

From telemedicine technology to telemedicine services

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ABSTRACT

The aim of this study was to design and pilot test ICT-supported rehabilitation services across twelve health care institutions and four different diagnosis groups (i.e. acute hip, arthritis, cancer and chronic obstructive pulmonary disease) starting from a multimodal service platform that offers four different telemedicine technologies: 1) teleconsultation, 2) activity coaching, 3) web-based exercising and 4) health monitoring. Results showed that using the same technologies, different telemedicine services can be developed with different clinical purposes. Results also show that different implementation strategies are needed for different patient groups, or even within different patient groups, to get the services implemented in everyday care. Evaluation of the ICT-supported rehabilitation services in everyday care showed that the ICT support is being accepted and highly used by the patient. However, the use of the ICT support by care professionals was dramatically low. Future studies should focus on full-scale implementation in clinical practice, on education of the health care professionals as well as large-scale trials.

Categories and Subject Descriptors

K.6.1 Project and People Management

K.4.3 Organizational Impact

J. Computer Applications

D.2.1 Requirements/Specifications

General terms

Design, experimentation

Keywords

Telemedicine, User centric, Design, evaluation, implementation,

Rehabilitation

1. INTRODUCTION

Currently, a lot of telemedicine applications are being developed for physical rehabilitation and there is ample literature describing the results of these applications when tested with patients. However, despite this great effort into development and testing and the potential that has been attributed to telemedicine, hardly any telemedicine application really gets beyond the project phase and as such penetration into clinical settings is really low [2]. In response to this, Jansen-Kosterink [11] advocates that it is not only the technology that should be taken into account. Instead, the technology together with the clinical purpose makes the telemedicine application. On its turn, the way this telemedicine application is being implemented in everyday care makes the actual ICT-supported rehabilitation service. Considering evaluation studies, despite that the number of studies is growing [6,7] they hardly focus on evaluation of the telemedicine application as a service i.e. tested in the way it will be used in everyday clinical practice [7, 12, 13] and there are only limited studies focusing on the evaluation from the health care professional perspective. This is considered very important to get telemedicine services implemented successfully. Starting from this, our study focuses on the design and testing of ICT-supported rehabilitation services using a scenario-based guideline approach for its design [9] and evaluating them with patients and professionals when used in everyday care. The study focuses on rehabilitation services for patients with various chronic diseases; hip fractures, hip/knee arthritis, cancer and Chronic Obstructive Pulmonary Disease (COPD) receiving rehabilitation in various health care settings (i.e. hospitals, nursing homes, primary care physiotherapy and a rehabilitation clinic).

2. METHODS

2.1 Design of the telemedicine services

According to the scenario-based design approach different stakeholders came together in various workshops to design the services. At the first 2 workshop between 10-15 people were present. Each group consisted of technicians (2 or 3), biomedical

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researchers (2 or 3), business developers (1), a patient organization (1) and health care professionals. The health care professionals varied across 4 different diagnosis groups and came from various health care organisations namely those organisations where the service is being put in place. These are for acute hip a hospital and nursing home, for hip/knee arthritis primary care physiotherapy and a hospital, for cancer a rehabilitation setting and for COPD a hospital setting and primary care physiotherapy. At each workshop, between 6-8 health care professionals were present and at each workshop each diagnosis group was covered. If needed smaller workshops with health care professionals and researchers were held in addition to get the design phase done. For each diagnosis group one or two extra workshops were organized.

The design of the services started from a multimodal service platform, called Continuous Care and Coaching Platform [1] that enables health care professionals to offer four different telemedicine technologies being:

1. A teleconsultation module, which enables patients and professionals to communicate to each other.
2. A web-based exercise programme that enables a professional to create an exercise programme for each individual patient. The patient is able to login at home, follow the exercise scheme, execute the exercises and provide feedback to the professional.
3. An activity coach for ambulant activity registration and real-time feedback to improve activity behaviour in daily life. The activity coach consists of a 3D-accelerometer and a smartphone. The smartphone shows the measured activity cumulatively in a graph, together with an individual tailored reference line the user should aim for. If desired, the patients can receive feedback text messages for awareness and extra motivation. The patient's measured activity levels are also displayed on the web portal and visible for the professional.
4. A health monitoring module, which consist of questionnaires that patients fill in frequently and which are used to give both the patient and the professionals insight in their health status, disease-related complaints and their progress over time.

During the workshops, a scenario is written for each of the diagnosis groups being a synoptical collage of an event or series of actions and events. The scenario integrates both the technically-oriented People, Activity, Context and Technology (PACT) framework [3] and the medically-oriented principles of evidence-based medicine. This gives a very clear mutual understanding starting from the end user on which *Person* performs which *Activity* in which *Context* and what is the role of the *Technology* in this.

Following these scenarios, implementation strategies are being described. These strategies describe who will do what in the treatment of the patients and how is the interaction with the technology. These protocols give clear indications on how the current care process is being altered with the implementation of the technology.

2.2 Evaluation of the telemedicine services

The implementation strategies developed are put into practice and the satisfaction and use of the ICT-supported rehabilitation services are evaluated for each of the four patient groups and their professionals.

2.2.1 Participants

Patients with acute hip problems, arthritis, cancer and COPD are included in the evaluation. General inclusion criteria are availability of a computer with internet at home and sufficient Dutch language skills. In addition, each patient group has specific in- and exclusion criteria in terms of age, disease stage, certain comorbidities, other conditions that hamper physical exercising or severe psychological problems.

2.2.2 Outcome assessment

Outcome assessment focuses on patient satisfaction and actual use of the service.

Satisfaction

- Client Satisfaction Questionnaire (CSQ) to measure degree of satisfaction with the received ICT-supported care [14]
- Patients rate each telemedicine application they used by means of a number ranging from 0-10
- Patients are asked whether they would recommend the service to others

Use of the service

- Number of days (expressed in % of the total treatment duration) the technology platform is being used by the patient and professional

3. RESULTS

3.1 Implementation strategies

3.1.1 Acute hip

The ICT-supported telemedicine service is a post-operative rehabilitation service provided during the stay at the hospital and at the follow-up treatment performed by the primary care physiotherapists or a (temporary) stay at a nursing home.

- In the hospital the service is used to increase the moments of exercising without extra effort of the physiotherapist as well as to teach the patient how to exercise and make transfers independently in a safe manner. For this, the web-based exercising and health monitoring modules are being used.
- In the nursing home and primary care, the telemedicine service is used to partly replace the treatment at the therapist or to increase the moments of exercising. All four modules can be used for this.

There was no standardized treatment protocol: the therapist determined per individual patient which, how and when the various telemedicine modules are being used.

3.1.2 Hip knee arthritis

Physiotherapy of patients with arthritis focuses on the consequences of the complaints, the development of a more active lifestyle as well as on increasing self-management of patients. The ICT-supported rehabilitation service is a blended care programme provided by physiotherapists and follows the same strict protocol for all patients. The treatment programme has a duration of twelve weeks. In the first week patients start with the web-based exercise module next to the treatment with their physiotherapist and continues using this module for twelve weeks. The daily activities are measured using the activity coach application during week one, two, six, seven, eleven and twelve. In these weeks the daily activities are discussed between the therapist and patient. In all cases the aim is to increase the frequency of exercise moments without increasing effort of the physiotherapist as well as to partly replace the traditional physiotherapy session.

3.1.3 Cancer

The ICT-supported rehabilitation service is a blended care programme provided by a rehabilitation clinic and follows the same strict protocol for all patients. The treatment programme has a duration of ten weeks. One week before the start of the treatment and during the sixth week of treatment the daily activities are measured using the activity coach application. These data are discussed between the therapist and patient in the first and seventh week of treatment, respectively. In week three patients start with the web-based exercise module next to the treatment at the rehabilitation clinic. From week 11 till week 33 there is only the web-based exercising at home. Implementation in this way aims at offering the possibility to exercise more intensive on the patients' individual goals than possible within the rehabilitation clinic.

3.1.4 COPD

The ICT-supported rehabilitation service is implemented as a transmural care path of the hospital and primary care physiotherapist. Before start of the programme, each participant attends two 90 min self-management sessions given by a nurse practitioner at the hospital, to learn completing the daily diary of the health monitoring. Patients are educated in early recognition of exacerbations and in starting standardized treatment in case of an exacerbation. They also have an intake appointment with the primary care physiotherapist explaining the webportal and for performing baseline measures. There is no standardized treatment protocol for the primary care physiotherapist who determines per individual patient how and when this activity coach module was used, and made the reference activity lines on the webportal. The physiotherapist also selects the exercises per patient for the web-based exercise module and adapts this exercise programme following the progress of the patient. Both primary and secondary care professionals could supervise at a distance by checking progress on the webportal. The aim of the program is to increase the selfmanagement and physical condition of the patients. All patients have access to the programme for 9 months.

3.2 Evaluation

3.2.1 Number of patients included

In total a number of 74 patients were treated using the telemedicine service modules (see table 1)

Table 1: Number of patients included in each diagnosis group.

Diagnosis	Asked to participate	Willing to participate	Started with ICT supported intervention	Control group
Acute Hip	205 in hospital	6 (3%)	n= 4 in hospital mean (sd) age: 66 (11) 80% women	N/A
	Missing for nursing home	12	n= 12 in nursing home mean (sd) age: 69 (14) 50% women	
Arthritis	Missing	15	n=10 mean (sd) age 61 (8) 63% women	n=5 mean (sd) age 58 (8) 80% women
Cancer	38	36 (95%)	n= 33 mean (sd) age 48 (8) 88% women	n=16 mean (sd) age 52 (11) 81% women
COPD	101	29 (29%)	n=15 mean (sd) age 64 (8) 47% women	n=14 mean (sd) age 61 (8) 43% women
Total			n= 74	n= 35

For the acute hip the participation rate is only 3%. Surgery after a fall appears to be a too big life event for these patients resulting in problems like cognitive co-morbidities or deliria and making exercising using technology too difficult. In addition the age of this group was very high making the technology too difficult as

there is no experience with ICT at all. As those patients with acute hip problems who did use the ICT-supported rehabilitation service and their professionals are very satisfied, they together developed a new service concept for the nursing home situation where patients enter as they are in a more stable phase. It was not set up as an individual service but as a sort of KIOSK where elderly people can sit together to exercise, each having their own personalized exercise scheme. For this, the web-based exercising and health monitoring applications were used by 12 patients. For COPD the participation rate is also low (29%) probably caused by worries of the patients about the technology beforehand or because of the strict in- and exclusion criteria with a focus on patients with regular exacerbations. In contrast the participation rate for cancer is extremely high (95%) which is probably related to the way the telemedicine service is being implemented. Cancer patients are being treated in a group and if not willing to participate in the ICT-supported intervention they could not participate in the treatment at all. Participation rate for arthritis was missing as for this group professionals did not follow a strict protocol for asking every potential patient but just those from which they were sure they would like it.

3.2.2 User satisfaction

All patient groups, except for the arthritis group, were highly satisfied with the ICT-supported rehabilitation services. The average satisfaction is 27 out of 32 (range 22.4-28.8). Concerning the individual telemedicine applications, the acute hip patients and COPD patients were quite positive whereas the arthritis and cancer group rated the applications less positive. Satisfaction with the web-based exercising application is the highest and can be considered good (≥ 7) (average 7, range 6.1-8.6), followed by the health monitoring application (average 6.8, range 5.1-9) and the activity coach (average 6.2, range 5.4-7.8), both rated as moderate (in between 5-7). The teleconsultation application was not rated as this application was hardly used in clinical practice. A high percentage of patients (71%) would recommend the telemedicine service to others.

3.2.3 Use of the service

Table 2 present the actual use of the telemedicine platform offering the telemedicine applications. It shows that the platform is being accessed very extensively by patients. On average 80% of the days the patients were in treatment the platform was visited. On the contrary the use of the platform by the professionals was unexpectedly low. They only visited the platform between 9-32% of the treatment days. Results concerning the use of the different applications in specific, show that the health monitoring application was visited by far most frequently, followed by the web-based exercising application. The activity coach was used only for a limited extend whereas the teleconsultation was hardly used or not used at all. In addition to the variability between the different applications used, there is also large variability in use between the individual patients and professionals.

Table 2: Use of the portal expressed in general logins by the patient and professional

Diagnosis	Treatment duration (average)	Patients use (average % of treatment days)	Professionals use (average % of treatment days)
Acute hip, hospital	60 days	70%	18%

Arthritis	Missing	Missing	Missing
Cancer	231 days	87%	9%

4. DISCUSSION

The aim of this study was to design and pilot test ICT-supported rehabilitation services across 12 health care institutions and 4 different diagnosis groups; acute hip, arthritis, cancer and COPD starting from using a multimodal service platform. Results of this study show that it is possible to develop with all the stakeholders together, different telemedicine services using the same technology for different patient groups in different health care settings. The services are quite satisfying for and positively judged when used in care by the patients and used to a large extent by the various patient groups. We did not succeed by the fact that the use among the professionals was disappointingly low. Apparently designing together telemedicine services and treatment protocols that are considered useful for their patients is not sufficient to get professionals up and running with telemedicine services in their daily practice. In literature, a reported problem regarding the use of telemedicine by professionals is distrust in the technology due to problems and reliability of the measurements [8,15]. Another issue is that only a few patients of the involved health care professionals took part, causing that the telemedicine was not a part of their regular routine. Professionals are however considered important to help patients understand the nature of the disease, potential benefits of treatment, and encouraging development of self-management skills [4]. As such their attitude towards telemedicine can greatly influence the perception and adherence of the patients. As such full-scale implementation, meaning not only used for a small portion of their patient group, in their daily care practice is important as is better education of health care professional by integrating the telemedicine in their primary education as well as in continuing education.

The satisfaction with the telemedicine services was moderate to good and the use of the telemedicine service was high across all patients groups. This indicates that patients are willing to adopt the telemedicine service more than the professionals do. Remarkable in this sense is that the cancer group who is on average less satisfied with the ICT-supported rehabilitation services in general used the telemedicine system to a large extend. This is probably related to the fact that it concerns a full-scale implementation here, but it also supports the finding that there apparently is no significant relation between patient satisfaction and compliance [10]. Probably satisfaction with the service is not as important for getting telemedicine services used as is hypothesized by the different Technology acceptance models as TAM [16] and Unified Theory of Acceptance and Use of Technology (UTAUT) [17].

Another important result of the present study was the low participation rate in some of the diagnosis groups, especially the COPD and acute hip group. COPD patients are on average lower educated and the acute hip group is very high aged. As a consequence they might lack confidence in using technology all by themselves, and thereby choose not to participate in the study. The kiosk concept we designed for the nursing home, where the patients were also of high age, showed however that the technology developed is easy to use also for these patients and that their enthusiasm to use the service is actually very high. Probably the idea that there will be someone around in case of problems is important in their uptake of technology. As such for

COPD	256 days	80%	32%
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some patients the home situation might be a step too far, but exercising independently at a facility in the neighborhood might be a good intermediate to get telemedicine adopted and implemented by a larger group of patients. Earlier studies [5] also showed that this fits the preferences of chronic patients above a home situation.

5. CONCLUSION

This study showed that a variety of ICT-supported rehabilitation services, that are being accepted and used by its patients, can be designed using the same telemedicine technologies. However, this study also indicates that the barrier for widespread implementation is related to professionals who showed only a very limited use. Future studies should focus on full-scale implementation in clinical practice, on education of the health care professionals as well as large-scale trials.

6. ACKNOWLEDGMENTS

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