Telerehabilitation Web Application for Health Care Professionals And Adults With Multiple Sclerosis

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ABSTRACT

No matter the severity of their ability or disability, people with Multiple Sclerosis (MS) need regular physical activities. The goal of our work is to support face-to-face sessions performed by patients one day a week at the medical center, with exercises at home for the rest of the week. A two month duration pilot study was conducted with a tailor-made telerehabilitation tool used by 20 MS patients and 10 professionals of the ADEMBI association. At the conclusion of the study they were given a 10 item questionnaire which contained 5 response options in order to evaluate the usability of the system. The usability values from the questionnaires were 71.75 and 75 out of 100 points on the SUS scale in patients and professionals respectively. Results demonstrate that our system is valid for both patients and professionals, and so we will now be able to evaluate the long-term evolution of MS patients through the use of our tool.

Categories and Subject Descriptors
J.3 [Computer applications]: Life and Medical Sciences – health, medical information systems

General Terms
Management, Experimentation, Human Factors.

Keywords
Multiple Sclerosis, telerehabilitation, web application.

1. INTRODUCTION

Multiple sclerosis (MS) is a chronic illness that involves many complications for the person affected; it has both physical and psychosocial implications, with the latter being the most disruptive for the patient’s psycho-emotional balance on certain occasions [1-5]. In MS, neither medical nor rehabilitative action exists for the disease [6-9]. The patients need to have a clear understanding that they must live within certain limitations, and so they must be able to physically and psychologically adapt to these limitations [10-13]. Patients with chronic disorders need to maintain a continuous exercise regimen in order to improve their condition and their motor skills. Some people will be able to undertake their rehabilitation at home by themselves with occasional support from a health professional. Others will need more intensive care and therapy. The treatments the patients must undergo, such as physiotherapy, medical, psychological and occupational therapy cannot return them to their previous physical condition, but they can help to relieve the symptoms, to delay or avoid the dieses progress, and to try to make their quality of life as acceptable as possible. At the same time, the family also has to adjust to this new situation and understand the key role they play in the patient’s treatment. Moreover, no two patients are alike in their circumstances or their symptoms, so no two treatments can be equal. This project intends to address the following points:

• To re-train voluntary movement control and keep it fully available.
• To include treatment techniques in their day-to-day working lives, suitably relating them to daily activities, thus maintaining the improvements achieved.
• To stimulate sensory and perceptual experience and so keep the experience of normal movement throughout the progression of the disease, not only to exploit its potential, but also to enable the patient to feel safer and to move more freely, requesting the assistance of relatives or aides only when required, at the later stages of the illness.

The paper is organized as follows: first of all, the materials and methods section gives details of the experiment. System Design section describes the technological solution and the findings of the study are then presented in experiment results section, followed by a conclusion explanation.

2. MATERIALS AND METHODS

2.1 Materials

The ADEMBI (Multiple Sclerosis Basque Foundation) created a set of exercises and questions with which to perform the pilot test. These materials include pictures, both static and animated (n=307, 162 MB), videos (n=201, 1.45 GB) and documents (n=140, 21 MB), which are classified according to six main categories: Speech Therapy, Neuropsychology, Occupational Therapy, Yoga, Physiotherapy and Rehabilitation.

The telerehabilitation tool used in this pilot test was modular-designed, and each feature was represented by a module. To create these modules, we used WEB technologies like PHP, JavaScript and AJAX, and some multimedia technologies like...
Red5 and Adobe Flex. Web technologies allowed us to develop all the necessary modules based on the needs of users, and multimedia technologies provided us with the necessary tools with which to build the online communication modules. We chose Adobe Flex instead of another Web technology like HTML5 because HTML5’s necessary APIs for multimedia treatment (videoconferencing and recording) can’t run properly on some web browsers like Internet Explorer 6, 7 and 8 or Firefox 3.x and above [14].

2.2 Participants
To obtain the sample, a group of 40 people belonging to the ADEMBI were invited to participate based on the two main groups that were the intended end users of the system: medical professionals and people with multiple sclerosis. 75% (n = 30), 10 in the medical group and 20 in the group of people with multiple sclerosis answered in the affirmative. No distinctions were made for any of the groups in recruitment on grounds of origin, ethnicity, religious belief or social status. However, for the group of people with multiple sclerosis, different inclusion and exclusion criteria were defined:

- **Collective of people with multiple sclerosis:** For this group, the requirements to participate in the study were: (1) to have a diagnosis of multiple sclerosis, and (2) that the diagnosis was Benign Multiple Sclerosis or Relapsing-Remitting Multiple Sclerosis. Furthermore, the exclusion criteria comprised (1) having a diagnosis of a disempowering and serious illness and (2) a severe cognitive impairment (MMSE <24).

2.3 Methods
A professional met patients individually at the ADEMBI for one session that lasted 15 minutes on average in order to explain the aim of the pilot test and its duration. The following week, both professional and patient had another session, which lasted for one hour on average, to fully explain the telerehabilitation tool, and to provide the patient with access details. The patients tested the system for one week and then professionals assigned exercises for a six week period, which consisted of an average of 35 exercises which were performed by the patients. After this period of time, both professionals and patients completed a satisfaction survey focused on the usability of the system. This satisfaction survey was based on a 10 item questionnaire with 5 response options, with values from 0 to 4; and a System Usability Scale (SUS) [15] questionnaire. The SUS scale consisted of over 40 points, so it was necessary to multiply the values obtained by 2.5 in order to obtain values out of 100.

Joomla, a Content Management System (CMS), acts as the infrastructure for data and modules handling. The data storage is powered by MySQL. Finally, the system runs in a Linux environment, in particular, Ubuntu Server environment, with Apache server.

To create these modules, we used WEB technologies like PHP (a widely-used Open Source general-purpose scripting language that is especially suited for web development), JavaScript (a dynamic scripting language supporting prototype based object construction) and AJAX (a web development technique for creating RIAs running on the client’s browser, maintaining communication asynchronously with the server in the background) and some multimedia technologies like Red5 (an Open Source server for presenting stream contents in Adobe Flash using RTMP/RTMPT/RTMPS) and Adobe Flex (Flex allows programmers to rapidly develop cross-platform applications and their layouts using MXML and ActionScript language).

3. SYSTEM DESIGN
In order to create an accessible, powerful, low-cost and easy-to-use tool we have designed a technological solution presented in Figure 1. The telerehabilitation tool has two views, one for the medical professionals and one for the patients:

- The professional’s view contains everything necessary to ensure efficient monitoring as well as all the necessary system content. To add content, professionals have several modules: exercises, questions, repository, forum, blog and users’ management. To monitor users, the system offers a monitoring and a history module. Finally, the professional’s view has a chat and videoconference modules along with a notification center.
- Users’ view offers a personalized monitoring module, forum, blog, videoconference, chat, and recording and notification center modules.

As stated above, the system is designed on the basis of modularity, and each module is independent, with some of them interconnected to offer extra functionality. Each module is briefly described below (see Figure 2):

- **Recording module.** This module is exclusive to patients; by means of it, every patient has the opportunity of recording the exercise during its execution.
- **Monitoring/History module.** The Monitoring module allows the professional to see the daily evolution of each patient, as well as enabling a personalized treatment based on the patient’s characteristics and evolution. The History module acts as the monitoring module but with the option to choose between two dates.
- **Exercises/Questions modules.** Only the professionals are able to use these modules. With these modules, the professionals can set up a repository of exercises and questions.
- **Users’ management module.** This module is used for creating users and for controlling system and account policies.
- **Notification center.** This module shows the latest updates in the system.

![Figure 1. High level diagram.](image-url)
**Forum/Blog modules.** Forum and blog offer offline communication. These modules make it possible to create thematic threads involving both professionals and patients.

**Chat/Videoconference modules.** Both use Red5 technology. Those modules offer a direct link between the professional and the patient, either by text or by video/audio.

4. RESULTS

4.1 Experiment example

The picture below, Figure 3, shows the proposed system used in the pilot test, specifically, the professional’s monitoring module with a patient’s video recording.

![Figure 3. Professional monitoring a patient.](image)

Figure 4 shows an exercise, with a video that explain how to perform the exercise correctly. Every exercise provides information of its purpose, how to perform it (with text, images and/or videos) and the number of repetitions, if any.

4.2 Assessment analysis

Table 1 shows the questionnaire users filled after the test. The questionnaire (see Table 1) was a 10 item questionnaire with five response options; with values from 0 to 4: a value of 0 represents totally disagree and 4 represents totally agree. This questionnaire follows the guidelines of System Usability Scale (SUS)

<table>
<thead>
<tr>
<th>#</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The system includes demonstrations that allowed me to observe and practice complex processes new to me</td>
</tr>
<tr>
<td>2</td>
<td>I think that the system interface clearly displays information, is easy to understand and consistent</td>
</tr>
<tr>
<td>3</td>
<td>I felt comfortable and confident using the system</td>
</tr>
<tr>
<td>4</td>
<td>I think that the system modules were consistent and do their job properly</td>
</tr>
<tr>
<td>5</td>
<td>I knew what I was doing at all times</td>
</tr>
<tr>
<td>6</td>
<td>I was able to perform all actions of the system</td>
</tr>
<tr>
<td>7</td>
<td>I was able to read every option of the system</td>
</tr>
<tr>
<td>8</td>
<td>I knew why I was doing the processes at all times</td>
</tr>
<tr>
<td>9</td>
<td>I found the various functions in this system to be well integrated</td>
</tr>
<tr>
<td>10</td>
<td>I needed to learn a lot of things before I could get going with this system</td>
</tr>
</tbody>
</table>

With respect to the patients (n=20), we obtained a median score (MS) of 71.75 with a standard deviation (SD) of 11.18 and standard error of the mean (SEM) of 2.5 (α=0.05). On the SUS scale, values over 68 are considered to be above average. In this case, our system obtained the 2nd quartile [15], meaning that our system was considered acceptable with a value of 71.75. As far as the professionals were concerned (n=10), we obtained MS=75 with SD=5.65 and SEM=1.78 (α=0.05). In this case, our system obtained results in the 3rd quartile, meaning that our system was considered acceptable with a value of 75. Patients’ answers’
correlation coefficient between men and women showed a value of \( r = 0.73 \) (\( p = 0.014 \)), so the results were consistent, positive with considerable correlation, and so the test was considered to be reliable; nevertheless, the professionals obtained a value of \( r = 0.09 \) (\( p = 0.788 \)), no correlation, so the results were inconsistent and the test was not reliable.

![Figure 5. Questions values of usability questionnaire.](image)

5. CONCLUSION
As seen above in the results section, these types of systems are feasible and are acceptable to users. The technology is getting more and more common in our daily routine, and this opens up new possibilities for systems such as the one proposed. The ease of use is one of the advantages of this system, and the users' feedback helped us just right. Carrying out the rehabilitation at home is a great step forward in users' quality of life, because they don't need to travel, they don't need to wait for treatment, they can decide when and where they want to carry out the rehabilitation, etc., emphasizing the patient's empowerment. It's also an improvement for medical professionals because they can provide a personalized treatment for several patients at the same time, maintaining the quality of service reaching more people. Another important advantage of this system is the cost reduction factor. This is the result of, among other things, the reduction of trips undertaken by users and of the cheap infrastructure needed to host the whole system.

6. ACKNOWLEDGMENTS
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7. REFERENCES