beïnvloed door de toegepaste implementatiestrategie en de omgeving waarin de interventie wordt gebruikt. Deze implementatiestrategie en omgeving kunnen sterk variëren, afhankelijk van bijvoorbeeld het type interventie, de organisatie, of het land waarin eHealth wordt aangeboden [1,2]. Daarom is de complexe samenhang tussen de effectiviteit, de implementatie en de context van eHealth interventies in de CVA-revalidatie het onderwerp van dit proefschrift.

Het Fit After Stroke @Home (Fast@home) onderzoek staat in dit proefschrift centraal. Dit onderzoek werd onderverdeeld in drie fasen (Figuur 1). Fase 1 bestond uit een systematisch onderzoek naar de verwachte bevorderende en belemmerende factoren voor de inzet van eHealth in de medisch specialistische revalidatie (MSR; context). Met de informatie uit Fase 1 zijn een eHealth interventie en een op maat gemaakte implementatiestrategie ontwikkeld. Dit ontwikkeltraject liep gedurende de controleperiode van de effectstudie in Fase 2. In Fase 2 werd de effectiviteit van de eHealth interventie geëvalueerd en in Fase 3 de implementatiestrategie. Deze drie deelonderzoeken werden in dezelfde klinische setting uitgevoerd. Hierdoor kan het effect van de interventie geïnterpreteerd worden in de context waarin deze uiteindelijk wordt gebruikt (de MSR) en in samenhang met de implementatiestrategie van de eHealth interventie.

Het gezamenlijk onderzoeken van de effectiviteit, implementatie en context leidt tot een beter begrip van hoe en waarom eHealth werkt, dan wanneer de effectiviteit van een eHealth interventie als losstaande interventie bestudeerd wordt. De resultaten van dit onderzoek zijn van belang voor patiënten en zorgverleners. Ook kunnen uitkomsten gebruikt worden om andere betrokkenen, zoals managers en beleidsmakers in de zorg, te informeren over de toekomstige implementatie en opschaling van eHealth [3]. In deze Algemene Discussie wordt de samenhang tussen de verschillende fasen van de onderzoeksprojecten besproken. Daarnaast worden aanbevelingen gedaan voor toekomstig onderzoek en de klinische praktijk.



Figuur 1. Overzicht van de drie onderzoekfases van de Fast@home-studie in dit proefschrift, met als onderwerp de context van de CVA-revalidatie (groen, hoofdstukken 2-4), het effect van de eHealth interventie (oranje, hoofdstuk 5) en het effect van de implementatiestrategie (blauw, hoofdstuk 6).

8

Deel 1: De samenhang tussen de effectiviteit, implementatie en context

1.1 Beïnvloedende factoren voor de inzet van eHealth in de context van de MSR

Meerdere onderzoeken in dit proefschrift (Hoofdstukken 2-4 en 6) beschrijven belemmerende en bevorderende factoren voor het gebruik van eHealth. Deze werden onderzocht bij meerdere groepen gebruikers (patiënten, mantelzorgers en zorgverleners) en op meerdere tijdstippen (voor en tijdens/na de implementatie). Tot nu toe omvatten de meeste onderzoeken naar belemmerende en bevorderende factoren voor de implementatie van eHealth slechts één groep gebruikers en/of werden ze alleen uitgevoerd vóór [4-6] of tijdens en na [7-11] het gebruik van een eHealth interventie.

1.1.1 Meerdere perspectieven

Door meerdere gebruikers te betrekken in dit onderzoek is aangetoond dat de perspectieven van verschillende gebruikers slechts ten dele overeenkomstig waren. Alle gebruikers (zorgverleners, patiënten en mantelzorgers) verwachtten dat een specifieke eHealth interventie, in dit geval de Fast@home-interventie, waarde zou toevoegen aan de reguliere CVA-revalidatie. Bijvoorbeeld doordat er online extra oefenfaciliteiten werden geboden of doordat de informatievoorziening verbeterde. Aan de andere kant rapporteerden gebruikers ook factoren die specifiek waren voor hun eigen situatie. Patiënten rapporteerden voornamelijk persoonlijke redenen om eHealth te gebruiken (bv. de mogelijkheid om reistijd van en naar het revalidatiecentrum te verminderen en om de behandeling na ontslag voort te zetten). Zorgverleners meldden vooral factoren die te maken hadden met de organisatie van eHealth en definieerden enkele organisatorische vereisten voor succesvolle toepassing (bv. taken en verantwoordelijkheden van zowel management als zorgverleners, en middelen zoals hardware).

Hoewel een verschil in factoren tussen gebruikers voor de hand ligt, is meer aandacht nodig voor deze verschillende perspectieven. In slecht één andere studie naar factoren van invloed op het gebruik van eHealth werden meerdere groepen gebruikers betrokken [12]. Ook hier werden verschillen tussen groepen gebruikers gevonden. Op basis van de uitkomst van dit eerdere onderzoek en ons eigen onderzoek kan daarom worden geconcludeerd dat belangrijke informatie zal worden gemist wanneer het perspectief van slechts één groep gebruikers meegenomen wordt. Dit zal waarschijnlijk leiden tot een minder effectieve implementatiestrategie. Een goede aansluiting tussen de implementatiestrategie en de belemmerende en bevorderende factoren zoals die door alle gebruikers worden ervaren, is immers cruciaal voor een optimaal gebruik van eHealth [13].

1.1.2 Verwachte versus ervaren factoren

Naast het onderzoeken van verwachte factoren voorafgaand aan de implementatie (Hoofdstukken 2 en 3), is ook onderzocht welke factoren *daadwerkelijk werden ervaren* tijdens het gebruik van eHealth (Hoofdstuk 6). Het vergelijken van verwachte en ervaren factoren resulteerde in interessante verschillen. Voorafgaand aan de implementatie hadden zorgverleners vooral zorgen over de organisatie van de eHealth interventie, zoals hierboven besproken. Tijdens de implementatie ondervonden zorgverleners onvoorziene belemmeringen met betrekking tot de integratie van eHealth in reguliere zorgpaden en het begeleiden van het gebruik van eHealth door de patiënt. Deze factoren hadden deels betrekking op het implementatieproces; onvoldoende tijd om vertrouwd te raken met en gebruik te maken van de eHealth interventie tijdens reguliere therapietijd en onvoldoende integratie in reguliere revalidatie. Anderzijds hadden ze te maken met context waarin zorgverleners gebruik maakten van de eHealth interventie; een periode van bezuinigingen en relatief lage prioriteit voor de implementatie bij managers en revalidatieartsen.

Om onvoorziene belemmeringen tegen te gaan, wordt aanbevolen om op meerdere tijdstippen tijdens de implementatiefase te monitoren welke factoren worden ervaren, en indien nodig direct maatregelen te nemen. Hoewel tussentijdse aanpassingen van de implementatiestrategie in de literatuur worden aanbevolen, worden in de literatuur tot dusverre nauwelijks dergelijke geplande of uitgevoerde aanpassingen beschreven [14]. In ons onderzoek werden aanvullende implementatieactiviteiten ondernomen toen nieuwe belemmeringen werden opgemerkt. Deze aanpassingen werden echter ad hoc uitgevoerd en niet formeel geëvalueerd. Het gebruik en het daaropvolgende effect van de eHealth interventie in ons onderzoek was mogelijk groter geweest als het gebruik van de eHealth interventie beter zou zijn gemonitord, met regelmatige analyses van belemmerende factoren en systematisch acties om het gebruik te verbeteren.

1.2 Effect van eHealth

In Hoofdstuk 5 worden de effecten van de eHealth interventie geëvalueerd. Deze evaluatie liet tijdens de eerste drie maanden van de revalidatie geen significant verschil in de gezondheidswinst tussen de controle- en interventiegroep zien. Mogelijk was het extra effect van de eHealth interventie niet groot genoeg om tijdens de eerste drie maanden van de behandeling tot significante verschillen te leiden. Deze hypothese wordt ondersteund door het feit dat in het algemeen de meeste vooruitgang bij de CVA-revalidatie wordt gezien tijdens de eerste drie maanden [15,16]. Noch gerandomiseerde, gecontroleerde studies [17-22], noch verschillende systematische reviews [23-25] rapporteerden effecten van het gebruik van eHealth tijdens de eerste drie maanden van de revalidatiebehandeling.

Tussen drie en zes maanden na start van de behandeling werden wel enkele significant grotere verbeteringen waargenomen in de interventiegroep in vergelijking met de controlegroep. Deze verschillen werden nog groter als alleen de gebruikers van de interventie werden vergeleken met de controlegroep. Dit vertraagde effect kan mogelijk worden verklaard door een groter contrast tussen interventie- en controlegroep; als de revalidatietrajecten grotendeels zijn afgebouwd zal het effect van extra online oefenen thuis meer uitgesproken zijn. Twee eerdere studies naar het effect van eHealth interventies in de CVA-revalidatie hadden ook een follow-up van zes maanden [19,20]. Deze studies lieten echter geen groepsverschillen zien na zes maanden. Een mogelijke verklaring voor het uitblijven van effect in die onderzoeken zou kunnen zijn dat daarin mixed-model analyses zijn gebruikt, wat inhoudt dat de groepen werden vergeleken over de totale periode van zes maanden. Een aparte analyse van de verbeteringen tussen drie en zes maanden is in de twee voorgaande onderzoeken niet uitgevoerd. Aangezien eHealth juist op de langere termijn meer uitgesproken toegevoegde waarde kan hebben is het voor toekomstig onderzoek aanbevolen om afzonderlijke analyses uit te voeren voor de eerste drie maanden en tussen drie en zes maanden.

1.2.1 Gebruik van eHealth

De Fast@Home interventie werd door een relatief laag percentage patiënten gezien en gebruikt; 82 van de 165 (50%) patiënten kreeg het aangeboden, van deze 82 hebben 54 (64%, 32% van de hele interventiegroep) het daadwerkelijk gebruikt. Dit is deels overeenkomstig met de literatuur [7,11,17,20,21, 26-29]. Vergelijk met eerder onderzoek worden echter bemoeilijkt doordat een deel van de eerdere effectiviteitsonderzoeken geen details geven over gebruik en therapietrouw. Studies die wel details noemden, rapporteerden het percentage patiënten dat de eHealth interventie minstens één keer gebruikte (tussen 66-100% [20,21,26,28,29]) of degenen die het gedurende de gehele beoogde periode gebruikten (10%-93%, [7,11,27]). Anderen rapporteerden de duur van het gebruik (gemiddeld 12-20 minuten per dag, 1190 minuten in totaal of voor een totaal van 5 dagen [7,11,26,27]). In vergelijking met die onderzoeken is het percentage patiënten dat de interventie in ons onderzoek gebruikt inderdaad relatief laag, maar de gebruiksduur (19 dagen) was beter dan het eerder gerapporteerde gemiddelde van 5 dagen [26].

In Hoofdstuk 6 werden verschillende verklaringen gevonden voor het relatief beperkte gebruik door patiënten. De attitude van zorgverleners ten opzichte van de interventie, de mate van integratie in de reguliere CVA-revalidatie en financiële en technische tegenslagen bleken de voornaamste redenen voor zorgverleners te zijn om eHealth niet aan te bieden of patiënten onvoldoende te ondersteunen bij het gebruik. Eerdere studies rapporteerden vergelijkbare redenen voor het niet gebruiken van eHealth door zorgverleners, zoals problemen met de interventie (bijv. technische fouten) en gebrek aan ondersteuning voor de zorgverleners [21,27,28].

1.3 Implementatie in de klinische context

De effectiviteit van de Fast@home-interventie werd onderzocht binnen de reguliere CVA-revalidatie, dus in een real-life setting en niet in een onderzoek-setting. In dit geval betekende dit dat zorgverleners vrijheid hadden om de eHealth interventie al dan niet aan te bieden aan een CVA-patient, en de vrijheid hadden in de mate waarin zij vervolgens het gebruik door de patiënt ondersteunden. De procesevaluatie in Hoofdstuk 6 toonde aan dat een intensievere en beter gecontroleerde implementatiestrategie waarschijnlijk zou hebben geleid tot een groter percentage patiënten dat de eHealth interventie aangeboden kreeg en gebruikt zou hebben. Aangezien de gebruikers van de interventie meer gezondheidswinst hadden in vergelijking met de interventiegroep als geheel (Hoofdstuk 5), zal intensiever gebruik van eHealth als gevolg van een beter aangepaste implementatiestrategie waarschijnlijk leiden tot grotere effecten op de gezondheid, zoals wordt ondersteund door eerder onderzoek [24].

Eerdere effectiviteitsstudies met een gerandomiseerd en gecontroleerd studiedesign hadden de bovenstaande problemen met de implementatie van eHealth niet. In deze studies werden de interventies niet aangeboden als onderdeel van de reguliere behandeling, maar bestonden bijvoorbeeld uit een vast aantal digitale consulten naast de reguliere consulten [18,31], of uit applicaties die patiënten zelfstandig konden gebruiken zonder tussenkomst van een zorgverlener [20,21,26,29]. In deze studies werd niet gekeken hoe de interventies na afloop van de studie geborgd konden worden in de dagelijkse zorgpraktijk. Ondanks de voor de hand liggende nadelen van een evaluatie in een real-life setting, zijn de resultaten van onze effectstudie waarschijnlijk beter overdraagbaar naar de klinische praktijk in vergelijking tot studies in een gecontroleerde setting.

Ondanks alle inspanningen om het gebruik en de implementatie van eHealth te vergroten, kunnen externe contextuele factoren een grote impact hebben. Een duidelijk voorbeeld hiervan is de situatie die zich voordeed tijdens de COVID-19-pandemie in het voorjaar van 2020. Tijdens de eerste golf van deze pandemie was het onmogelijk om reguliere revalidatie aan te bieden. Het ontbreken van een alternatief bleek zorgverleners aan te zetten om eHealth te gebruiken [38] en heeft in het geval van de COVID-19 pandemie geleid tot een gedwongen vervanging van de fysieke consulten door zorg op afstand [39]. Hoewel eHealth werd aangeboden als alternatief voor reguliere CVA-revalidatie en niet als geïntegreerd onderdeel, werd aangetoond dat urgentie barrières kan overwinnen. Het toegenomen gebruik van eHealth tijdens de COVID-19 pandemie [40] biedt de mogelijkheid om in de toekomst de positieve ervaringen en toenemende competenties van de gebruikers te benutten, waarbij de nadruk ligt op optimale integratie van eHealth in zorgprocessen, om te voorkomen dat gebruikers terugvallen in oude gewoonten.

1.3.1 Integratie in de reguliere zorg

Juist de integratie van eHealth in reguliere zorgprocessen bleek een van de grootste uitdagingen bij de implementatie van eHealth in de klinische setting te zijn. Deze constatering is in lijn met de bevindingen van eerdere studies [32,33]. Hoewel het een uitdaging blijkt, is het cruciaal om eHealth geïntegreerd aan te bieden in reguliere revalidatie, wat betekent dat het ingebed moet worden in bestaande zorgpaden. Sommige studies concludeerden zelfs dat eHealth alleen zijn volledige potentieel kan bereiken als het wordt geïntegreerd in reguliere CVA-revalidatie [32,34]. Deze integratie vereist dat reguliere zorgtrajecten worden herontworpen, wat inhoudt dat taken en verantwoordelijkheden opnieuw moeten worden toegewezen [33,34]. Zorgverleners moeten nieuwe routines aanleren, inclusief het introduceren van eHealth bij patiënten, het voorschrijven van oefeningen in het eHealth-programma, het bespreken van het gebruik en de resultaten van eHealth met patiënten tijdens reguliere consulten en hierin samenwerken met collega's van het multidisciplinaire team. Ook moet het gebruik van eHealth terugkomen in de elektronisch patiëntendossiers.

Door het aanbieden van eHealth als onderdeel van de reguliere zorg, worden patiënten ondersteund in het gebruik van eHealth door een zorgverlener. Deze ondersteuning blijkt cruciaal. Patiënten rapporteerden namelijk dat eHealth niet de reguliere revalidatiebehandeling kan vervangen (Hoofdstukken 2 en 3) en dat begeleiding van hun zorgverlener het meest motiveerde om eHealth te gebruiken (Hoofdstuk 6). Voor effectief gebruik van eHealth bestaat de ondersteuning van een zorgverlener uit het bespreken van de meerwaarde, het begeleiden van het eerste gebruik en het klaarzetten van een oefenprogramma afgestemd op de veranderende behoeften van de individuele patiënt, een werkwijze die in lijn is met eerder onderzoek [11,27,34-37].

Door zorgverleners werd vooral de rol van de gespecialiseerde ambassadeurs (collega's met kennis en ervaring met de interventie, die als aanspreekpunt en vraagbaak fungeerden) als zeer waardevol gerapporteerd in het stimuleren van de integratie (Hoofdstuk 6). Daarnaast zou de integratie kunnen worden verbeterd door andere zorgverleners dan alleen fysiotherapeuten en ergotherapeuten (d.w.z. logopedisten, maatschappelijk werkers, verpleegkundigen) te instrueren in het gebruik van eHealth. Het gebruik van eHealth werd in onze studie als te omvangrijk ervaren om alleen door één fysio- of ergotherapeut te worden aangestuurd. Door betrokkenheid van het hele multidisciplinaire team kan één zorgverlener het gebruik van eHealth uitleggen aan de patiënt, waarna meerdere behandelaren via de eHealth interventie oefeningen voorschrijven.

Deel 2: Aanbevelingen voor onderzoek en ehealth gebruik in de klinische praktijk

De grote samenhang tussen de effectiviteit, de implementatie en de context leidt tot overlap tussen de aanbevelingen voor het gebruik van eHealth in de klinische praktijk en aanbevelingen voor toekomstig onderzoek. Deze worden daarom gezamenlijk in de onderstaande paragraaf beschreven en de aanbevelingen wordt samengevat weergegeven in Figuur 2.

Figuur 2. Aanbevelingen voor toekomstig gebruik en evaluatie van eHealth in de klinische setting

2.1 Evaluaties en onderzoeksdesign

Traditionele onderzoeksdesigns (bijv. gerandomiseerde gecontroleerde studie of een pre-test post-test) design zijn niet altijd het meest geschikt om eHealth in een klinische setting te evalueren. Ontwikkelingen op het gebied van eHealth volgen elkaar snel op en worden toegepast in een context die aan verandering onderhevig is. Onderzoeksdesigns met een kortere looptijd zijn geschikter, doordat het proces van de start van het onderzoek tot acceptatie op grote schaal versneld wordt [41,42]. Daarbij zal een iteratief design, dat de mogelijkheid biedt voor het doorvoeren van tussentijdse verbeteringen, de kwaliteit, bruikbaarheid en relevantie van de resultaten voor de klinische praktijk vergroten [43].

Onlangs is een overzicht van 75 onderzoeksdesigns voor de evaluatie van eHealth gepubliceerd [42]. De resultaten werden samengevat in een eHealth methodologie-gids [44]. Een nuttige methode voor het proces van de ontwikkeling, evaluatie en implementatie van eHealth interventies is de roadmap van het Centrum voor eHealth Research (CeHRes) [45]. Deze roadmap kan worden gebruikt als leidraad voor de ontwikkeling, implementatie en evaluatie van eHealth. Daarbij is elke opeenvolgende fase gerelateerd aan eerdere fasen. Daarnaast is actieve deelname van de betrokkenen (waaronder patiënten, zorgverleners en managers) een vereiste voor het tussentijds identificeren van problemen en oplossingen. Ondanks dat het niet expliciet gedefinieerd is in het studieprotocol, zijn enkele aspecten uit de CeHRes-roadmap in het Fast@home-onderzoek toegepast, zoals het gebruik van informatie van de eerste fasen (Hoofdstukken 2-4) bij de ontwikkeling van de interventie- en implementatiestrategie en de nauwe betrokkenheid van gebruikers tijdens het onderzoek.

In dit proefschrift is een hybride implementatie- en effectstudie uitgevoerd. Een dergelijk design houdt in dat de effectiviteit van eHealth wordt onderzocht samen met de implementatiestrategie en een verkenning van de context waarin het wordt gebruikt. Zulke hybride studiedesigns vergroten het nut en de relevantie van de resultaten voor de klinische praktijk [43], omdat de manier waarop eHealth aan de patiënt wordt aangeboden beter aansluit bij de zorgpraktijk en wordt meegenomen in de evaluatie van de effecten [46]. Dit resulteert in een meer valide inschatting van de effectiviteit in de klinische praktijk [47]. Met deze onderzoeksopzet werd aannemelijk gemaakt dat de relatief kleine effecten van eHealth zoals die werden waargenomen, waarschijnlijk verbeterd kunnen worden door een aangepaste implementatiestrategie die beter inspeelt op factoren in de context, wat waarschijnlijk zal leiden tot intensiever gebruik van eHealth.

2.2 Gebruik van eHealth in de revalidatie

Bij het gebruik van eHealth in de klinische praktijk is het van belang om een goede afweging te maken of een patiënt in staat is tot het gebruik van eHealth. In ons onderzoek werd de beslissing om de interventie al dan niet aan te bieden overgelaten aan de behandelend zorgverleners, zonder daarvoor expliciete criteria te formuleren. Om beter inzicht te krijgen in de redenen waarom de interventie (niet) worden aangeboden door zorgverleners, is het aan te raden om bij toekomstige projecten een duidelijke beslisboom te gebruiken om dergelijke klinische beslissingen te ondersteunen en rapporteren. Een voorbeeld van een veelbelovende hulpmiddel in deze keuze is de ‘Quick scan voor de digitale vaardigheden van uw patiënt’ [48]. Met deze quick scan kan een zorgverlener zien of een patiënt gebruik kan maken van eHealth. Op deze manier wordt voorkomen dat een deel van de patiënten in de interventiegroep mogelijk onterecht geen gebruik kan van eHealth, of dat patiënten deze krijgen aangeboden terwijl zij niet in staat zijn deze te gebruiken.

Naast het doelgericht aanbieden van eHealth aan de patiënten is het voor het verhogen van het gebruik van eHealth van belang de betrokkenheid van zorgverleners te vergroten. Deze betrokkenheid wordt gestimuleerd door eHealth een integraal onderdeel te maken van de revalidatiebehandeling. Dit vraag echter om een grondige herziening van de huidige zorgtrajecten om eHealth in alle stappen van het revalidatieproces in te passen. Ondersteuning en leiderschap van de organisatie is nodig voor een dergelijke herziening [49,50]. Goede integratie omvat ook het voortdurende monitoren van het gebruik van eHealth, zowel van de zorgverleners als van de patiënten, om op niet-gebruikers te reageren en de oefeningen en therapietrouw in elektronische medische dossiers te registreren.

Om het gebruik van eHealth in de klinische praktijk te monitoren, is een minimale set van gegevens nodig. Het verzamelen van een dergelijke data in de applicaties zelf zal echter niet gemakkelijk zijn, aangezien eHealth applicaties sterk verschillen in hun aard, opgeslagen gegevens en het gemak waarmee deze gegevens uit de applicatie kunnen worden geëxtraheerd [23]. Bij de start van toekomstige eHealth projecten is het aan te bevelen om in ieder geval een goede definitie en operationalisering te hebben van de termen ‘aanbieden en ‘gebruik’. Is een patiënt bijvoorbeeld een gebruiker na de eerste keer ingelogd te zijn geweest, als er een minimum aantal oefeningen is gestart of als het voorgeschreven programma volledig is afgerond? Voor elke trainingssessie is een markering nodig van zowel start als afsluiting. Daarnaast zijn bij sommige interventies ook de intensiteit, het aantal sets en ervaringen zoals pijn- of inspanningsscores van belang. Om de mate van therapietrouw te kunnen bepalen, is een verband tussen wat wordt voorgeschreven en uitgevoerd, noodzakelijk. Er moet ook rekening mee worden gehouden dat oefeningen soms vele malen worden herhaald, waardoor de patiënt deze “uit het hoofd kent” en inloggen en digitale ondersteuning niet meer nodig zijn. Dit hoeft dus niet te betekenen dat de patiënt niet meer traint. Een pilotfase waarin de gewenste gebruikersdata daadwerkelijk verzameld en geanalyseerd worden is sterk aan te bevelen. Samenwerking met applicatieontwikkelaars waarin wordt afgestemd welke data verzameld moeten worden is een voorwaarde voor succesvolle monitoring van het gebruik van eHealth interventies in de klinische praktijk.

2.3 Toekomstige projecten

De lessen uit het Fast@home-onderzoek zijn verwerkt in een vervolgproject, “Ikoefenzelf” (gefinancierd door Stimuleringsregeling Ehealth Thuis, SET 1900002, www.ikoefenzelf.nl). In dit project wordt gebruik gemaakt van een verbeterde versie van de Fast@home-interventie, met meer applicaties en een kleinere kans op technische fouten. “Ikoefenzelf” wordt op grotere schaal geïmplementeerd in de gespecialiseerde revalidatie, waarbij het multidisciplinaire team als geheel wordt betrokken. Het gebruik van de interventie kan na de revalidatiebehandeling voorgezet worden in de 1^{e}-lijns fysiotherapiepraktijk. Daarnaast is bij dit vervolgproject een zorgverzekeraar betrokken om te onderzoeken hoe het gebruik van eHealth vergoed kan worden als regulier onderdeel van de revalidatiebehandeling.

CONCLUSIE

Met dit proefschrift is inzicht verkregen in de samenhang tussen de effectiviteit, de implementatie en de context waarin eHealth na een CVA gebruikt wordt. Het gebruik van eHealth naast de reguliere CVA-revalidatie leidde tot enkele significant grotere verbeteringen in gezondheidsuitkomsten op langere termijn. Deze verbeteringen waren nog duidelijker wanneer alleen de gebruikers van de interventie in de analyse werden meegenomen. Er werden echter in de eerste drie maanden geen verschillen in gezondheidswinst gevonden. Daarnaast werd de interventie slechts door een beperkt aantal patiënten gebruikt en waren alle gevonden verschillen in verbetering relatief klein.

Redenen voor het beperkte gebruik en effect hadden zowel te maken met de implementatie als met contextuele factoren. Door middel van een hybride onderzoeksopzet werd aannemelijk gemaakt dat het beperkte gebruik en de beperkte effecten van eHealth waarschijnlijk verbeterd kunnen worden door een aangepaste implementatiestrategie die beter inspeelt op factoren in de context. Vooral de volledige integratie van Fast@home in klinische zorgpaden bleek een uitdaging. Om het gebruik en effect van eHealth te vergroten zou het een integraal onderdeel moeten worden van de revalidatie, wat een uitgebreide herziening van de huidige praktijk vereist.

Om meer inzicht te krijgen in de klinische effectiviteit van eHealth moeten effectevaluaties worden gecombineerd met procesevaluaties die de implementatiestrategie onderzoeken. Het is daarnaast aan te bevelen om ook de context, inclusief de organisatie van de zorgverlening, mee te nemen. Bij dergelijk hybride onderzoek is het van belang om gebruik te maken van iteratieve studiedesigns, die tussentijdse aanpassingen van zowel de interventie als van de implementatiestrategie mogelijk maken, en een minimale set gebruikersdata te verzamelen voor een gedegen analyse van het gebruik.

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A

Appendix

Publications
Curriculum Vitae
Dankwoord

PUBLICATIONS

Brouns B, Meesters JJL, de Kloet AJ, Vliet Vlieland TPM, Houdijk S, Arwert HJ, van Bodegom-Vos L . What works and why in the implementation of eRehabilitation after stroke: a process evaluation. *Submitted*.

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CURRICULUM VITAE

Berber Brouns werd op 26 juli 1991 geboren in Groningen, waar zij ook opgroeide. In 2009 voltooide zij het VWO aan het Maartens College in Haren, waarna zij startte met de opleiding Bewegingswetenschappen aan de Rijksuniversiteit in Groningen. In 2012 slaagde zij voor de Bachelor Bewegingswetenschappen. Begin 2015 behaalde Berber de Master Human Movement Science, waarvoor zij onder andere een stage uitvoerde bij revalidatiecentrum De Hoogstraat in Utrecht.

Onderzoek en zorginnovatie

Na het afronden van haar studie was Berber van 2016 tot eind 2020 als parttime onderzoeker aangesteld bij de Haagse Hogeschool, lectoraat revalidatie. In deze tijd was zij ook als promovendus verbonden aan het Leids Universitair Medisch Centrum (LUMC). Haar werkzaamheden richtten zich op het opzetten en uitvoeren van Fit After Stroke @ Home (Fast@home) onderzoek, het praktijkgerichte onderzoek dat in dit proefschrift beschreven is. Het implementeren en evalueren van eHealth in de CVA-revalidatie was voor haar een mooie combinatie tussen onderzoek en daadwerkelijk verbetering van de zorg. Het onderzoek vond plaats in twee revalidatiecentra, Sophia Revalidatie in Den Haag en het Rijnlands Revalidatiecentrum in Leiden (in 2019 gefuseerd tot Basalt). Begin 2021 rondde Berber haar promotieonderzoek af.

Vanaf 1 januari 2021 is Berber als data-analist werkzaam bij het Value-Based Healthcare team het St. Antoniusziekenhuis in Nieuwegein. Hier houdt zij zich bezig met verbeterprocessen en implementatieprojecten binnen het ziekenhuis.

Coaching

Al van jongs af aan is Berber actief geweest in het sportklimmen en alpineren. Nadat zij in haar jeugd en studententijd veel wedstrijden had geklommen is zij vanaf 2015 ook sportklimtrainingen gaan verzorgen. In eerste instantie ging dit om regionale trainingen en trainingen voor het Talenten Centra Midden Nederland. In 2017 kwamen daar de trainingen voor het Nederlands Team paraklimmen bij, een team van klimmers met een fysieke beperking. Hierin verzorgt Berber als Bondscoach de teamtrainingen, begeleidt ze de internationale wedstijden en draagt ze zorg voor een transparante selectieprocedure. Omdat het denken in mogelijkheden en atleten stimuleren om te blijven ontwikkelen goed aansluiten bij haar werk in de zorginnovatie, wil ze ook in de toekomst deze twee graag blijven combineren.

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