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ARTICLE

Physiotherapists' clinical use and acceptance of a telemonitoring platform during anterior cruciate ligament rehabilitation: a prospective clinical study

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ABSTRACT

Purpose: The aim of this study was to assess physiotherapists' clinical use and acceptance of a novel telemonitoring platform to facilitate the recording of measurements during rehabilitation of patients following anterior cruciate ligament reconstruction. Additionally, suggestions for platform improvement were explored.

Methods: Physiotherapists from seven Dutch private physiotherapy practices participated in the study. Data were collected through log files, a technology acceptance questionnaire and focus group meetings using the "buy a feature" method. Data regarding platform use and acceptance (7-point/11-point numeric rating scale) were descriptively analysed. Total scores were calculated for the features suggested to improve the platform, based on the priority rating (1 = nice to have, 2 = should have, 3 = must have).

Results: Participating physiotherapists (N= 15, mean [SD] age 33.1 [9.1] years) together treated 52 patients during the study period. Platform use by the therapists was generally limited, with the number of log-ins per patient varying from 3 to 73. Overall, therapists' acceptance of the platform was low to moderate, with average (SD) scores ranging from 2.5 (1.1) to 4.9 (1.5) on the 7-point Likert scale. The three most important suggestions for platform improvement were: (1) development of a native app, (2) system interoperability, and (3) flexibility regarding type and frequency of measurements.

Conclusions: Even though health care professionals were involved in the design of the telemonitoring platform, use in routine care was limited. Physiotherapists recognized the relevance of using health technology, but there are still barriers to overcome in order to successfully implement eHealth in routine care.

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Telemonitoring; anterior cruciate ligament reconstruction; physiotherapy; user experience; technology acceptance

➤ IMPLICATIONS FOR REHABILITATION

- The use and acceptance of the telemonitoring platform by physiotherapists for patients following anterior cruciate ligament reconstruction was limited.
- Suggestions made by therapists for platform improvement mainly related to user-friendliness and efficiency of workflow.
- Novel digital health technology needs to fit into daily routines, be easily accessible and easy to use for the end users.

Introduction

Ruptures of the anterior cruciate ligament (ACL) are among the most frequent sports-related injuries to the knee, with an annual incidence of 68.6 per 100,000 person-years in the USA [1, 2]. The absolute number of ACL injuries in the USA is estimated at more than 120,000 per year [3] and about the same number of reconstructions of the ACL were performed in 2006 [4]. The incidence of ACL injuries seems to be related to the sports performance level of athletes: 3% of amateur athletes and up to 15% of professional athletes suffer from ACL injuries each year [5].

Rehabilitation following ACL reconstruction

After ACL reconstruction, patients are expected to actively take part in an intensive rehabilitation programme, which may take up to 12 months. ACL rehabilitation usually involves various health care professionals, such as physiotherapists, orthopaedic surgeons and mental coaches [6]. Patients undergoing an ACL reconstruction mostly expect to fully recover and consider a return to their previous sports level as one of the most important rehabilitation goals [7]. Return to sports is therefore regarded as one of the main outcomes of a successful rehabilitation [8]. Despite intrinsic

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Supplemental data for this article can be accessed here.

motivation and the fact that approximately 90% of patients show normal knee function after ACL reconstruction, only 65% achieve their pre-injury sports level and a mere 55% return to their former competitive sports level [9, 10].

Recovery following ACL reconstruction may be hampered by a number of physical and psychological factors. For instance, an ACL injury has major consequences for the neuromuscular control of the knee. Loss of joint proprioception cannot be restored after surgery. Several patient characteristics, such as a decreased post-surgical range of motion of the knee, reduced strength of the m. quadriceps and poor rehabilitation adherence might also contribute to an overall protracted rehabilitation process and a lower likelihood of return to sport [9,11–13]. On the other hand, positive psychological responses such as higher degrees of motivation and self-efficacy have been associated with a higher likelihood of returning to the previous level of sports 12 months after surgery [8,14–17].

Potential benefits of using telemonitoring in ACL rehabilitation

Many potential benefits of using digital technology to monitor and support rehabilitation programmes have been described in the literature [18, 19]. Data monitoring and visualization can provide insights into the rehabilitation process, allowing physiotherapists to deliver customized information and guidance to patients [20]. There is evidence that involving patients in their own data collection during a relatively lengthy rehabilitation process might facilitate patients' compliance, satisfaction regarding care delivery and perceived quality of life [18, 19]. Furthermore, it can also encourage patients to take greater responsibility for their rehabilitation outcomes [21].

To guide patients through the different ACL rehabilitation stages and to assess their readiness to return to sport, existing rehabilitation guidelines [22–24] recommend systematically measuring specific variables, such as range of motion of the knee joint, quality of movement and psychological factors. However, the use and documentation of relevant measurements by physiotherapists in routine care is generally poor [25–27]. Digital technologies such as telemonitoring platforms might facilitate the use and documentation of these measurements in routine care during the entire rehabilitation process.

Preliminary work

During a 9-month preliminary phase, a prototype of a telemonitoring platform, the ACL-monitor (vkbmonitor.nl), was developed in co-design with various stakeholders. The platform development involved patients who underwent ACL reconstruction, physiotherapists, orthopaedic surgeons, multimedia designers, software developers and researchers.

Determining the content

In two focus group meetings, these stakeholders agreed on a core set of relevant outcome measurements (e.g., questionnaires, clinical and performance tests) and their capture frequency. All measurements that needed to be accomplished during the different rehabilitation phases were defined in accordance with international guidelines [22–24,28,29].

Development of the platform

The core set of outcome measurements and their capture frequency were incorporated in a low-fidelity prototype of the telemonitoring platform. Subsequently, the technical functionality and usability of the prototype were evaluated in the lab by members of the research and development team, to construct a medium-fidelity prototype. Finally, the usability of the telemonitoring platform was evaluated in routine care by a small group of physiotherapists and patients. Their feedback was incorporated in the iterative design process to construct a high-fidelity prototype of the telemonitoring platform. The telemonitoring platform was then introduced in routine care over a period of 18 months. Physiotherapists were expected to use the telemonitoring platform two to three times a week for each individual patient for the measurements performed in the first rehabilitation phase and once a month in the following two rehabilitation phases.

Aim of this study

The aim of this study was to explore physiotherapists' clinical use and acceptance of the telemonitoring platform. In addition, potential suggestions for future improvements to the platform were assessed.

The following research questions were addressed:

1. Which components of the telemonitoring platform were used by physiotherapists and to what extent?
2. To what extent did physiotherapists accept the telemonitoring platform?
3. What improvements were suggested by physiotherapists regarding the features of the telemonitoring platform?

Methods

Design

This prospective, single-group clinical study used both quantitative and qualitative data collection methods, as shown in Table 1. The study protocol was approved by the Ethics committee of Zuyderland Hospital Heerlen, the Netherlands (reference no. 17-N-108) and registered in the Netherlands Trial Registry, part of the Dutch Cochrane Centre (ID NL6901). The clinical study was conducted from October 2017 to April 2019. Zuyd University of Applied Sciences in Heerlen, The Netherlands, was responsible for conducting the study.

Participants and procedure

Physiotherapists of seven Dutch private physiotherapy practices, who were experienced in the treatment of patients after ACL reconstruction, participated in this study. Data were collected from physiotherapists who used the telemonitoring platform during the rehabilitation of at least one patient after ACL reconstruction. The study sample included adult patients who were scheduled for or had recently undergone ACL reconstruction. Patients who had severe comorbidity that could negatively affect their rehabilitation progress (e.g., additional ligament injury) were not included. All participating physiotherapists and patients provided written informed consent before enrolment in the study.

Outcome measures

Table 1 shows the different qualitative and quantitative data collection methods that were used in the study to obtain the information needed to answer the three research questions. Demographic characteristics of participating therapists (e.g., age, sex, number of patients treated) were recorded alongside data regarding user acceptance, using an online questionnaire (Supplementary Appendix).

Use of the telemonitoring platform

Log data regarding physiotherapists' platform use were automatically collected and anonymously stored in an individual log file

on a web server (Roessingh Research and Development, the Netherlands). Each physiotherapist's log-in to the telemonitoring platform and each activity performed was stored by recording (1) the identification number of the physiotherapist, (2) the time, date and duration of the log-in, and (3) the type of page viewed. The use of the following pages was logged: log-in, dashboard providing an overview of measurements, patient management, history with measurement data, events and settings. In addition, the system identified the duration of individual web sessions for each physiotherapist, defined as the time between log-in and log-out. The physiotherapists had to perform and record several measurements in the telemonitoring platform on a regular basis throughout the different rehabilitation phases. In phases 2 and 3 (weeks 12–52), muscle strength (m. quadriceps, hamstrings and m. glutaeus medius) and dynamic stability (hop tests) had to be measured and recorded once a month, resulting in a total of 22 expected time points of measurement per patient. In the present study, outcome variables regarding the platform use were the total number and duration of log-ins per physiotherapist, the type of pages viewed most frequently, and the number and completion rate of recorded time points of measurement in rehabilitation phases 2 and 3. As the total number of patients treated by one therapist and the duration of platform use within the 18-month study period differed between individual therapists, we additionally calculated the average number of log-ins per patient treated.

Acceptance of the telemonitoring platform

A self-administered seven-item questionnaire (Supplementary Appendix) was used to assess physiotherapists' acceptance of the telemonitoring platform. Platform acceptance questions included (1) the perceived ease of use (three items), (2) the perceived usefulness, (three items), and (3) overall user satisfaction (one item). Six items were based on the Technology Adoption Readiness Scale (TARS) [30] and the Technology Acceptance Model (TAM) [31, 32]. Each of these six items was scored on a 7-point Likert scale from 1 (completely disagree) to 7 (completely agree). The additional item on overall user satisfaction was scored on an 11-point Likert scale from 0 (completely dissatisfied) to 10 (completely satisfied).

Table 1. Overview of qualitative and quantitative measurements used.

Outcome	Measurement	Time point of measurement
Platform use	Log files	Through months 1-18
User acceptance –Perceived ease of use –Perceived usefulness –User satisfaction	Online questionnaire	Month 18
Suggestions for improvement of platform	Focus groups	Month 18

Suggestions for improvement to the telemonitoring platform

Three separate focus group meetings were conducted to explore physiotherapists' potential suggestions for improvements to relevant features and functions for a modified (future) version of the telemonitoring platform, using the "buy a feature" method [33]. This method is used to explore user requirements and consists of two parts: in the first part, the physiotherapists were encouraged to generate ideas about their requirements and preferences regarding improvements and desirable modifications of the platform. The second part concerned clustering and prioritization of the most desired and valued features and functions (Figure 1). All three focus group sessions, with different participating physiotherapists, were performed according to the same method and were led by two members of the research team.

Data collection and analysis

Preparatory and descriptive analyses were conducted using Microsoft Excel and IBM © SPSS © Statistics for Windows (Version 26.0). The dataset was assessed for aberrant measuring data. Missing data were not imputed.

Individual log data of the physiotherapists were descriptively analysed. In addition to the total and median number of log-ins, the mean duration of platform use per log-in (min) was assessed. Furthermore, the total number of measurements and the completion rate over all patients were calculated.

The individual data from the acceptance questionnaire were descriptively analysed, and sum scores for each item of user acceptance were collected in a frequency table. In addition, average acceptance scores (mean, SD) were calculated from the six items of the "perceived ease of use" and "perceived usefulness" categories.

During the focus group interviews, data collection and data analysis partly took place simultaneously. Physiotherapists' ideas

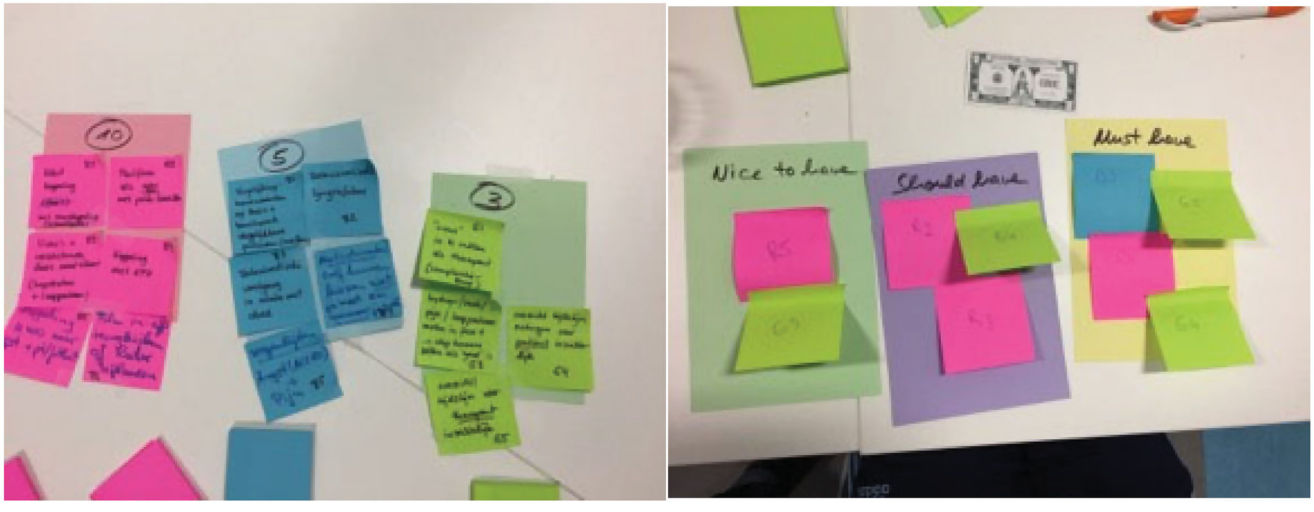

Figure 1. Example of clustering and prioritization of features using the "buy a feature" method.

about improvements regarding desirable features and functions of a future telemonitoring platform were noted on post-it notes and then clustered into themes jointly by the participants and researchers. Thereafter, a price tag (3, 5 or 10 $) was assigned to each feature, depending on the expected development complexity and/or costs. Subsequently, all features were offered in the "shop" and each participant received a fixed amount of play money, with which only 60% of the proposed features could be purchased. After participants had purchased a feature, they had to weigh the importance of this feature, resulting in a score of 1 (nice to have), 2 (should have), or 3 (must have) (Figure 1). The individually chosen features, including the importance scores, were recorded, and total scores were calculated for the importance of each feature, resulting from the three focus groups.

Results

Table 2 shows the characteristics of the participating physiotherapists ($N = 15$; 12 male). In total, 52 patients (38 male, mean age 26 years, SD = 7) were treated including the use of the telemonitoring platform. On average, each physiotherapist used the telemonitoring platform for 3.8 (SD = 2.2) patients.

Use of the telemonitoring platform

Overall, the 15 physiotherapists performed a total median number of 62 log-ins (range 14–220) during the 18-month intervention period, with the number of log-ins per patient ranging between 3 and 73. The mean duration of each log-in was 7.1 (SD = 11.3) minutes (Table 3). The completion rate for measurements used in rehabilitation phases 2 and 3 ranged from 0 to 16.7%. None of the therapists succeeded in providing a complete data set including all recommended 22 measurements (muscle force, hop tests) for a single patient. The following pages of the telemonitoring platform were viewed most by therapists: (1) the dashboard providing an overview of individual patients and measurements; (2) the individual measurements that had to be performed and (3) the history of individual patient data.

Acceptance of the telemonitoring platform

Overall, physiotherapists reported low to moderate acceptance rates, with large individual variations ranging from 2.3 (SD = 2.1.) to 4.7 (SD = 0.8) on the 7-point Likert scale (Table 4). Therapists gave the highest rating to the item regarding "sufficient skills to use the platform" and the lowest rating to the item regarding the "imposed workload in relation to the perceived benefits". Moderate overall satisfaction rates were given with regard to the platform (Table 4).

Suggestions for improvements to the telemonitoring platform

In total, 8 of the 15 participating physiotherapists attended the three separate focus group meetings. The seven remaining physiotherapists were unable to attend, for the following reasons: having moved abroad ($n = 1$), sick leave ($n = 1$) and unavailability at the time of the meeting ($n = 5$). A total of 16 suggestions regarding potential improvements to the platform were made by the users. Table 5 shows the 10 most frequently suggested features. The majority of the physiotherapists preferred a native app for the ACL-monitor instead of a web-based platform. They also suggested linking the telemonitoring platform to their own personal electronic patient records, to enable them to accumulate data. Furthermore, the majority of physiotherapists wanted to be able to adapt the type and timing of measurements in the platform according to their personal preferences instead of following predefined settings.

Discussion

Main findings

The present study found limited use of a novel telemonitoring platform by 15 participating physiotherapists during routine care of 52 patients following ACL reconstruction. Despite the fact that the type and frequency of the measurements used in the ACL-monitor had been selected in consultation with the participating therapists, the various measurements that had to be applied and recorded in the platform were not performed by physiotherapists with the recommended frequency. For example, only 0–16.7% of the expected 22 time points of measurement in rehabilitation phases 2 and 3 were completed. It seemed as if physiotherapists adopted different perspectives and roles in this project, one as a researcher and another as a practitioner, each of them reflecting different needs and requirements. This may have contributed to the low usage observed.

The number of online sessions per patient did, however, differ widely across individual therapists, ranging between 3 and 73 log-ins per patient. Furthermore, a decrease in the use of the platform was observed over time.

Table 2. Characteristics of participating physiotherapists.

Therapist	Age (years)	Sex	Work experience (years)	Experience with ACL rehabilitation (years)	Perceived computer skills[a]
1	64	m	34	24	5
2	31	m	7	5	7
3	27	m	6	6	5
4	28	m	4	4	6
5	28	m	7	5	5
6	28	m	5	5	6
7	35	m	15	15	6
8	34	m	5	5	7
9	35	m	13	12	3
10	32	m	9	9	5
11	29	m	7	7	7
12	33	f	9	9	4
13	31	m	9	9	7
14	35	f	12	12	5
15	26	f	4	3	7
Mean (SD)	33.1 (9.1)		10.1 (7.6)	9.0 (5.4)	5.7 (1.2)

Notes: m = male; f = female; ACL = anterior cruciate ligament.
[a]scored on a 7-point Likert scale ranging from 1 (totally not at ease) to 7 (totally at ease).

Table 3. Use of the telemonitoring platform.

Therapist	Total duration of platform use (months)	No. of patients treated	Total No. of log-ins	No. of log-ins per patient	Mean duration platform use per log-in (min)	Total No. of measurements over all patients[a]	Completion rate over all patients (%)
1	12	2	md	md	md	md	md
2	12	3	43	14.3	6.9	0	0
3	12	2	56	28.0	4.5	3	6.3
4	10	4	112	28.0	3.8	3	12.5
5	10	2	29	14.5	8.0	0	0
6	6	3	105	35.0	5.7	2	4.2
7	15	8	210	26.3	10.7	23	10.6
8	15	4	68	17.0	4.6	2	2.8
9	3	1	16	16.0	8.1	0	0
10	3	2	23	11.5	6.5	0	0
11	12	4	36	9.0	6.8	2	2.8
12	5	3	220	73.3	8.4	4	16.7
13	13	5	71	14.2	4.6	0	0
14	14	4	111	27.8	6.4	0	0
15	7	5	14	2.8	8.6	11	11.5

Notes: [a]in rehabilitation phases 2 and 3 (weeks 12–52), physiotherapists were instructed to record a total of 22 datasets per patient for muscle strength and dynamic stability (hop tests); no.= number; md = missing data.

Table 4. Physiotherapists' acceptance rates of telemonitoring platform.

	Perceived ease of use			Perceived usefulness			Average acceptance score	User satisfaction[a]
Therapist	Sufficient skills to use platform	Platform is easy to use	Balance workload-benefits	Platform increases formatting of rehabilitation	Platform supports tailored treatment	Platform increases quality of treatment	*Mean* (SD)	Overall satisfaction
1	4	4	4	6	5	5	4.7 (0.8)	7
2	2	4	3	4	4	4	3.5 (0.8)	5
3	4	4	3	4	4	3	3.7 (0.5)	5
4	6	5	2	2	2	2	3.2 (1.7)	3
5	4	3	1	5	3	3	3.2 (1.2)	6
6	5	3	2	4	4	3	3.5 (1.0)	6
7	7	2	2	1	1	1	2.3 (2.1)	3
8	6	5	2	3	4	4	4.0 (1.3)	6
9	5	2	2	2	2	4	2.8 (1.2)	5
10	2	2	2	4	5	5	3.3 (1.4)	7
11	6	4	4	4	4	5	4.5 (0.8)	6
12	4	5	5	5	5	4	4.7 (0.5)	7
13	6	3	2	5	5	5	4.3 (1.4)	6
14	6	3	2	2	2	2	2.8 (1.5)	4
15	7	3	1	2	2	2	2.8 (2.0)	3
Mean (SD)	4.9 (1.5)	3.5 (1.0)	2.5 (1.1)	3.5 (1.5)	3.5 (1.4)	3.5 (1.3)	3.6 (0.7)	5.3 (1.4)

Notes: SD = standard deviation; all items scored on a 7-point Likert scale ranging from 1 (completely disagree) to 7 (completely agree).
[a]item scored on an 11-point Likert scale from 0 (completely dissatisfied) to 10 (completely satisfied).

Table 5. Suggestions for improvement to the telemonitoring platform.

Feature	**Total score**[a]
1. Native app on smartphone including push messages	22
2. Link with electronic patient record	21
3. Possibility to choose timing and type of measurement	21
4. Clear data visualization providing insights into individual rehabilitation progress in relation to personal goals and rehabilitation stages	15
5. Attractive and (more) user-friendly design of the platform	12
6. Comparison of individual scores (e.g., hop test, muscle strength) with "norm values" of comparable patients	6
7. Automatic recording and transfer of data as far as possible (e.g., by using sensor technology and wearables)	6
8. Video recording and analysis of hop tests and gait pattern using the smartphone	5
9. Motivating and engaging patients for self-administered measurements using gaming elements (e.g., rewards, scores)	3
10. Contact with patients and/or therapist community (e.g., virtual groups/chat)	2

Notes: [a]sumscore of physiotherapists ($n = 8$); each physiotherapist rated the priority of each feature by awarding a score from 1 (nice to have), 2 (should have) to 3 (must have).

The physiotherapists showed only low to moderate average acceptance rates for the platform, again with a large variation between individual therapists, ranging from 2.8 to 4.7 on the 7-point Likert scale. A possible explanation might be that physiotherapists needed more time to get sufficiently accustomed to the use of the telemonitoring platform. Therapists who were enrolled later in the study treated a smaller number of patients, which might have contributed to insufficient familiarity with using the platform and low acceptance rates.

Most of the therapists rated the ease of use as moderate, but at the same time they indicated that the time and effort needed to use the platform was not outweighed by its benefits. The mean

overall satisfaction rating was 5.3 on the 11-point Likert scale. Overall, the physiotherapists imposed high demands on the proposed eHealth technology as regards optimized compatibility with their daily routines. Physiotherapists' suggestions for an updated future version of the platform included improvement of user-friendliness, efficiency and design. The prototype of the ACL-monitor insufficiently met these requirements and was therefore not fully embraced by the users. Using the platform meant that the physiotherapists had to enter data in an additional electronic health record, leading to extra workload that was not outweighed by the perceived benefits of its use.

Comparison with previous research

A review from 2013 [34] identified several eHealth acceptance factors and clusters such as "performance expectancy", reflecting the degree to which a health care provider believes that using an eHealth system would enhance their clinical or non-clinical job performance. In addition, recent studies demonstrated that the adoption of eHealth in routine care depends on its perceived ease of use, user satisfaction and therapeutic persuasiveness (i.e., incorporation of persuasive design and behaviour change principles) [35–38]. In our study, the physiotherapists rated the perceived usefulness of the platform for their daily work as low, which might have contributed to the low acceptance and adoption rates observed. However, the physiotherapists recognized the relevance of using health technology in routine care, which is in line with the 2019 findings from the Dutch eHealth monitor [39], which has been measuring the availability, use and acceptance of eHealth in the Netherlands since 2013. According to the eHealth monitor, health care providers are predominantly enthusiastic about eHealth and are willing to use it in routine care [40].

In a recent study [36], a web–based tool was used to support ACL rehabilitation, which provided individually tailored exercise programmes. It also found that the effort and time needed to use the tool was one particular concern reported by physiotherapists, which is in line with the findings from our study and demonstrates that the degree of ease associated with using the technology is crucial for its acceptance. Contrary to our study, that study did not use the telemonitoring platform in ACL rehabilitation to gain more insight into the course of recovery of individual patients. Patients were not involved in data collection through self-monitoring, which has been reported to increase patients' self-efficacy and adherence [21, 40].

Implications for research and clinical practice

The availability of eHealth is still much greater than its actual use. Healthcare providers state that the technology does not always fit in with their daily care processes and creates additional workload, which is associated with the lack of eHealth adoption [39]. Several barriers have been identified by users that made it difficult to implement eHealth in routine care. These insights can be used to increase the chances of successfully implementing innovative technology in clinical practice in the future.

First, novel digital health technology should be easily accessible (e.g., through the use of a native app), be easy to use in routine care, and be visually appealing (therapeutic persuasiveness). Furthermore, attention should be paid to the interoperability with existing software (e.g., electronic health records). A common finding in eHealth evaluations is the decreasing use of the technology over time [41]. Long-term use of the technology can be facilitated by taking into account features such as push messages, persuasive design and incorporation of behaviour change techniques which are known to be important predictors of user adherence [38].

Second, integrating novel (digital health) technology in routine care requires changes to the daily routines of health care professionals, which are still hard to achieve in clinical practice. During the implementation of novel technology, particular attention should, therefore, be paid to the way the technology can best be integrated into daily routines to become a new habit. The lack of structured training and education of current and future health care professionals regarding digital health technologies seems to be a crucial factor for their "eHealth readiness" [42]. The education of (future) health care professionals needs to focus more on promoting knowledge, attitude and skills regarding novel health technologies, to enable them to use these technologies in an efficient and clinically meaningful way. A recent study [43] proposed a framework which highlights the necessary capacities of (future) health care professionals regarding the successful implementation of eHealth.

Limitations

The population in the present study consisted of a relatively small and selected sample, meaning that the results of the present study might not be applicable to the general Dutch physiotherapy community. Furthermore, for the analysis of verbal and written data from the focus groups, a quantitative method ("buy a feature") was used. However, in our view sufficient in-depth information was generated for the purposes of this study.

Conclusions

The present study shows that physiotherapists who initially had a favourable attitude towards using new technology and were involved in its design, actually did not use the telemonitoring platform sufficiently in their routine care. Even though health care professionals recognize the need to use (digital) health technology, there are still many barriers to overcome before eHealth can be successfully implemented in routine care. An imbalance between the perceived workload and the benefits seemed to have played an important role in the present findings. The most important issues that need to be addressed in future projects are the development of technology that is easy to use and fits into routine care processes, and giving more attention to structured training and education of (future) health care professionals.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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