

A telehealth approach to oropharyngeal dysphagia therapy

Helena Bascuñana¹, Berenice Blanco³, Yliana Rivero³, Josep Monguet², José Luis Muñoz², Mónica Sampieri³
June 2010

¹ Hospital de Sant Pau. Servicio de Rehabilitación y Terapia; ² Universidad Politécnica de Cataluña; ³ Sicta

Abstract

The objective of this paper is to describe a telemedicine system called e-dis that aims to replace a part of the treatment of oropharyngeal dysphagia of neurologic origin through the use of information and communication technologies. A clinical test is going to be conducted to get evidence to demonstrate that as a result of the use of the e-dis system the clinical outcome is comparable to conventional therapy, more patients can have access to treatment, the cost of the treatment would reduce and the clinical work can be improved.

Introduction

Oropharyngeal dysphagia of neuronal origin affects about 55% of patients with neurological diseases and diseases associated with aging (Clavé et al, 2004). Publications show a high incidence and prevalence of dysphagia in patients with neurological disabilities (Buchholz, 1994 and 1995, Lügger 1994, Mann et al, 2000). The most common consequences are malnutrition, with a high prevalence in these patients; and tracheobronchial aspiration, which is the main cause of mortality. The treatment of oropharyngeal dysphagia reduces the incidence of aspiration pneumonia and tends to improve the nutritional status. The objective is to obtain an oral food with a safety swallow, while maintaining an adequate hydration and nutrition.

Background

Dysphagia adversely affects quality of life. Today, a wide range of medical, surgical and behavior medical treatments are employed to improve the physiology of swallowing. However, “the effectiveness of these treatments is not fully understood because the outcome evaluations are few and are limited to assessments made pathophysiological aspects” (McHorney et al, 2000). According to McHorney et al (2000) “a full evaluation of a health treatment should include four outcomes: (a) clinical status, such as mortality, morbidity, and pathophysiology; (b) health care costs and utilization; (c) quality of life, including function and well-being; and (d) patient satisfaction”.

Measuring the quality of life related to health is increasingly important as a way of studying the health of the population and to analyze the efficiency and effectiveness of health interventions (Herdman et al, 2001). The EuroQOL-5D (EQ-5D) was designed as a simple questionnaire to be administered in very varied conditions of measurement and to facilitate the acquisition of securities of preference (or utility) of individuals for a series of health states for inclusion in cost studies cost-effectiveness or utility. Since its adaptation in Spain, the EQ-5D has been tested in numerous studies to measure the psychometric properties (validity, reliability, sensitivity to change), to obtain reference population norms, as well as rates of population values (Herdman et al, 2001).

To date, existing studies have focused their attention on the usefulness of the oropharyngeal kinestherapy to improve muscle strength and mobility of the oropharyngeal structures (Logemann, 1983, Lazarus, 2003 and 2005 and Robbins et al, 2005). There are also studies in the rehabilitation of dysphagia that show the ability of exercise on affect neuronal plasticity, thus the long-term changes of neuronal organization (Kays, 2006). There is no currently published study involving the implementation of a program for oropharyngeal kinestherapy using a telemedicine system.

The conventional rehabilitative treatment of dysphagia, which includes postural strategies, neuromuscular practices and specific maneuvers, are traditionally performed in the consulting room

under the supervision of a speech therapist or a doctor. The speech therapist teaches the patient the exercise routine and then observed as it runs it. Implicit in this routine are the discomfort and inconveniences associated with transferring the patient to the medical centre, waiting times for care and transfer of patients back home.

An alternative to conventional treatment is to perform exercises at home, videotape a complete session and send the videos to a Web where the speech therapist can see the performance of the exercises and provide feedback to the patient. This is a telehealth application because involves the electronic transfer of medical and health information between participants (patients and therapists) separated by distance.

Early definitions of telemedicine focused on medical care as the only function and justification for telemedicine. However, Bennet and associates (cited by Rashid et al, 2001) expanded the definition and scope of telemedicine to include the concept of telehealth. In this expanded context, telehealth included “system that support the health care process by providing the means for more effective and more efficient information exchange”. Nonetheless, in both telemedicine and telehealth, all applications share two common elements, namely the geographic separations between two or more actors engaged in health care and the use of telecommunication and related technology to enable, facilitate, and possibly enhance clinical care and the gathering, storage, and dissemination of health-related information.

The aim of this paper is describe the telemedicine system called e-dis that aims to replace a part of the treatment of oropharyngeal dysphagia of neurologic origin through the use of information and communication technologies.

E-Dis System Description

The part of the treatment of oropharyngeal dysphagia of neurologic origin to be replaced by e-dis system is related to oropharyngeal praxis. Patients who carry out this part of the treatment watch several videos where the doctor performs the exercises and gives specific instructions for proper performance (see an example in Figure 1). Then the patient by him/herself or assisted by a relative/carer performs exercises, repeating as often as deemed necessary to perform properly. Once mastered the exercise the patient, alone or assisted by their family/carer, records each exercise on video and sends it through the system so that the person responsible for implementing therapy review and issue its recommendations (Figure 2). The system also collects information on body mass index, diet of the patient and specific indicators of respiratory symptoms (cough, increased mucus, increased expectoration, feeling of suffocation, etc.).

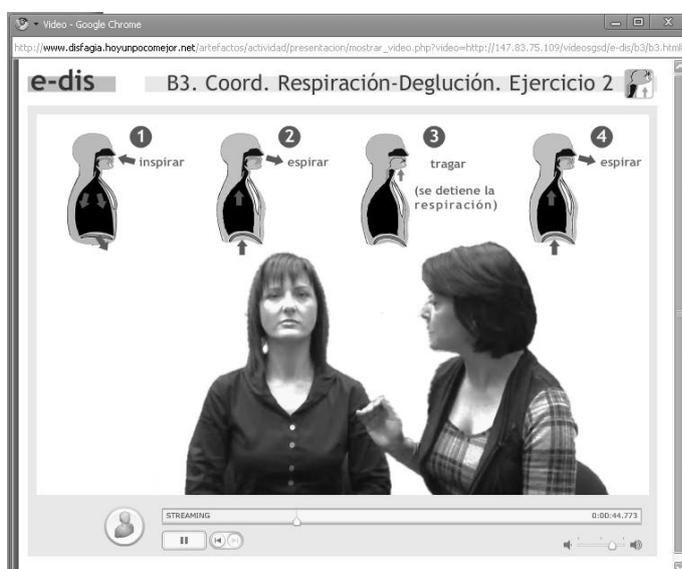


Figure 1. Example of a video showing breathing-swallowing coordination exercise.

The initial hypothesis is that the use of telemedicine as part of the treatment of oropharyngeal dysphagia of neurological origin (e-dis) is comparable to conventional therapy in terms of patient outcomes. The e-dis system should allow:

- 1) That more patients access to treatment: is estimated that through the e-dis system a speech therapist may review up to three times more patient at the time of a conventional session (1 hour). This directly increases the number of patients that can be incorporated into the therapy.
- 2) Reduce the cost of treatment with regard to conventional therapy: The project must demonstrate that the e-dis system is cost effective.
- 3) A clinical outcome comparable to conventional therapy.
- 4) The added benefit of facilitating and possibly improve the clinical work.

The e-dis system will allow collecting and store the patient outcomes and the resulting feedback to and their family or caregiver. Thus, attention can be focused on patients with more difficult without diminishing the effectiveness of its intervention in the other. Moreover the patients themselves, their families and / or caregivers maintain the record of rehabilitation (videos, compliance guidelines, etc.) with the therapist feedback. The use of the system should also have a direct impact on the number of trips to the hospital reduced only to the indispensable (initial assessment or difficulties).

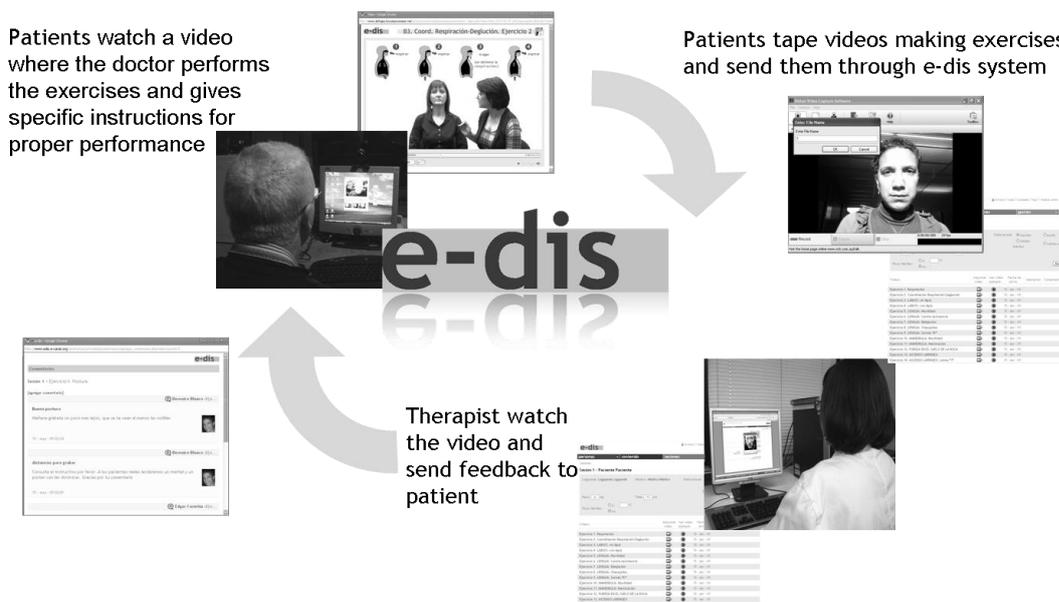


Figure 2. e-dis System cycle

To demonstrate the hypothesis proposed it is planned to conduct a clinical test with 20 patients with oropharyngeal dysphagia of neuronal origin with no spontaneous recuperation. Patients will be divided into two random groups each with different levels of severity but comparable dysphagia. One group carried out the rehabilitation program for 10 days at a distance with the recommendation to conduct three daily sessions of 25 minutes. The other group, the control one, will perform the conventional rehabilitation program in the Department of Physical Medicine and Rehabilitation at the Hospital de Sant Pau during 10 days at a rate of one meeting per day for 1 hour. All patients will use the following scales: (1) Scale of Severity and Outcomes of Dysphagia (O'Neil et al, 1999) to determine the severity of dysphagia based on objective measures and the functional disability that occurs and (2) the instrument for measuring quality of life Euro-QOL-5D (EQ-5D). Also it will be recorded for all patients in both groups, body mass index, type and form of food, and medical complications associated with dysphagia (over infection breath, aspiration pneumonia, and weight changes). In both groups will be recorded the patient satisfaction (SWAL-CARE items), family involvement and satisfaction of the family. Also the actual total time spent on therapy (in the case of conventional therapy including preparation time and transfers).

Some technical aspects to be considered

From the technical point of view e-dis is a sample from a broader platform on which various web applications integrate for multiple users. The technological design of e-dis and the other components of the platform have been developed following the design pattern Model-View Controller MVC (Buschmann et al., 1996). The result is to differentiate and separate data elements and specific functions of the platform from the presentation of data in the user interface and control logic. More specifically, for e-dis MVC implementation is represented as: model (users, settings, artifacts, content); views (php pages, and CSS layers implemented in appropriate formats to interact with users) and control (communication between the model and view layers, control of events and access to content). The conceptual design of the layer model is based on a system of distributed cognition (Ferruzca et al. 2007) with the four above-named entities involved: users, environments, artifacts and contents, as shown in figure 3.

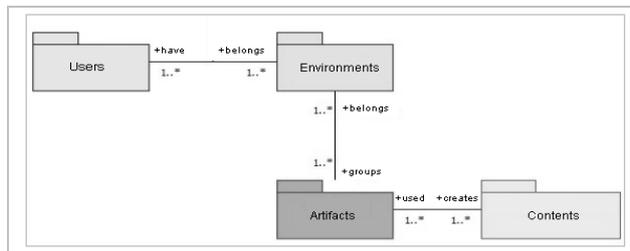


Figure 3. Entities involved in e-dis system

Three modules are integrated from these four elements: (1) User Module: represents a single module to manage user data across a centralized platform. (2) Content Module: represents a single module to manage the contents of the entire platform centrally. The environments are interpreted as micro-platform (or communities) who live within the macro platform; e-dis is an environment. Artifacts are interpreted as applications (features or tools) that facilitate the users' tasks of a specific environment. Both, environments and artifacts constitute (3) the Control Module.

Additionally, it is used a services architecture, represented by web services, in which components of the platform are prepared to facilitate the integration, communication and distribution of applications to multiple users in different environments. An important advantage of this approach is that it leads to a flexible and agile development process, able to meet rapidly changing needs of any organization that carries out tasks of knowledge management and innovation. "Software has become a critical element in all aspects of modern life, supporting wealth creation and being deployed in products and processes designed to improve the quality of life. The demands placed on the software engineering community, such as productivity, flexibility, robustness and quality, have increased at an exponential rate, leading to new development paradigms, formalisms and methods of working, the success of which have been truly remarkable" (Bennett et al. 2000).

The content module of the platform is based on the data model of LOM standard. According to the IEEE LOM (Learning Object Metadata), "a learning object is defined as any entity-digital or non-digital-that may be used for learning, education or training (LOM, 2002)" and its "metadata describes relevant characteristics that may be the group in general, life cycle, meta-metadata, educational, technical, educational, rights, relation, annotation, and classification categories" (LOM, 2002).

To manage other objects that are not necessarily *learning objects* we worked with the concept of a *content object* as a generalization of *learning objects*. For that reason, in addition to implementing a repository based on the data model of LOM standard, this model was expanded to add a new category of metadata, called external, where depending on the type of content object, you can store information that does not follow the standard. This repository consists of: (a) a database that implements the conceptual model of metadata for content objects, (b) a website that hosts the data files, (c) web services available to artifacts for the creation, consultation and modification of content objects, and (d) services of upload and download of files.

In the e-dis system the content objects are represented by the videos, which are of two types: the sample videos of the therapists showing how to make each of the exercises and the videos of the

execution of the exercise by the patient, that are uploaded to the system by the same patient or with the help of a relative / carer. The upload service of the videos has been developed in a way that is easy to use and accept any digital video format, thereby facilitating the task of the patient. The sample videos of the therapists are high quality multimedia pieces with clear instructions how to perform the exercises.

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