Paper

A scenario guideline for designing new teletreatments: a multidisciplinary approach

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Summary

Lack of user acceptance of telemedicine services is an important barrier to deployment and stresses the need for involving users, i.e. medical professionals. However, the involvement of users in the service development process of telemedicine services is difficult because of (a) the knowledge gap between the expertise of medical and technical experts; (b) the language gap, i.e. the use of different terminologies between the medical and the technical professions; and (c) the methodological gap in applying requirement methods to multidisciplinary scientific matters. We have developed a guideline in which the medical and technical domains meet. The guideline can be used to develop a scenario from which requirements can be elicited. In a retrospective analysis of a myofeedback-based teletreatment service, the technically-oriented People-Activities-Context-Technology (PACT) framework and medically-oriented principles of evidence-based medicine were incorporated into a guideline. The guideline was developed to construct the content of a scenario which describes the new teletreatment service. This allows the different stakeholders to come together and develop the service. Our approach provides an arena for different stakeholders to take part in the early stages of the design process. This should increase the chance of user acceptance and thus adoption of the service being developed.

Introduction

The growing financial pressures in health care and the increase in chronic diseases (due to ageing) mean that rehabilitation care is shifting towards self-management in the patients' home.[1] In the delivery of extra-mural rehabilitation care, a promising approach is the use of information and communication technologies for transferring medical information between patients and clinicians and bringing rehabilitation expertise to the patients. Despite numerous trials of telemedicine services, very few become used routinely in health care.[1] Lack of user acceptance of tele-rehabilitation services is one of the essential barriers to deployment.[2,3]

According to sociotechnical approaches, both professionals and patients must be involved in specifying their needs during each stage of the design process.[4,5] They alone have the relevant knowledge and understanding of the medical intentions, medical ethics conditions and the goals of their treatment.[4–6] However, the involvement of users in the development of tele-rehabilitation services is difficult because of the knowledge gap between the expertise of health-care staff and patients, and that of a technical design team. It is also difficult because of the language gap (the use of different terminologies) and the methodological gap in applying requirement methods to multidisciplinary scientific design.

One of the reasons for these gaps is the scarcity of services in daily routine care[7] and therefore patients and health-care professionals are commonly unfamiliar with technology,[1] which hampers the definition of the requirements. Also, although there are many techniques for collecting needs from users, including qualitative (e.g. examining existing materials, interviews, focus groups) and quantitative (e.g. surveys, rating scales) approaches, there are none for retrieving the contents and themes which are important in the early phase of developing new teletreatments.[6] The main challenge is thus to understand the needs of the health-care staff at an early stage of the development process, so that those involved can be provided with a system they actually need for their various work processes. The use of scenarios can play an important role, because they can bridge the collaboration gaps.[8,9] A scenario is defined here as a concrete description of an activity that the users engage in when performing specific tasks.[10–12]

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In practice, is is difficult to address the appropriate content and themes when constructing a scenario.[13] On one hand, in the technical area a useful structure to elicit the content and themes of the scenario is the PACT approach.[14] PACT stands for People, Activity, Context and Technology, for example related to the patient using a technology in their daily life with a certain (medical) context. This framework is used in requirements engineering to help think about concrete scenarios, which are defined as abstract descriptions of the PACT elements.[15] On the other hand, in the medical area new treatment concepts are designed based on the principles of evidence-based medicine. Evidence-based medicine aims to apply the best available evidence gained from scientific reasoning.[16]

Incorporating the principles of evidence-based medicine into PACT scenario development could provide starting points for more effective and efficient design of teletreatment applications.[8] The aim of the present study was to develop guidance which could be used to develop scenarios, in the area of designing teletreatment services.

Methods

We conducted a retrospective analysis of the early phase design requirements in the myofeedback-based teletreatment project MyoTel. There were 11 medical experts from four clinical centres in Europe (The Netherlands, Sweden, Belgium and Germany) and four system engineers. The group developed a scenario which reflected the teletreatment. This scenario provided the starting point for developing the guideline presented in the present paper.

Procedure

The medical experts investigated the literature on scenarios and requirements engineering, and the system engineers investigated the literature on pain treatment. During this process, the system engineers communicated with the medical experts by email. Semi-structured interviews also took place by telephone and face-to-face. Group discussions were used for feedback on the scenario in development and associated requirements. The procedures and requirements have been described elsewhere.[8,9]

The approach is summarised in Figure 1. The 'guideline' to be developed can be used to develop PACT scenarios (M1, Figure 1) from which domain requirements[17] of the intended teletreatment services can be elicited. Whereas the PACT scenario outlines the activities involved, the requirement is to support these activities.[17] A definition of the PACT attributes is presented in Table 1. Phase 2 of requirements engineering was outside the scope of the present work.

The scenario used as a starting point for developing the guideline is presented in Box 1. It described a narrative in a day in the life of a patient[10] named Lisa being treated with the myofeedback-based teletreatment and the corresponding activities of the treating therapist.

Development of scenario guideline

In order to develop the guideline, the principles of evidence-based medicine were incorporated into a generic

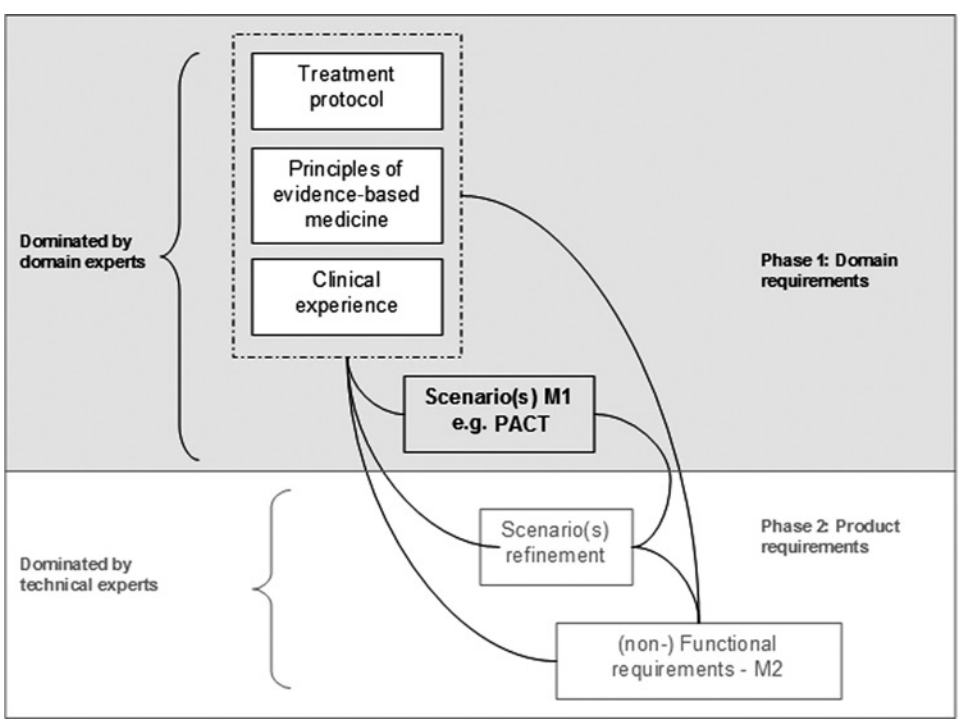

Figure 1 Focus of the study. PACT stands for Person (i.e. actor), Activity (of domain tasks for which actor is responsible), Context and Technology. Milestone 1 (M1): scenario. Milestone 2 (M2): list of functional and non-functional requirements

Table 1 The PACT criteria

Criterion	Definition
People	Roles and/or actors of typical users involved in delivering and receiving the telemedicine intervention.
Activities	Activities to be performed by the actors in order to successfully provide and receive the telemedicine intervention.
Context	Puts the telemedicine intervention in a health-care context. Activities always happen in a context, so there is a need to analyze these two together.
Technology	Typically, to realize telemedicine, technology needs to transform some input data into some output data which can be used by the medical expert and patient to support the activities defined earlier. The features of the technology are input, output, communication and content.

list of PACT attributes and a retrospective analysis of the teletreatment scenario was performed.

The Council for International Organizations of Medical Sciences developed a list of evidence-based items to be included in the research protocol. The items included treatment objectives, criteria for target population, frequency and dose of the intervention, measurements to be taken, instruments to be used to collect information, safety considerations, expected outcomes; and considerations of how the intervention will affect health care, health systems or health policies.[16,18,19] A PACT analysis is useful for analysis and design activities. It is also useful for understanding the current situation, seeing where possible improvements can be made and envisaging the future. To perform a PACT analysis the designer scopes out the variety of people, activities, contexts and technology that are possible.[20]

Box 1 Scenario

Lisa is 35 years old. She is working at a large administrative company and predominantly performs computer work. She suffers from neck and shoulder pain which is, in Lisa's opinion related to her computer work, because during holidays the complaints reduce. Because of this, she was allowed to have a new treatment approach, the myofeedback treatment service. By means of the teletreatment service subjects are taught to relax their neck and shoulder muscles (e.g. the trapezius muscle). During her daily work, Lisa carries her teletreatment system with her. The system consists of a garment, in which dry surface electrodes are incorporated, which continuously measure the muscle tension of her trapezius muscle. The garment can be worn under the clothes. The garment is connected to a processing and feedback unit which vibrates when an insufficient amount of muscle relaxation is measured. The vibration of this unit provides feedback on results (sufficient or not sufficient relaxation). Because of this vibration, Lisa knows her muscle relaxation has been insufficient for a while. In order to stop the vibrating signal, Lisa has to relax her trapezius muscle, for instance by means of the relaxation exercises she has learnt from her myofeedback therapist, who attended a one-day education session on using the system and interpreting the data. She is able to check her muscle relaxation patterns (parameters: root mean square (RMS) and relative rest time (RRT)) for both her right and left side of her trapezius muscle on the visual display. This visual information provides Lisa with more detailed information about her performance than the vibrations of the processing unit. Automatically the encoded and anonymized muscle pattern data are sent via wireless communication to the website which is accessible for remote consultation. Lisa receives four weeks of treatment during which she wears the equipment and notes her activities and pain intensity in a diary on the web portal. Weekly counselling sessions lasting approximately 30 min with the myofeedback therapist take place. At the start of treatment, Lisa and the myofeedback therapist meet in person. During the introductory session, the therapist gives instructions about the system and explains the principles of remotely supervised treatment. Lisa can read all the instructions in the manual which is provided along with the equipment. In addition, the therapist ensures that Lisa's workstation complies with the ergonomic guidelines and uses a checklist for the main work times, work tasks, working hours, workload and work style. On the visual display of the PDA the therapist views the muscle activation patterns to check whether the garment which is worn by Lisa for the first time is properly adapted to her anatomy. Thereafter, at least three weekly remote counselling sessions take place (by telephone) in which Lisa is taught about personal work style in relation to muscle tension and beginning techniques to manage the stress factors at work and at home that affect her musculoskeletal health. Prior to the remote counselling session (conducted by telephone), the therapist prepares the consultation. This means the therapist logs in on the website, selects Lisa from the patient list, and inspects the (historical) muscle activation patterns available. The therapists looks for differences in left and right side of the trapezius muscle, tries to find patterns in muscle relaxation over time and identifies tasks which accompany elevated levels of muscle activation of the trapezius. In addition, screenshots of deviating or remarkable muscle activation patterns can be sent to Lisa for more detailed feedback and discussion. After four weeks of treatment, Lisa visits the myofeedback therapist (in person) for the final counselling session and to collect the myofeedback equipment. After four weeks of treatment the pain intensity in the neck and shoulder region has been reduced and Lisa is able to recognize symptoms of insufficient levels of muscle relaxation even in the absence of the service.

Results

The result of the retrospective analysis is summarised in Table 2. The columns of Table 2 show: (a) the attributes written down in the teletreatment scenario; (b) the international elements of a medical research protocol proposed by the WHO; (c) what kind of information should be elicited from the experts in the user requirements phase 1 (Figure 1) in order to fit the PACT criteria; and (d) the motivation.

Based on the results presented in Table 2, an 'ingredient list' can be composed. This provides a detailed narrative of a day in the life of an average user . The recipe describing how to link the ingredients in the scenario is outside the scope of the present paper.

Discussion

The present paper describes the systematic development of an attribute list (Table 2) for scenario-designers to construct a medical PACT scenario. In our view, this attribute list guides the process of making a scenario. Thus the present study provides a scenario guideline for starting and discussing the early phase requirement elicitation process in which technical and medical experts meet. Use of such a guideline could bridge the communication, language and methodological gap commonly faced in telemedicine design and should ultimately lead to more effective and efficient early requirements elicitation. Participatory design in telemedicine has the potential to improve the sustainability beyond the initial pilot phase.[1]

The guidance (Table 2) represents a kind of ingredient list which can be used to compose a scenario describing the use

Table 2 Attribute list for medical PACT scenario

PACT	For example Lisa Myotel...	WHO	Key practices scenario composition: Guideline	Key practices scenario composition: Motivation
P	Suffers from chronic neck and shoulder pain related to computer work	Patient population: pathology	– Describe the *disabilities* of the patient related to the pathology – Describe the *educational/cognitive* disabilities of the patient (related to the pathology)	E.g. physical disabilities (e.g. spasticity in the arm) and/or cognitive disabilities (e.g. memory) might hamper the possible activities to be performed with a system
	Lisa 'female' is 35 years old	Patient population: sociodemographic variables	– Describe the *age* of the patient – Describe the *gender* of the patient	Age and gender are associated with technology adoption
	Lisa predominantly performs computer work, therapist educates her on system usage	Patient population: teletreatment skills	– Describe the level of *computer experience* to interact properly with the system – Describe the type and frequency of *instruction/training*	Highly experienced/skilled patients are better able to (learn to) use the telemedicine intervention; usability and understandability are different compared to less experienced subjects. Patient instruction and manuals should be adapted to the level of experience
	Myofeedback therapist	Professional(s) population: specialization	– Mention the *specialty* of the professional(s) and their role/ responsibility in the management of the patient's disease – Describe the frequency and type of *communication* needed to be able to remotely treat patients	The expertise and communication skills of the responsible professionals determine the activities to be performed, the information needed from the system and the communication technologies that can be applied
	Therapist attended one-day instruction session	Professional population: teletreatment skills	– Describe the level of *computer experience* of professionals – Describe the type and frequency of *instruction/training*	Computer experience is related to learnability, usability and understandability. Instruction could be adapted to the level of experience
	After the teletreatment Lisa perceives less pain and pain-related disability	Clinical benefits: patient	Describe the *goals* and *benefits* (e.g. *clinical outcomes)* of the telemedicine intervention	The identification of the clinical goals addresses the clinical relevance of the application. The identification of clinical outcomes is crucial for the composition of an end-to-end storyline in the scenario
	Objectively monitored sEMG data improves quality of consultation	Clinical benefits: professional	Describe with what *goal* and *benefit* professionals will use the telemedicine intervention	Similar to previous motivation
A	Explanation of system. Adapt system to her anatomy, analyse EMG and diary data, prepare and conduct teleconsultation	Treatment protocol: professional procedures	Describe what *activities* need to be executed by the professional to provide the telemedicine service to the patient	The activities to be executed by the professionals determine the functional abilities of the telemedicine to be developed. From these functional abilities, the functional requirements of the system can be derived by the designers. Activities can be related to technical instructions and support, medical instruction and coaching, and consultations
	Wear the system, relax neck and shoulder after signal, fill in diary, weekly teleconsultation	Treatment protocol: patient procedures	Describe what *activities* need to be executed by the professional to provide the service to the patient	Similar to previous motivation
	EMG signal quality for appropriate intervention and feedback are RMS and RRT	Treatment protocol: quality of treatment	Describe the main *parameters* that determine the measures used in the intervention – for example the parameters of the feedback modality of the teletraining component	The main parameters determine the quality of service delivery by the teletreatment. The quality indicators provide starting points for prioritizing future specifications
C	Travel time savings, increased treatment intensity, quality of care	Rationale behind medical innovations	Describe the *socio-medical relevance* of the telemedicine intervention and its hypothesized effects	The socio-medical relevance describes the benefits of the teletreatment service, i.e. it puts the innovation in place on a macro-level to estimate its magnitude and viability.
	EMG data are encoded and anonymized	Privacy considerations	Describe which patient information should be protected from a *privacy* perspective (and how to deal with this privacy, e.g. possible solutions applied in medical research)	Privacy issues need to be taken into account in all phases of the design cycle. The sooner they are identified the better
	Lisa is able to see the EMG data on a visual analogue display	Safety considerations	Describe the *risks* associated with using the telemedicine intervention	Safety issues, or mal-adaptive usage of the system, should be taken into account in the development of the telemedicine intervention in order to eliminate the risks associated with it. By viewing the EMG signal on the PDA, Lisa has a better idea about the quality of the signal and the

(*Continued*)

Table 2 (Continued)

PACT	For example Lisa Myotel…	WHO	Key practices scenario composition Guideline	Motivation
				reliability of the feedback provided by the system
	Lisa uses the teletreatment system continuously; both at home and at work	–	Describe *the locations* where the telemedicine intervention is going to be used by the patient	Information about location of use provides starting points for deciding which type of devices is needed (e.g. fixed PC or mobile PDA?) and the communication platform (e.g. continuous versus non-continuous)
T	Muscle relaxation left and right shoulder, type of activities performed	Measurements: input content	Describe *the type of information/ parameters* that are relevant in monitoring the health status of the patient	From the type of information that needs to be collected, designers may get an idea of which sensors and logging-data need to be used/stored by the application
	Patient list on portal, muscle relaxation patterns, diary of activities	Measurements: output content	Describe the type and frequency of accessibility of information which should be *available for and/or fed back* to the patient and/or professional	Information about frequency of accessibility provides starting points for the design of the system's communication infrastructure. Designers may get a first idea about the interfaces for the users
	Lisa can view the level of muscle relaxation and muscle activation real-time on the PDA. When insufficient, she receives a vibrating signal as a sign to relax	Measurement protocol: communication	Describe the feedback modalities needed for the patient to be able to train remotely	Information about frequency of accessibility provides starting points for the design of the system's communication infrastructure

of the teletreatment application. This allows different stakeholders to come together, bridging the knowledge, language and methodological gaps that are referred to above. Apart from bridging these gaps, our approach also provides an arena for different stakeholders to contribute their interest and thoughts about the application to be developed. This coming together over a narrated description allows the different stakeholders to express their views, wishes and service demands.

Although involving users in the early phase of requirements engineering increases the possibility that the telemedicine intervention will be aligned to their needs and will be used in routine care, a frequently mentioned drawback of this approach is the fact that there are other design methods that are more cost-effective.[6,21] Involving users in a multidisciplinary setting is known to require a lot of effort and time because of the communication barriers between the stakeholders. We believe that applying the scenario guideline (Table 2), is likely to result in a reasonable trade-off between costs and effectiveness of participatory design approaches.

In the literature, studies addressing the early use of participatory design for system development share a theoretical perspective, but no specific coherent methods have been developed. The present guideline incorporates medical knowledge of health care in a technical-oriented requirement engineering approach, i.e. the PACT elements. The guideline developed in the present study has formalized the practical experience gained from the application of participatory design in the teletreatment project. The assumption was that from the scenario, the appropriate requirements were derived and the needs of the medical professionals were addressed. This assumption was supported by the positive findings resulting from the validation trials in a large sample of patients ($n >$ 100) in four different countries,[22–24] suggesting the proper engineering of their requirements.

The guideline was specially developed for, and is thus restricted to, the context of teletreatment interventions based on body area networks. Because of the limited number of stakeholders and the qualitative nature of the process underlying the development of the guideline, future research is needed about its applicability in design by other groups of stakeholders. Furthermore, the present framework only addresses the early phase of constructing a PACT scenario from which requirements[17] can be elicited.

Users must have reasons to think about new solutions for traditional working practices. Once motivated, the appropriate information can be derived. The guideline provides a practical tool which contains familiar themes to be discussed, i.e. the principles of evidence-based medicine, even when the technology is complex and unfamiliar.

In conclusion, the present study suggests a scenario-based guideline which provides a starting point for mutual understanding and collaboration in a multidisciplinary setting, in which medical professionals shape the system to be designed. It demonstrates the concept of incorporating the principles of evidence-based medicine into telemedicine design.

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