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

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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.

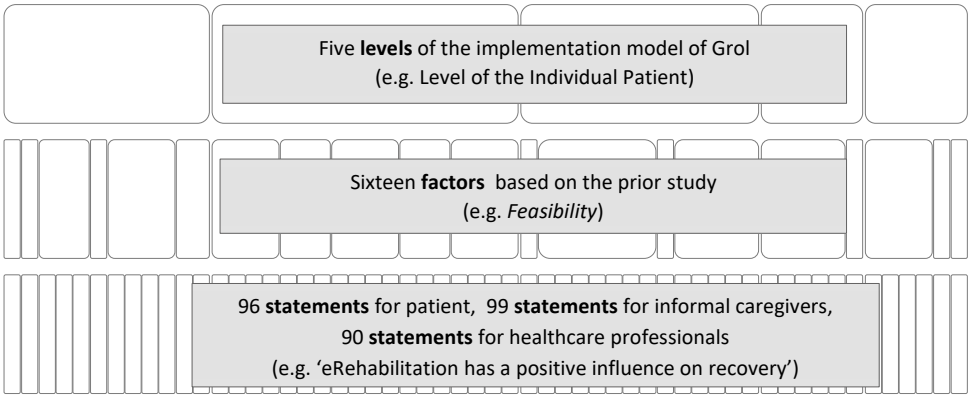

Figure 1. Relation between levels, factors and statements

3. 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.

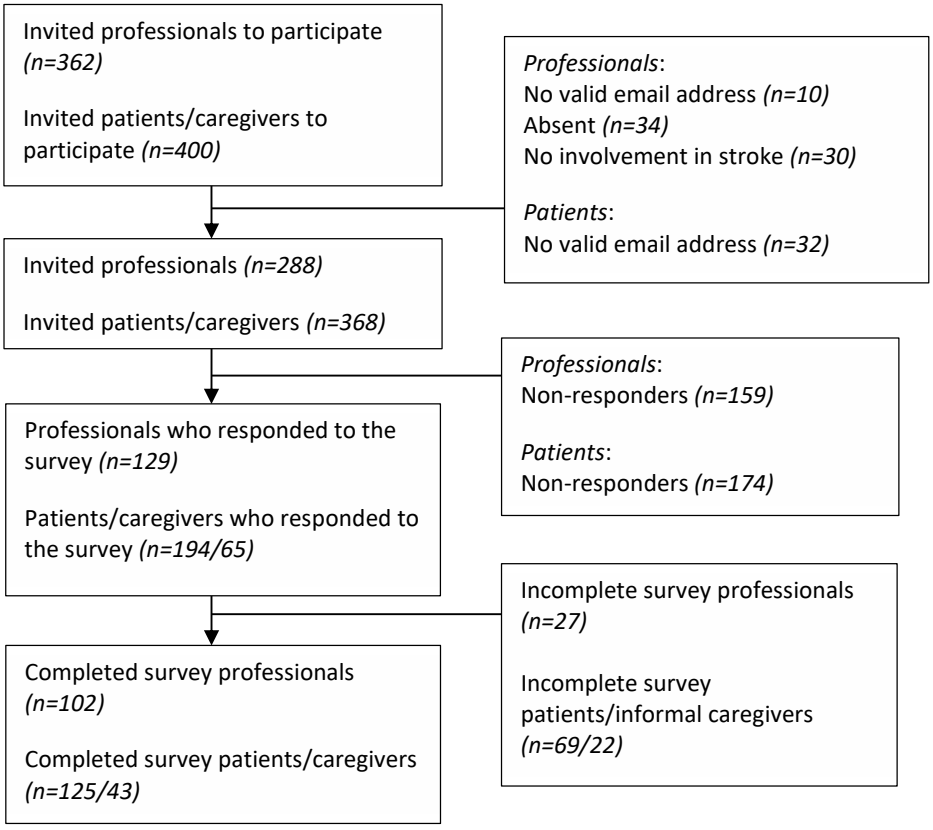

Figure 2. Flow of inclusion

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

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