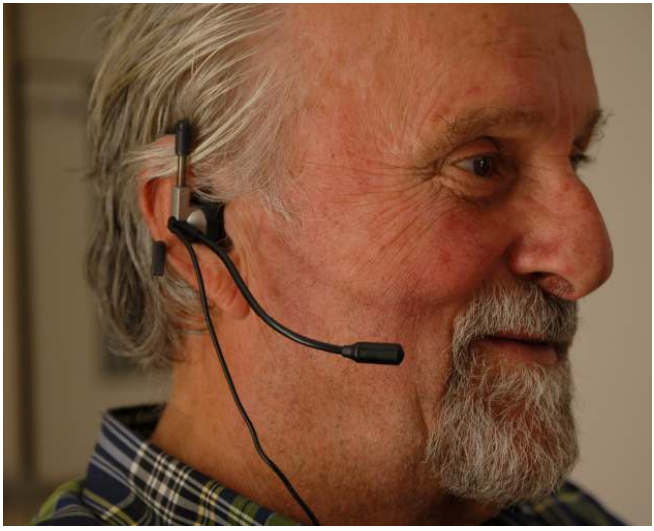

Towards an ICT based Chronic Care Model: the Habilis approach for Sustainable Tele-Rehabilitation Services

Towards an ICT based Chronic Care Model:
the Habilis approach for Sustainable Tele-Rehabilitation Services

eChallenges e-2010
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Organized by the Consortium of the project "CLEAR": Clinical Leading Environment for the Assessment and validation of Rehabilitation protocols for home care.
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Introduction

Nowadays the need for treatment and care of people with chronic diseases is not sustainable. Notwithstanding this historical period is characterized by insufficient resources in healthcare, a long term vision is needed to the study, simulation and testing of new cost effective and efficient innovative models in the field of rehabilitation.

Indeed, ICT applications into the health domain have had, in the last decades, a controversial destiny. Despite it is widely recognized that any regional healthcare systems can greatly benefit from ICT provisions, their applications are far to be trivial when the technology implies a change of the paradigm of clinical delivery together with a re-arrangement of the organizational model.

The human factor, the technology driven policies, together with lack of proper reimbursement and robust evaluation methodologies carried out through a consistent Health Technology Assessment have led to this big discrepancy between offer and actual application.

In the rehabilitation domain, key objectives are to maintain and improve patients' social, physical and mental capabilities by overcoming the ideas and barriers of considering a patient as a passive subject. Overall rehabilitation treatments are effective in the short term, but long term maintenance is far to be optimal. Explanations for this are to be inwardly looked at the difficulties for patients of translating the learned skills in their everyday life and probably, more importantly, in the drop of motivation caused by inappropriate environments and lack of supporting facilities.
During the past years, a lot of experience has been gained with new approaches that enable treatment in the daily environment by utilizing communication and information technology (ICT) and

combining this with biomedical engineering: enabling remotely supervised training. This offers a wide range of possibilities, varying from very specific training like upper extremity training post-stroke, up to a general fitness like training to improve the physical condition. It is expected that when rehabilitation treatments or even part of these treatments are provided in the daily environment of the patients but supervised by a professional at distance the effectiveness and efficiency of the rehabilitation will increase substantially.

From here the Habilis approach is an evolutionary approach looking at sustainable territorial models ICT based covering the needs of patients with different diagnosis like COPD, chronic pain, osteoarthritis and neurological diseases such as cognitive problems exploiting the resources offered by a given territory as a whole. During the past years extensive clinical protocols have been developed, specific for these disorders, together with a user friendly web interoperable platform implemented in close collaboration between engineers and all stakeholders involved like physical therapists, psychologists and rehabilitation doctors, health care insurance companies. Different territorial models designed and led by clinicians service are now running in four countries specific for these major disorders. Pilot studies have been carried out and major clinical trials are starting.

Workshop contents and objectives

The presentations given will deal with the concepts of a sustainable service provision based on the Habilis Platform, and with the protocols developed for the different pathology specific rehabilitation services, the service assessment (HTA) and how the service will be made operative in different country specific contexts.

The Habilis Europe team will address:

- How the tele-rehabilitation service has been designed and how the user requirements have been collected;

- How the tele-rehabilitation service is implemented in four countries and which is the added value of the service;
- Which are the fundamental building blocks necessary to provide the service
- How the service performances can be assessed
- Which is the business model behind Habilis

The workshop will be interactive with the audience; a great emphasis will be given to business relations.

Questionnaires will be distributed to validate the proposed Habilis Tele-rehabilitation concept

Workshop Programme

Chair: Sandro Scattareggia Marchese, Signo Motus srl, Italy

14,00 - 14,10	**ICT Solutions for the Management of Chronic Diseases: the Habilis Concept and the CLEAR project** Sandro Scattareggia Marchese, Signo Motus srl, Italy
14,10 - 14,20	**Tele-rehabilitation needs assessment: A multi-disciplinary approach** Rianne Huis in 't Veld, Roessingh Research and Development, Netherlands
14,20 - 14,30	**Methodology for HTA within the CLEAR Tele-rehabilitation Project** Velio Macellari, Istituto Superiore di Sanità, Italy
14,30 - 14,40	**Extending Upper Limb Rehabilitation for Stroke Survivors by the Habilis Platform** Francesco Benvenuti, AUSL11, Italy
14,40 - 14,50	**Clinical program of cognitive tele-rehabilitation for traumatic brain injury** Rocío Sánchez-Carrión, Fundació Privada Institut de Neurorehabilitació Guttmann, Spain
14,50 - 15,00	**Pre-surgery and post-Surgery Tele-rehabilitation for Hip and Knee Replacement** Wojciech Glinkowski, Medical University of Warsaw, Poland
15,00 - 15,30	**Discussion**

Information about CLEAR

The CLEAR project (Clinical Leading Environment for the Assessment and validation of Rehabilitation protocols for home care) sets up an innovative e-Health service based on the development of protocols for rehabilitation and chronic disease management therapies, which can be implemented at home following well defined procedures under the control of medical staff. The ambition to contribute to the harmonization of eHealth and rehabilitation services in Europe.

The project is funded under the ICT Policy Support Program Area CIP-ICT-PSP-2007.2.2 – ICT for ageing well.

CLEAR objectives

CLEAR is a 2.74M€ EC-funded project which brings together 13 European public and private organisations to focus on two main different goals:

- To set-up a tele-rehabilitation service allowing doctors to design, develop and implement clinical based protocols for home rehabilitation and tele-care.
- To contribute to establish a "European standard" for rehabilitation services freely accessible from the WEB.

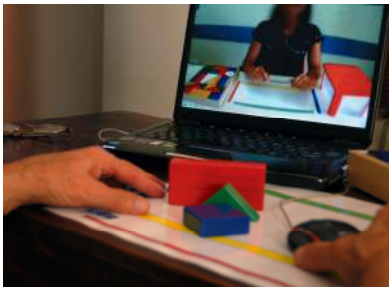
The project aims at treating through the "Habilis platform" at least 800 European patients affected by cognitive, neurological, orthopaedic, pulmonary pathologies as well as chronic pain in Italy, Spain, Poland and The Netherlands. CLEAR objective is to increase patients' autonomy and quality of life, decrease family's burden, stress and isolation.

Expected results

1. An open, interoperable and robust platform, independent from specialised hardware at home;
2. Integrated e-rehabilitation modules helping to optimise healthcare centre resources;
3. Individually tailored clinical exercises and treatment protocols for home rehabilitation, remote patient supervision and self-care management;
4. Data accessibility to enable the interpreting of results on patient progress/deterioration;
5. Customised and defined service operational modes inside the four participating hospitals.

Current Status

- The Habilis Web based platform for service provision has been already implemented and tested on a consistent target group of patients;
- The clinical protocols have been prepared and standardized among the participant clinical centres;
- The Health Technology Assessment methodological approach has been designed and set up;
- Clinical trials started on May 2010.



Socio-economic benefits

The economic impact of the service on the health structure concerned is assessed during the project life accounting local policies of national/regional governments as well as individuals health centres.
The expected socio economic benefits are:

1. **Improved quality of life for patients** through a reduced need to attend healthcare centres;
2. **Improved healthcare centre effectiveness** by treating more patients at the same time;
3. **Greater understanding** of the socio-economic impact of the e-Health services proposed, which will help both the future adaptability and economic viability of healthcare systems;
4. **Standardisation and coordination** of the activities of national companies, to provide a pan-European service customised in each Member State;
5. **Contribute to the impact of the ICT PSP** as the project is conceived as a platform to deliver services for patient's , and particularly elderly people, benefit;
6. **Increased European SME market potential** as the structure of the service attributes an important role to the Local Service Providers, whose main task is the technical support of the local hospitals and healthcare centres;
7. **Increased quality of European rehabilitation practice** through the push for common standards, making it possible to design rehabilitation paths that can be implemented remotely.

Organisations involved

- **Hospitals:** Fundaciò Privada Institut de Neurorehabilitaciò Guttmann (ES), Rehabilitation Centre Het Roessingh (NL), Warszawski Uniwersytet Medyczny (PL), Azienda Unità Sanitaria Locale 11-Empoli (IT);
- **Platform integrators:** Signo Motus Srl (IT), Universidad Politécnica de Madrid, (ES);

- **Project development assessors and validators:** Istituto Superiore di Sanità (IT), Roessingh Research and Development and Stichting Menzis Beheer (NL), Regione Toscana (IT), Centrum Systemow Informacyjnych (PL), Fundaciò Privada Centre Tic I Salut and Fundaciò Institut Català de l'Envellinment (ES);
- **Local service providers** : are enrolled by the hospital under a sub-contract basis).

Practical Example Scenario:

Piero is a 49 years old man with left upper limb impairments after a stroke and was referred to the clinic 3 months ago. Before his stroke, Piero lived at home with his family. The doctors decided that he needed mass practice to improve his upper limb functionality. The physiotherapists therefore provided a therapy plan for him to train the functional skills of his left arm. In this plan, Piero was assisted by physio- and occupational therapists to train for several hours per day, 5 days a week. At the end of the rehabilitation program Piero finally can go back home. He made important improvements, but the therapists thinks Piero could improve even more if there was more time to practice. His doctors therefore asks Piero to use the Habilis system, in which Piero can practice outside the clinic, but still can contact therapists. In this way he can expand the period of practicing functional tasks with his arm, while he lives at home.

Further rehabilitation areas are : Cognitive diseases, Chronic Pain, Pulmonary Diseases, Post surgery rehabilitation for hip and knee replacement.

Main Concepts

ICT Model for chronic diseases: An ICT model is composed by a technical component (which technology is used to do what) and by its delivery modality to perform an action or to ensure a service to a user. ICT models referred to in the proposal are mostly "pathology specific" (e.g. Models for dementia, for stroke, etc.) although some of them present a high potential for adaptation to other pathologies.

Chronic Care Model (CCM): Chronic care models are emerging in the current debate on healthcare innovation. What is intended as a chronic care model, is a management model related to a wide range of chronic diseases, that integrates technology (e.g. ICT Models) and other components (insurance, reimbursement, prevention policies, etc.) in a systemic manner within a given healthcare system. Shaping a chronic care model requires the involvement and consultation of several stakeholders as opposed to individual ICT models for specific pathologies that focus essentially on how ICT can alleviate a chronic condition. Indicators: The assessment of current models and of the impact they may have on the regional healthcare systems cannot be done without recurring to shared indicators.

Habilis Platform It is the SW platform that allows the Therapist to provide the Tele-rehabilitation service to their patients. It is the main outcome of the WP4 and it will progressively substitute the already existing TRS platform.

Technical Support Service It is the service that Habilis will provide to the Clinical Centres. It includes:

- the server, doctor stations and patient stations provision;
- the server and clients installation;
- the maintenance and the assistance for SW and HW;

- the training courses for the professionals and for the Service and Network administration.

Tele Rehabilitation Service It is the service that the Clinical Centres will provide to their patients. It is based on the telerehabilitation platform (server, patient station, doctor station) provided by Habilis, and includes:

- rehabilitation exercise definition and therapy assignment (by means of the doctor station);
- patient compliance monitoring (by means of the server);
- rehabilitation exercise execution (registered by the patients stations);

- tele-assessment and videoconferences (by means of both client stations

Scientific papers

ICT Solutions for the Management of Chronic Diseases: the Habilis Concept and the CLEAR project

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Abstract

In the last decades, ICT applications into the health domain have had a controversial destiny. Despite it is widely recognized that regional healthcare systems can greatly benefit from ICT provisions, their applications are far to be trivial when the technology implies a change of the paradigm of clinical delivery together with a re-arrangement of the organizational model. This means that when the technology, or the service proposed, affect the delivery modality, the process of integration is much slower and difficult. The human factor, technology driven policies, together with lack of proper reimbursement and robust evaluation methodologies carried out through a consistent Health Technology Assessment have led to this big discrepancy between offer and actual application. This potential, but not yet mature, market is a common leitmotiv throughout the entire Europe. With this scenario in mind, the CLEAR project is focussed on new territorial based models of delivery setting up an innovative e-Health service to be implemented at patients' home following well defined procedures under the control of the medical staff. By treating more than eight hundred patients in four different

Member States CLEAR is, undoubtedly, one of the biggest studies on tele-rehabilitation in Europe.

Keywords: ICT, Chronic Diseases, Health Technology Assessment, e-Health services

Introduction

Rehabilitation has been defined by the World Health Organisation as "…The use of all means aimed at reducing the impact of disabling and handicapping conditions and at enabling people with disabilities to achieve optimal social integration". This definition incorporates clinical rehabilitation but also, more importantly, it addresses the concept of social participation highlighting the need to remove societal barriers for people with a different ability.

As a result of the increasing life expectancy, rehabilitation systems, as a whole, have to be continuously developed considering the following basic principles:

1. Rehabilitation following injuries or illness and even in a chronic condition is a basic human right (Fifty-Eighth World Health Assembly: Resolution 58.23,"Disability, including prevention, management and rehabilitation" Geneva, World Health Organization, 2005.)
2. Equitable and easy access to all aspects of rehabilitation including specialist rehabilitation medicine, assistive technology and social support for the entire population in Europe;
3. Uniformly high standards of care in rehabilitation, including quality assurance and treatments based on scientific evidence;
4. A scientific basis to develop rehabilitation models and standards of care to guide clinical practice.

As a matter of fact, the challenge for the rehabilitation services in not simply caused by the increased number of individuals which require treatment but, more inwardly, on the quality of the rehabilitation care delivered. The usual rehabilitation care offered by the Health Systems is not adequate. Rehabilitation services deal with chronic conditions in the same way they deal with the acute ones: *short treatment cycles repeated at intervals*. These cycles of treatments have a very limited and short term effects on the health and functional status. They influence only marginally the long term disabling process and generate illusion of care while fostering dependence of patients on rehabilitation systems.

Innovative models are to be adopted according to the following principles derived from Wagner' extended Chronic Care Model (Figure 1) accounting the need for an extension of the period of care.

1. to empower and prepare patients to manage their health and health care [2], [3];
2. to promote clinical care that is consistent with scientific evidence and patient preferences [4], [7];
3. to facilitate transmission of patient data and the efficacy and effectiveness of care;
4. to mobilize community resources to meet patients' needs and to review delivery costs [8], [9], [10], [11].

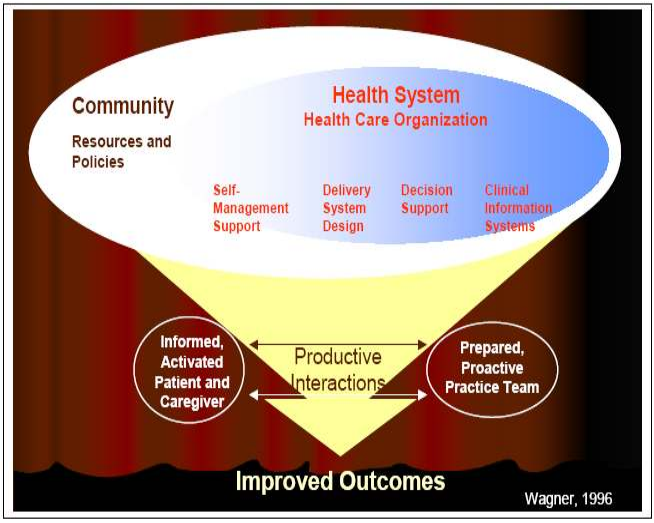

Figure 1:*Wagner's Extended Chronic Care Model*

The necessity of a great extension of the rehabilitation treatment at a reasonable cost has created a window for a new methodology based on ICT: *the tele-rehabilitation approach* [13],[14].
But what does the term "tele-rehabilitation service" mean? *It is a service that allows patients to extend greatly part of the rehabilitation treatment at the point of their need under the supervision of a remote team guaranteeing efficacy, safety, privacy and ethical methods*.

This paper provides information regarding a "*clinical led*" methodological approach to implement efficiently such innovative service in the clinical practice. This approach has been followed within the project CLEAR.

The overall rationale of the service, designed through the CLEAR project [20], [21], is built on the concepts of protocol customisation based on the patients' specific needs (thus ensuring a higher level of efficacy), and on the optimisation of healthcare centres resources by integrating as possible ICT and community resources. From a technical point of view, it incorporates recent advances in ICT, secure communication, privacy and security of data together with the application of modules to be integrated as necessary in case data monitoring and analysis is needed. It is based on open standards and ensures the highest possible level for interoperability with different systems in use by healthcare systems or other types of stakeholders involved.
CLEAR lays upon the extensive experience of six years achieved during the run of two European projects H-CAD [14] and HELLODOC [15] where efficacy of the treatment has been clearly demonstrated [18], [19] carried out under the 5th Framework and e-Ten Programmes respectively.

Objectives
The fundamental objectives of the paper are to describe the concept behind the project CLEAR and its main goals.
CLEAR comes from an extensive experience achieved in the field of tele-rehabilitation by two European projects, H-CAD and HELLODOC.
As it is shown in Figure 2, the objectives of both projects were focussed on the development of devices capable to allow the execution of monitored exercises at patients' home.

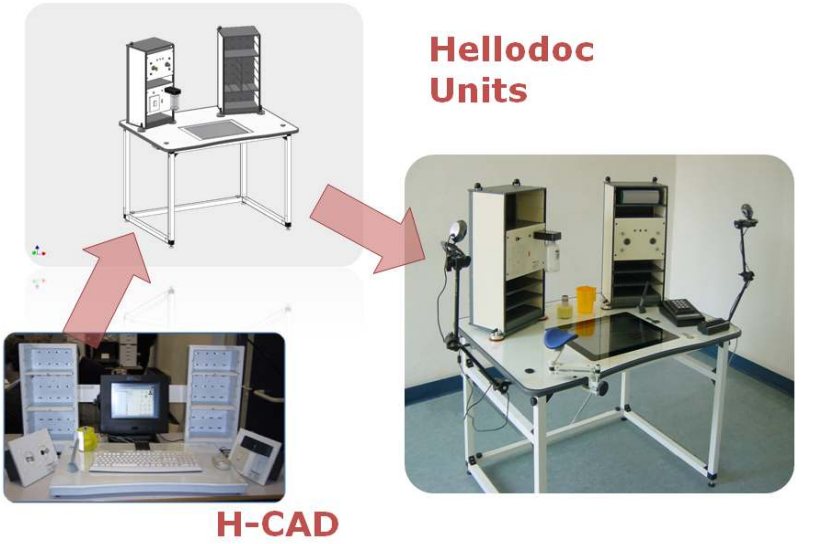

Figure 2: ***H-CAD and Hellodoc Project Outcomes***

In the H-CAD project the main questions were related to the kind of exercises to be made at home, to the information to be transferred to the hospital and to the eligible criteria to enrol patients to be treated in a home environment. The result was a fully sensorised device comprehending a desk, two shelves and different sensorised modules.
In the Hellodoc project, the prototype was engineered and tested on sixty patients affected by traumatic brain injury (TBI), multiple sclerosis (MS) and stroke in three European countries (Italy, Spain and Belgium).
The efficacy of the treatment was clearly demonstrated. In Figure 3 a typical result obtained by treating a patient with the Hellodoc system is shown. The figure illustrates the decrease in the execution time of five different exercises during a period of nineteen days as a clear sign of functional recovery.

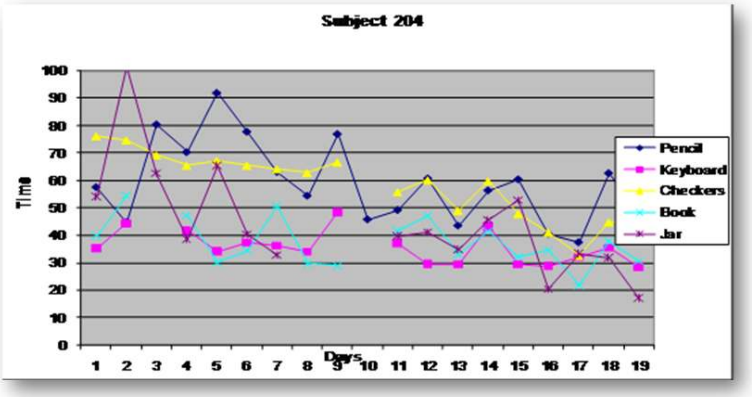

Figure 3: ***Results obtained during a nineteen days treatment period***

Despite that, *the main lesson learned from the projects H-CAD and Hellodoc was certainly related to the difficulties of the hospital in carrying out even simple technical activities related to service provision at patients' home.*

With this scenario in mind, the CLEAR project deals, instead, on the organizational impact of the service and in particular with the following aspects:

1. to prove feasibility of the service and to evaluate its impact of these tele-rehabilitation services in view of deployment;
2. to set up a tele-rehabilitation platform based on interoperable and open source, standards and components;
3. to define European standard for home rehabilitation for the concerned pathologies
4. to treat at home or at the point of their need, at a prudential estimate, 800÷1000 elderly patients affected by common pathologies (musculoskeletal, neurological, pneumonic diseases) in four European countries (Italy, Spain, Poland, The Netherlands);

Such objectives will be pursued by inserting the service in the board of services delivered by the hospital concerned. Which means to allow that any *private or public clinical rehabilitation centre should establish proper administrative and technical procedures as routine practices during the entire treatment cycle.*

The following section deals with the description of the methodological approach implemented in the CLEAR project.

Methodology

The tele-rehabilitation service is built upon an open, interoperable and robust platform, enabling different users (patients, health professionals, physiotherapists, administrators and other relevant subjects) to:

- Design individually tailored clinical exercises and treatment protocols for home rehabilitation and self care management covering different target pathologies affecting people abilities (pneumonic, muscular-skeletal and cognitive diseases);
- Implement home therapies, designed by clinicians, based on a set of rehabilitation exercises tailored to treat patients at home;
- Train/exercise in their home situations any time they want instead of intramural bounded to the working hours of the professionals;
- Receive remote supervision of health care professionals during the treatment;
- Have access to the data and be able, in this way, to analyse the results in terms of progress/deterioration. As such the data provide a basis to discuss possible next steps;
- Define and customize the service operational mode inside the four hospitals participating in the trials;
- Integrate analysis modules in case monitoring of patients signs is needed;
- Contribute to develop European guidelines for rehabilitation treatment at home (four of the partners of the net are working currently in this direction http://www.habiliseurope.net).

The project methodology rotates around a “clinical leading environment” which allows clinicians to design, implement and assess clinical protocols and therapies for home care.

The “CLEAR” vision offers a methodological approach and clear indications to allow clinicians to test the service involving all the actors of the value chain, implementing and assessing home care protocols that will be developed by the clinical institutes. The system works without the need of any hardware at home being conceived as a *pure software platform.*

Technology Description

The service, illustrated in Figure 4, can be provided in different environments:

- An hospital centre where the rehabilitation team can define the procedures to enroll, treat and dismiss the patient as well as to teach patient in the use of the platform;
- A home environment where patients can extend their treatment or
- An intermediate environment, called "*the kiosk*", where patients can perform the rehabilitation exercises all together according to the clinical protocols tailored to their specific conditions.

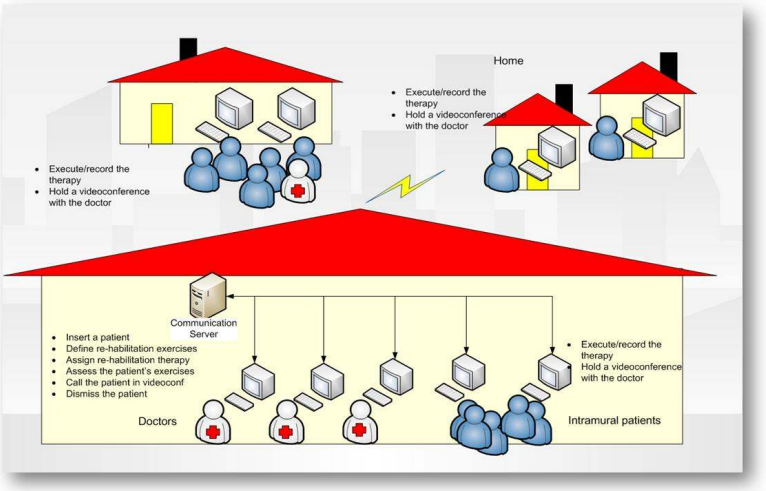

Figure 4: *Service Model*

The platform functionalities are described in more detail in Figure 5, where typical operations pertaining to a tele-rehabilitation session are given.

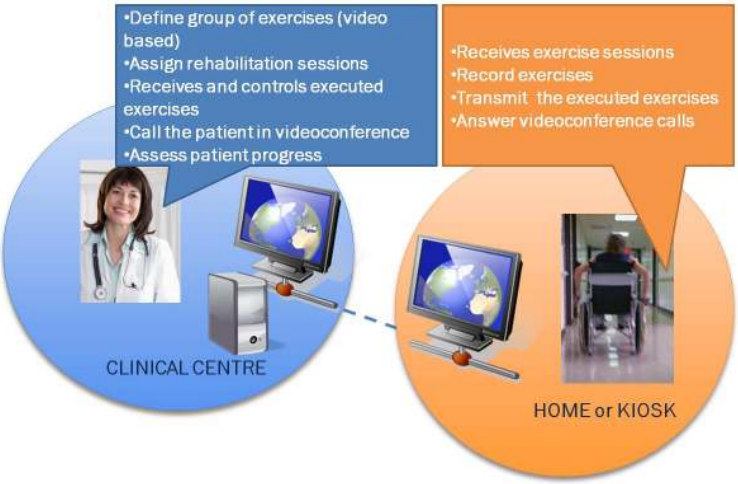

Figure 5: *Platform Functionalities*

Developments

The results already reached during the project course are given in Figure 6 where the achievements are described following the project run.

During the first eighteen project months, three important objectives have been already reached:

- a Web based platform for service provision already implemented and tested on a consistent target group of patients;
- Clinical protocols prepared and standardized among the participant clinical centres;
- Health Technology Assessment methodological approach designed and set up.

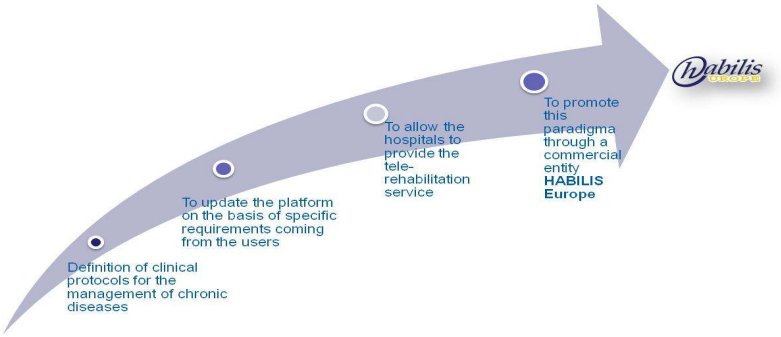

Figure 6: ***Project Objectives***

Results

The most relevant results already obtained in CLEAR are those ones related to the clinical implementation. These comprehend not only the definition of the clinical protocols, but also the clinical models of the service implemented at each clinical site to deal with the chosen pathology.

It is worth mentioning that the service model is pathology driven, which means that the delivery of the service is implemented according to the clinical protocols and the territorial model chosen by each clinical centre for the specific pathology. In Figure 7 the sites where the clinical trials are taking place are given together with the treated pathologies.

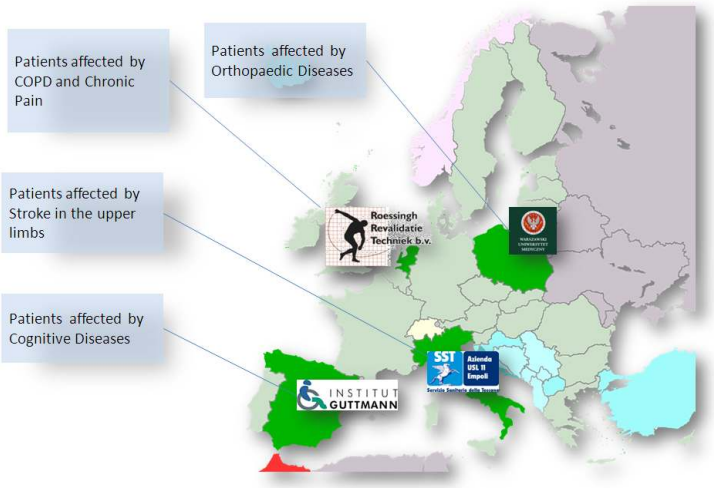

Figure 7: *Sites where the clinical trials will take place*

In order to clarify better the meaning of "territorial model", the clinical implementation in Tuscany is given in more detail here below.

The tele-rehabilitation service in the region of Tuscany is provided throughout rehabilitation kiosks that are spread in the territory using resources already available in the community (internet access point, health houses, etc.).

The added value of the kiosk model can be found in the opportunity for the patient to extend and combine the rehabilitation treatment in an environment where the social aspect is accounted.

In the Netherlands and in Spain, on the other hand, where cognitive diseases as well as chronic obstructive pneumonic disease (COPD) and chronic pain are treated, the service is provided through clinical protocols allowing the minimal intervention of the professionals.

The main results already obtained from a clinical point of view can be briefed in:

1. Service settlement in all the Member States involved;
2. Design and implementation of complete exercise libraries;
3. Definition of the clinical protocols;
4. Definition of the Health Technology Assessment Methodological Approach;

while those ones related to service deployment are given in the next section.

Business Benefits

From a business perspective, the top objective to be reached within the project CLEAR is certainly the validation of the service impact. A WIN-TO-WIN strategy has been implemented to allow the right profit margin for all the stakeholders involved. The business model foresees the establishment of a network of companies and partners called “Habilis Europe” linked by contractual relationships. The model, currently under evaluation, seems to be sustainable through a costs between 5-10 euro/day.

From an organisational point of view, the above described models acquire a great industrial significance allowing the insertion of the information and communication technologies (ICT) according to the needs of a specific territory: The Habilis concept. The ICT integration steps are highlighted in Figure 8 where an algorithm based on clinical indicators, resources and innovation available in each territory is given.

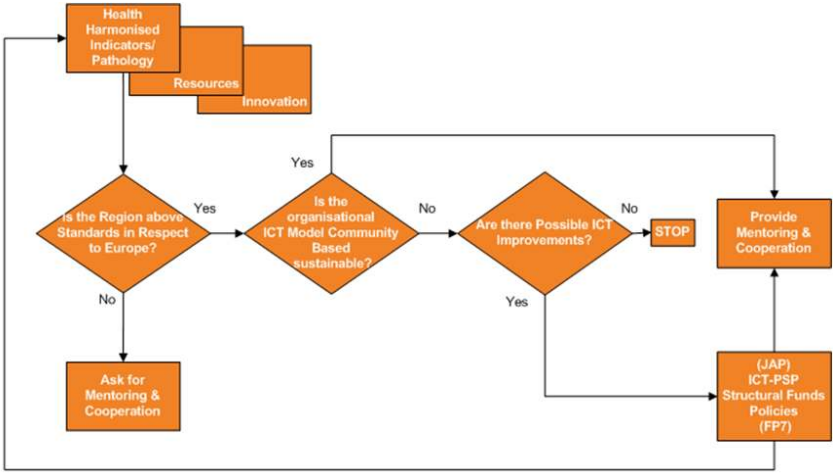

Figure 8: *The Habilis Concept*

This will allow a consistent integration led by innovation based on evidence.

Conclusions

CLEAR is one of the biggest European clinical studies in the tele-rehabilitation field. It enhances the clinical implementation through models accounting the needs of the centre and the resources available in the territory. It permits easily to generate different services according to the different context and promotes the establishment of regional and trans-regional clusters with consistent insertion of ICT technology in innovative clinical pathways.
The service will be validated through a health technology Assessment carried out by a consistent Assessor panel led by the Instituto Superiore di Sanità representing the technical arm of the Italian Health Ministry.

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Tele-rehabilitation needs assessment: A multi-disciplinary approach

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Introduction

The Habilis Europe concept [1] proposes the implementation and deployment of an innovative tele-rehabilitation service in four Member States of the European Union (Italy, Spain, Poland and The Netherlands) suited for different types of pathologies (neurological, orthopaedic, pneumonic disorders and chronic pain) usually affecting the elderly.

The importance of user needs

The manner in which the tele-rehabilitation platform is used in daily health care can have a significant impact on its clinical-economic impact and is largely dependent upon the readiness and acceptance of end-users [2]. The danger is that the potential benefits of the tele-rehabilitation applications could be lost if the users—professional and patients- cannot easily and effectively use such systems to meet their needs.
Understanding the (conditions) for acceptance in order to deliver high quality tele-rehabilitation is difficult since hardly any services have been available yet. User participation is expected to result in (improved) communication between users and technology developers, increasing the likelihood that technology will meet the user needs [3]. Consequently, user satisfaction and user acceptance are improved, leading to a higher use [2] and less failures (or non-wanted effects) in daily (rehabilitation) care which is the ultimate aim.

User needs assessment

In health informatics, the usage of "sociotechnical approaches" which attempt to actively involve the end users in the design process to help ensure that the 'product' designed meets their needs are recommended

[3]. Assuring that health professionals and patients are provided with tele-rehabilitation services they actually need, requires, as a first step establishment of a common understanding, within the design team [4]. Yet, it is easier said than done and little knowledge is available on how to realize a fruitful participation. Due to the fact that tele-rehabilitation services have hardly been deployed, (part of the) professionals have no prior experience of the potentialities of information technology in rehabilitation care; they neither know the requirements, nor they can articulate them [5].

Objectives

The current paper is aimed at showing our scenario-based approach in defining the user requirements, expressed as the functional and technical needs, of a tele-rehabilitation platform. These activities are fundamental to guide the technical work related to the upgrade, implementation and deployment.

Methodology

In order to 'guide' this difficult process a stepwise approach (Figure 1) was applied with a) the vision on traditional care as a starting point for envisioning tele-rehabilitation care and b) the use of 'scenarios' describing a fictive user as crucial elements. Scenario-composition is a technique to facilitate user-designer communication [6]. Scenario method is a design technique to help concretize and provide the product that users really want to use [7]. Within this method, the development of a persona, and storylines of user activities based on personae enables designers to go beyond an image of people such as patients and physicians, and to deepen understanding of users and their activities.

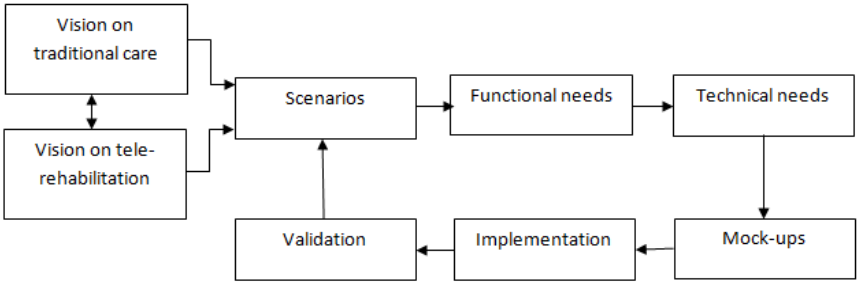

Figure 1: Overview needs assessment approach

As a consequence, the needs assessment phase ensures that 1) both health care professionals and developers understand the implications of the new systems for daily practice and 2) the tele-rehabilitation service 'fits' within their (current) way of working which facilitates its deployment in later stages.

In order to elicit the user needs and the associated functional specifications for the tele-rehabilitation platform a multi-method approach was applied by combining different techniques (Figure 2). In our view, the strength of this approach is the fact that a) different communication modalities (synchronous and a-synchronous, word and text) will be applied in which needs can be expressed by the user and b) it contains several moments in time implying time to (re-) consider about the needs.

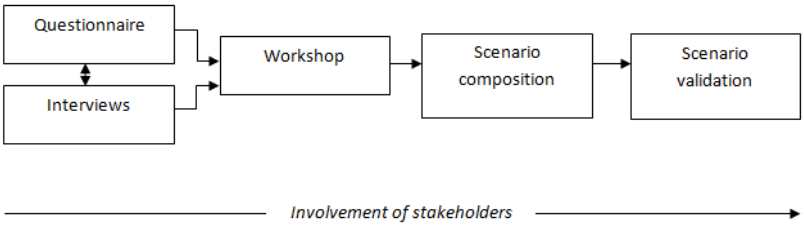

Figure 2: Our approach to compose a scenario

Technology Description

Based on the insights obtained from the questionnaire, the in-depth interviews and the seminar, four scenarios were composed.

The envisioned tele-rehabilitation platform consists of a tailored webbased home exercise program, which gives patients access to a variety of online exercise videos and tasks, selected by their professional.

An online agenda serves as both a stimulator and reminder for patients to exercise and enables the professional to monitor the duration and type of exercises/tasks a patient has to perform at home.

By means of a webcamera, patients are instructed to record specific exercises which a professional will examine to monitor the quality of the

performed exercises. In addition, the patient has the choice of scheduling a real time video- or phone-consult or to consult his professional by email.

Results

Based on the scenarios a detailed list of the functional needs of the tele-rehabilitation service was composed. The main functionalities are related to managing the access to the service (e.g. check access right, log in/logout), trace activities of patient while he/she is logged in, manage the rehabilitation content (e.g. exercise movies, cognitive tasks), perform rehabilitation session, manage communicate between professional and patient, manage patient information data, monitor and manage the system in case of updates, failures etc.

Based on the scenarios and the functional specifications, a list of technical specifications could be derived.

Business Benefits

The tele-rehabilitation service is conceived as a platform to treat at home or at the point of their need at, a prudential estimate, 800 ÷ 1000 elderly patients affected by common pathologies (musculoskeletal, neurological, orthopaedic and pneumonic diseases). The benefit is potentially enormous taking into account the time projections of therapies or treatment extensions, like in the case of chronic disease, in the long run.

Conclusions

Developing needs elicitation techniques are fundamental to guide the technical design, implementation and successful large-scale deployment of tele-rehabilitation services.

A stepwise approach was developed. In our view, literature does contain hardly any concrete methods yet to retrieve user needs in the complex field of rehabilitation care. We recommend others to publish their approaches and results as well so that we can improve the general understanding and awareness of the needs of people with disabilities and their acceptance for assistive technology (partially) delivered in the home environment.

Needs assessment is an ongoing and iterative process ultimately aiming at deploying a successful tele-rehabilitation business service. During a large scale European trial, which is running at the moment, the tele-rehabilitation system functionalities will be validated retrospectively. By doing so, we expect confirmation on the main functionalities of the

platform but also new functionalities could emerge which could benefit its business potential.

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Methodology for HTA within the CLEAR Tele-rehabilitation Project

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Abstract

The aim of this paper is to introduce the methodological approach adopted within the CLEAR project to perform the Health Technology Assessment (HTA) of the tele-rehabilitation service provided with the Habilis Platform. The HTA adopted approach has been refined by taking into account: the main HTA methodologies related to the use of Information and Communication Technologies (ICT) in Healthcare and international proposals for standardisation of the procedures, with particular reference to the EUnetHTA European project. The proposed model is based on nine dimensions to be investigated. Work is still in progress; before the start of the clinical trials, the model has been completed with a set of tools to be used for collecting information related to each single dimension. The most important tool is called "Clinical_study_and_HTA" and is aimed at harmonizing clinical studies in a standardised structure for collecting structured information and evaluating their quality with respect to HTA purposes and needs to be assessed by using validated Quality Appraisal Tools. Currently, clinical trials are near to start, as well as the retrieval of those HTA information which form the background dataset of each clinical study. After the conclusion of the data collection phase of the whole HTA process, the study will be continued with the analysis of evidence and the preparation and delivery of proper HTA Report.

Keywords: tele-rehabilitation, Health Technology Assessment

Introduction

The Clear project (Clinical Leading Environment for the Assessment and validation of Rehabilitation Protocols for home care) was launched, within the ICT-PSP framework, to implement a tele-rehabilitation service based on a new paradigm to be shared within the European Community. The core of the service is a platform called Habilis (www.habiliseurope.eu).

The aim of this paper is to introduce the methodological approach adopted within the project to perform the Health Technology Assessment (HTA) of the Tele-rehabilitation service provided with the Habilis Platform.

The multidisciplinary CLEAR Consortium is formed by Clinical Partners, Technical Partners, and Assessor Partners which are co-ordinated by Istituto Superiore di Sanità (ISS, Italy) whose main aim is to conduct a thorough and independent HTA on the envisaged technology and the implemented service.

The HTA adopted approach has been refined by taking into account: the main HTA methodologies [2, 3] related to the use of Information and Communication Technologies (ICT) in Healthcare and international proposals for standardisation of the procedures, with particular reference to the EUnetHTA European project [1]; the needs and the priorities of the ICT-CIP Project CLEAR and of the project Consortium; and trying to comply with the specificity of tele-rehabilitation services and to standardise procedures.

As a final result, the generalizability of the adopted HTA method to different telemedicine services will be investigated and reported.

The CLEAR project proposes the implementation of an innovative tele-rehabilitation service in four Member States of the European Union (IT, ES, NL and PL), with the ambition to convert the project after its completion and shown feasibility to a European platform to contribute to the harmonization of e-health services in the EU. The rationale behind this project is the HABILIS EUROPE concept, which principal objective is to establish a network of companies, under a legal corporate entity, providing an expandable set of tele-rehabilitation services across the whole EU, with significant potential to enhance the deployment of e-health services and optimization of healthcare resources. The CLEAR project plans to carry out 4 pilot tests in the 4 Member States on home protocols and therapies developed on a certain number of pathologies usually affecting the elderly: neurological, orthopaedic, pneumonic disorders and chronic pain.

Rehab services to be deployed by ICT

Within the Clear project the Rehabilitation Centres provide the Tele-rehabilitation service (TRS) to their patient by using the Habilis Platform. Patients can execute their rehabilitation tasks at home or at the nearest external rehabilitation unit (Kiosk), without the direct supervision of the Therapists. The Platform registers their tasks, and allows the therapists to asynchronously analyze them and assess the Patient's progresses. Videoconference can be used for communicating and for allowing therapist to assess Patient's status. The platform also provides tools and statistics to facilitate the monitoring of the patients compliance and progresses.

The HABILIS platform

The core technology consists of an open interoperable robust platform independent from any specialised hardware (basically a simple portable PC and a camera) which enables different users (patients, health professionals, physiotherapists, administrators and other relevant subjects) to:

- design individually tailored clinical exercises and treatment protocols for home rehabilitation and self care management covering different target pathologies affecting people abilities (pneumonic, musculo-skeletal and cognitive diseases);
- implement home therapies, designed by clinicians, based on a set of rehabilitation exercises tailored to treat patients at home at any time they want;
- receive remote supervision of health care professionals during the treatment;
- have access to the data and be able, in this way, to interpret results in terms of progress/deterioration;
- define and customize the service operational mode for the hospital;

Methodology

Introduction

A dedicated project work-package is aimed at conducting all the main activities related to the HTA of the tele-rehabilitation service provided with the Habilis Platform in the four EU countries**.**
Generally telemedicine, and more specifically tele-rehabilitation, is recognised as the innovation producing the most important effects on the organisation (e.g. re-design), costs (e.g. new investments for savings) and the social (e.g. isolation of operators) issues. In literature just few studies focussed on the assessment of rehabilitation services provided with tele-rehabilitation technologies are available; at present a deep and comprehensive assessment of the innovative services seems mandatory for better supporting the decision-makers in adopting or modulating innovative technologies in this specific field.

The international scenario
An accurate analysis of the literature has been performed in order to identify, in the international scenario and with special care to the European Community, assessment models developed and validated by international research groups that could be used as starting point within the CLEAR Project [4]. To this aim, relevant web sites have been explored by ISS for methodological issues:
http://www.eunethta.net
http://www.telemed.no/methotelemed 4567567-51256.html
http://www.integratedhomecare.eu/
http://www.inahta.org/Publications/
They will be continuously monitored along the entire project course.
Among this set of references, the ISS interest in the international scenario was mainly focused on the standardization aims in HTA procedures and methodologies at European level; specifically, attention was focussed on two EU projects, Methotelemed and EunetHta, briefly described in the following.

Methotelemed is an ongoing project whose main aims are to: i) provide systematic documentation of the manner and extent of telemedicine applications in healthcare systems; ii) provide a structured framework for assessing the effectiveness and contribution to quality of care of telemedicine applications.

EUnetHTA was selected for its purposes to furnish a standardised view of HTA methodology with respect to general fields of interest as well as the “Medicine and Surgical Interventions”; the core model selected after

stakeholder interview is mainly based on nine dimensions to be investigated:

1. Current use of technology (implementation level)
2. Description and technical characteristics of technology
3. Safety
4. Effectiveness
5. Costs, economic evaluation
6. Ethical aspects
7. Organisational aspects
8. Social aspects
9. Legal aspects

The latter model was considered mature and appropriate for the purposes of the CLEAR Project HTA, and was selected as a starting point. Anyway, the high level of specificity concerning the application of the EUnetHTA assessment model requires some adaptations to be performed for taking into account peculiar aspects and specific needs related to tele-rehabilitation and to the specific CLEAR Project framework.

HTA model within the CLEAR project

While it is known that HTA methods vary considerably accounting for different health care systems and organisations, a possible definition and a general standardized methodological approach consists of the following steps:

1. Definition of the HTA problem
2. Prioritization
3. Categorization
4. Data collection
5. Analysis of evidence
6. Report

During the preliminary phase of the project, all the stakeholders within the project were asked to answer a simple survey in the form of SWOT (Strengths, Weakness, Opportunities, Threats) to initially define the field of interest and the main categories to be investigated taking also into account the specific skillness of CLEAR partners. A prioritization phase was used to proceed towards a categorisation phase, carrying out a comprehensive and compact set of categories to be explored within the CLEAR HTA activity

These activities, in conjunction with necessary phase of tailoring the general core model applied by EUnetHTA to the specific field of tele-rehabilitation, lead out to the definition of an assessment model based on the following dimensions:

1. Clinical Impact
2. Evidence Based Information
3. Risk Management
4. Organizational Impact
5. Ethical and Social Issues
6. Quality Perception
7. Security
8. Privacy
9. Liability

With respect to the EUnetHTA model, the following adaptations have been applied:

- Effectiveness dimension was specialized in CLEAR into two main dimensions:
  - Evidence Based Information where standard methodology will be used to infer on efficacy and effectiveness of TR treatment based on clinical studies from scientific literature
  - Clinical Impact Assessment: this assessment argument (dimension) must be stressed, since remote administration of rehabilitation treatment (as it happens in TR services like Habilis) is an innovative element with respect to traditional treatment with not so high number of literature studies neither appropriate for any statistical pooling; furthermore, the dimension will deal with the clinical impact of the specific Habilis Tele-rehabilitation Service within the CLEAR Project;
- Safety dimension was specialised in CLEAR as Risk Management dimension mainly because:
  - TR services strongly rely on technologies and on remote administration of treatment which are not continuously supervised (compliance with the Medical Device Directive 2007/47 EEC for risk analysis);
  - risk has to be analysed and managed by mitigation methodology by the manufacturer, in agreement with harmonised standard ISO 14971:2009.

- Organization and Cost Dimensions were joined in CLEAR as Organizational Impact Assessment dimension:
    - due to the specific ICT technology and the different contexts (hospital, kiosk, home) of application selected within the CLEAR project it is reasonable to hypothesize that any organizational aspect will also have a direct or indirect impact on costs;
    - tools have been specialised to retrieve quantitative information for standard cost analysis and to assess impact on organization. This is considered the most relevant Assessment argument to be investigated because of the new opportunities a TR service could give to the re-design of Health Care System thanks to the ICT facilities

- Ethics and Societal Dimensions were joined in CLEAR project together with Quality Perception Assessment: in agreement with preliminary Methotelemed suggestion for telemedicine application , the latter was selected to give relevance to the Quality issues (which also deals with some ethical and societal aspects as reported also by EUnetHTA) since acceptance by users is mandatory for the success of TR services;
- Legal dimension was specialised in three main Assessment Arguments in CLEAR, and the focus will be centred on the following:
    - Privacy issues must be highlighted because they have the major legal impact when ICT digitally treat patient and operator sensitive information (e.g. patient record content).
    - Security was highlighted because the legal impact of the clinical data management is highly relevant in ICT introduced into Health Care (e.g. patient record storage and backup, digital signature etc)
    - Liability has also to be assessed in order to structure the responsibility of the innovative rehabilitation service within the every-day clinical practice.

Results

Work is still in progress; before the start of the clinical trials, the model has been completed with a set of tools to be used for collecting information related to each single dimension. The most important tool is called “Clinical_study_and_HTA” and is aimed at harmonizing clinical studies in a standardised structure for collecting structured information and evaluating their quality with respect to HTA purposes and needs to be assessed by using validated Quality Appraisal Tools

[http://www.phru.nhs.uk/pages/PHD/CASP.htm]. Information concerning this tool have been structured as in the following:

- the HTA question (HTA issue);
- the CLINICAL question (clinical issue);
- relevant details of the STUDY PROTOCOL tailored on the tele-rehabilitation service (both HTA and clinical issue);
- the identification of the detectable costs for each step of the rehabilitation process for both innovative and traditional treatment;

the identification of the COMPARATOR (the treatment to be compared with the innovative Habilis-based treatment) and of the HEALTH PARAMETERS to be used within the cost analysis (HTA issue);
the identification of the most suitable COST INDICATOR/S (HTA issues)
eventual additional indications (HTA issue);
the identification of the clinical study appropriate QUALITY APPRAISAL TOOL;
the results of the CLINICAL STUDY QUALITY APPRAISAL.

In details, information concerning the STUDY PROTOCOL can be further structured as in the following

1. Classification of the study;
2. Results of the Pilot Study;
3. Target Patient Group/s (TPG);
4. Organization issues;
5. Patient Management Procedures;
6. Management of HTA Quality Surveys: administration and collection;
7. Management of Clinical Questionnaires on satisfaction: administration and collection;
8. Clinical study process: flow-chart; identification of detectable costs for each step of the process;
9. Security issues;
10. Legal issue;
11. Administrative issues;
12. Risk management issues;
13. Ethical and social issues.

With respect to the developed model, the tool "Clinical_study_and_HTA" covers most of the dimensions to be investigated for assessing the innovative tele-rehabilitation service.

Discussion and Conclusion

The present paper describes the methodological approach to be used for assessing an innovative tele-rehabilitation service provided by the Habilis platform; the paper highlights that adaptations to the standard assessment model developed during the EUnetHTA project are needed in order to cope with specific needs related to the tele-rehabilitation service and the CLEAR Project framework. The model has been completed with a set of tools for retrieving the required information on the field; the most important tool, dealing with the thorough description of a structured, HTA-oriented clinical study, allows to cover most of the dimensions to be investigated for achieving a comprehensive assessment of the tele-rehabilitation service.

Currently, clinical trials are near to start, as well as the retrieval of those HTA information which form the background dataset of each clinical study.

After the conclusion of the data collection phase of the whole HTA process, the study will be continued with the analysis of evidence and the preparation and delivery of proper HTA Report.

At the end of the CLEAR Project both HTA methodology and tools are expected to form a whole set delivering guidelines for the implementation of HTA processes of the Habilis Tele-rehabilitation Service.

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Extending Upper Limb Rehabilitation for Stroke Survivors by the Habilis Platform

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Abstract

Within the European project CLEAR, a rehabilitation program for stroke survivors with paresis of the upper limb has been designed and implemented. The core idea was to extend hospital rehabilitation practice by integrating hospital treatment, with home practice and with an intermediate moment called "kiosk". The "kiosk" is an environment conveniently located near home, where patients can perform continuous and intensive practice and receive the necessary supervision and assessment by health professionals by a Tele-Rehabilitation Service based on the Habilis Platform. Preliminary data indicate that the rehabilitation program is effective and safe. Further studies are planned to verify the efficacy of the rehabilitation program, patients', caregivers' and clinicians' satisfaction, factors which influence treatment outcome and adherence.

Keywords: Tele-rehabilitation, Stroke, Upper limb, Paresis

Introduction

Stroke is one of the main causes of disability in developed countries. Within the CLEAR project (ICT-PSP224985), Local Health Authority 11 (AUSL11) of Empoli (Italy) focused its activity on rehabilitation of impairments of paretic upper limb (UL) after stroke. The UL is involved in a large variety of tasks which require the limb to produce different joint

configurations and different timing and sequencing of arm movements. When UL is impaired an important characteristic of human functioning is lost. It has been reported that only 5-20% of patients regain full arm and hand function after stroke while 20% remain with no functional use[1]. It is typically reported that most potential recovery of the upper limb take place in the first three months after stroke. However, studies of training, forced use, and other rehabilitation techniques commenced more than one year after stroke showed considerably recovery of UL function.[2-7] This discrepancy can be at least partially explained. Although the cerebral lesion is the primary cause, there is sufficient quantity of data in published literature that leads to the conclusion that the disability due to the stroke is made worse by the addictive effect of inactivity.[8-11] In addition, poor recovery may reflect an insufficient and time-limited therapeutic intervention for the upper limb.[12]

Objectives

The main objectives of the present paper are to show the results and the benefits obtained by using an integrated approach of treatment extended outside the boundaries of the Health System and beyond the time limits of conventional rehabilitation for stroke survivors with UL impairments.

Methodology

The core idea of the project is to integrate hospital rehabilitation with home practice and with an intermediate moment called “kiosk”, where the Patients use the telerehabilitation ICT platform, called Habilis. The “kiosk” is intended to provide patients an environment, possibly conveniently located near home to be easily accessible, where they can perform continued and intensive practice and receive the necessary supervision and assessment from health professionals by the use of the ICT Habilis platform.

The hospital is responsible to define the personalised treatment plan, updated with an incremental level of difficulty and progression, if necessary. In hospital setting, patients are instructed to practice specific rehabilitation tasks and to use the Habilis platform. The rehabilitation protocols used for treating the patients of the intervention group is designed according to the principles of the “Motor relearning program”.[12] Within the hospital setting, patients receive detailed explanation of how the long term task-oriented treatment works. The role of the hospital (patient education and updating treatment plan), the importance of home

practice (regularity, intensity of training) and the role of the kiosk (for both practice and assessment by the Habilis platform) are emphasized.

Figure 9 Rehabilitation kit distributed to all patients for home rehabilitation

Subsequently, they are instructed to practice a given list of therapeutic exercises aimed at improving UL function by using the rehabilitation kit provided by AUSL11.

The "rehabilitation kit" (see Figure 9) contains a set of objects with different shape and size (puzzle, printed paths to follow with different pens with different characteristics, etc.). These objects are very low cost and easy to find.
A library of exercises has been defined, in order to elicit the different functions (gross grip, fine grip, sensibility, etc.) and are organized in different levels according to the impairment of the patient.

The patients uses a “reference pad” to perform the exercises. The reference pad shows four different coloured lines, that give the patient the reference to the position where the objects should be moved during the exercise execution.
The patients are provided with the list of the home exercises with specification of frequency and intensity of exercise training (“home program sheet”);
In addition to home rehabilitation, patients are trained to use the “Patient Station” of the Habilis platform which is located in the “kiosk”.

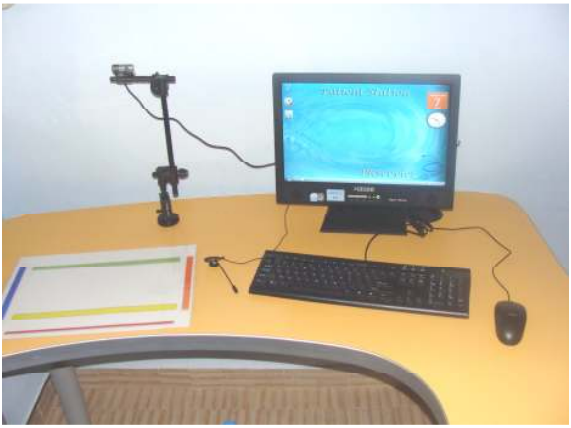

Figure 10 ICT equipment at the Kiosk

Also in the kiosk the patient uses the rehabilitation kit, but the exercises are assigned via the Habilis Platform and sent trough the web. When the patient goes to the kiosk, he/she can see a set of videos, showing the exercises to perform, and can record him/herself while executing the assigned exercises. Later, the therapist can see the videos recorded (it is an asynchronous communication) and provide his/her feed-backs to the patient . Figure 10 shows the ICT equipment at the kiosk (panel PC, with mouse, keyboard headset and web cam, the reference pad and an “adapter arm”, for adjusting the web cam position).

If necessary, a caregiver is associated to the entire process of training to assist the patient. At the end of the hospital instructional period (three to five 2-hour training sessions) patients are given: the “rehabilitation kit”,

the “home program sheet” and the weekly time schedule in which the kiosk will be available for him.

Patients practice at home the given exercise program using the devices of the rehabilitation kit with the intensity (number of times) and frequency (number of sessions per week) reported in the home program sheet. Each practicing session is recorded a logbook.

Patients are requested to attend the “kiosk” 2-3 times/week and practice while assisted by the “Patient Station” of the Habilis platform. From the “Doctor Station” of the Habilis platform located in the hospital, a physiotherapist observes patient performance at least once a week by videoconference, give advice for improving practice and, at regular intervals, reassess the patients. The patient may also request advice from the physiotherapist via Habilis platform. “Kiosks” are supervised by volunteers. If the treatment plan needs to be revised or if adverse clinical events are present, the physiotherapist asks the patients to return to the hospital to review the treatment program and/or a visit with a MD.

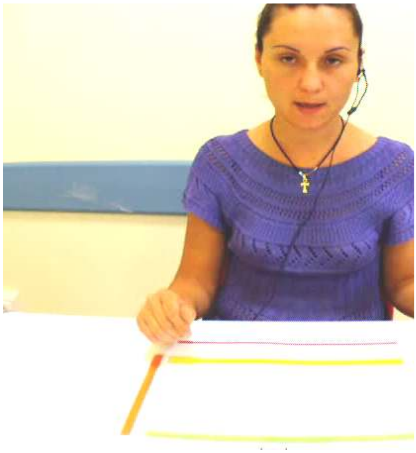

Figure 3- The therapist records an Exercise Tutorial by using coloured glasses

Figure 4- The patient uses the rehabilitation kit at the kiosk

Figure 5- The patient in videoconference with her therapist

The kiosks are a strategic locations for this methodology, because they are spread on the whole territory, and placed in areas that are easy to be accessed also for patients that cannot drive and cannot be accompanied by their relatives or care giver. Some kiosk are also located in public places (e.g. malls or shopping centers) where the patients can go for their daily live activities. In this way they can manage rehabilitation in a self-supporting way, and the rehabilitation becomes part of the routine for this people.

Moreover, especially for the elderly, the rehabilitation at the kiosk becomes a continuous commitment, that motivate them to go out from home, and a good opportunity to socialize with other people, with similar problems and conditions, that perform rehabilitation at the same kiosk.

Figure 6- The shopping center of Empoli, where the first Rehabilitation kiosk has been located

Even the usage of the Computer, that at the beginning could be seen as an obstacle, was turned in positive learning opportunity and some of the patients even declared to be proud to be able to using an ICT tool.

To summarize, this methodology gives the patients the opportunity to perform rehabilitation well outside the time limitation that a traditional treatment can support, bringing the patients to further recover their abilities with respect their recovery plafond, but also allows them to improve their (and their relatives) quality life , contributing to break the pernicious loop impairment - exclusion- sedentary life style- co-morbidity. This second aspect is supposed to compensates the investments requested to the health system for the kiosks management.

Technology Description

The Tele-Rehabilitation Service is based on the Habilis Platform. It is delivered through the following main equipment and software modules:

- Server: allows the management of the service; is installed at the Clinical Centre premises.
- Service Administrator Module: allows the execution of the administration tasks in relation to its clinical use; has the task to

manage users, distribute and save password; assign license to each user to access the service.

- Patient Station: permits patients to receive the clinical protocols, therapies or exercises assigned by the clinical team; allows patients to see the videos containing the instructions; permits to record videos during the execution of the exercises and to transmit them automatically to the clinicians who can evaluate them offline afterwards.
- Doctor Station: allows clinicians to define a set of rehab exercises, record audio/video exercises, assign patients a set of exercises, suggesting the correct applications execution, control the quality of the execution remotely by playing the videos recorded by patients. Through the Doctor Station, clinicians can also directly communicate with the patients by the Videoconference Module to verify their recovery.

Developments

A pilot study on 15 stroke patients (age 64.9+10, 6M, 9F, time from stroke >6 months) with UL paresis was carried out for a preliminary evaluation of effectiveness and safety of designed rehabilitation program. Study design included 2 baseline evaluations at one week time-distance and a third evaluation after a one-month treatment (one-week hospital training and 3-week home and kiosk training).

Results

The exercise program was concluded by 14 of the 15 participant. Main results are summarized in Table1. We did not observe changes between baselines. After 1-month rehabilitation treatment we observed a marked improvement in both UL tests (Motricity Index-UL[13] and Wolf Motor Function Test[14]. No difference was detected in lower limb function (Short Physical Performance Battery[15]). Barthel Index[16] showed a measurable improvement in disability. No adverse clinical events were observed. Home and kiosk adherence to the exercise program was high (>90% scheduled exercise sessions).

Table 1. Pilot study Results

	Baseline 1		Baseline 2		1-month therapy		Change	P*
	Mean	SD	Mean	SD	Mean	SD	%	
Motricity Index UL	77.6	10.8	78.5	9.8	87.7	14.1	12.9	0.001
Wolf's Motor Function Test	67.1	12.7	67.6	12.9	73.2	13.7	9.2	0.01
Short Physical Performance Battery	8.1	3.0	8.1	3.0	8.3	3.0	3.2	NS
Barthel Index	90.1	9.5	90.1	9.5	91.8	10.1	1.9	0.05

*Student t-test paired sample, compared to baselines

Business Benefits

Expected benefits must be considered under both patients' and AUSL11's perspective but also for the whole Health System. From patients' perspective a better functional outcome is expected since the time of practice is increased as compared to that allowed by the usual rehabilitation care, but also an enhancement of their life quality.

From the perspective of AUSL11 the first expected benefit is the reduction of the pressure of individuals with chronic stroke disabilities on the rehabilitation services which are already overcrowded given the high incidence of acute disabilities caused by the aging population.
From the perspective of the Health System this methodology contributes to educate the patients to a better and less sedentary life style, and to reduce the co-morbidity incidence, yielding to a reduction of costs.
It is worth also noticing that the kiosks are fundamental for the methodology sustainability, because the HW resources can be optimized, due to the fact that they are used by several persons during the whole day (instead of one person , at home, for one hour) .
Furthermore, the kiosk allows also to optimize the human resources, because the therapists can monitor the exercises from the patients in an asynchronous way, as supported by several ICT ad hoc tools, while the patients at the kiosks do not need a professional supervision. Volunteers associations can be used for providing technical support to the patients at

the kiosk. In this decentralized way, the care model is going to become a **territorial model**, where the patient become an active actor for his/her recovery, all the resources available on the territory are well exploited and a consistent part of the care is moved outside the Health System.

Conclusions

We propose a task-oriented, individually-tailored, intensive, and prolonged rehabilitation program which integrates hospital rehabilitation, with home and "kiosk" practice aimed at improving function of the paretic limb in stroke survivors. The pilot study indicates that the program is effective and safe. Within the CLEAR project further actions are planned: a) a controlled study to further verify the effectiveness of the rehabilitation program, and patients', caregivers' and clinicians' satisfaction; b) a longitudinal prospective study to define factors which influence treatment outcome and adherence (social, educational, and demographic characteristics; living characteristics; co-morbidity; functional limitations; disability; depression).
The purpose of this further study is to assess more precisely the impact on the Health System and to enlarge the proposed methodology also for further types of disability and for the Chronic care management in general

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Clinical program of cognitive tele-rehabilitation for traumatic brain injury

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Abstract

The purpose of this study was to clinically validate a new modality of cognitive rehabilitation services based on telemedicine systems (PREVIRNEC platform) for persons with moderate or severe traumatic brain injury (TBI).

Patients and Methods. Eighty patients with moderate or severe TBI; mean age: 36.1 years (SD= 18.19 years) received a 10-week cognitive rehabilitation (5 sessions-week). Differences between pre- and post-treatment neuropsychological test scores were used to measure patient's improvements in the domains of attention, memory and executive functions. Patients were divided in two groups based on the Competency Rating Scale (PCRS; adequate or inadequate everyday competence) post-rehabilitation score

Results. Patients showed significant cognitive improvement after the application of the computerized cognitive rehabilitation program. Significant differences were observed between both groups on the number of highly-performed tasks during cognitive treatment, in the attention (p=0.026) and executive (p=0.040) execution

Conclusions. The cognitive rehabilitation program based on telemedicine systems (PREVIRNEC platform) improves attention, memory, and executive functions, as well as in patient's everyday competence.

Keywords: Traumatic brain injury. Cognitive Rehabilitation. Telemedicine.

Introduction

Traumatic brain injury (TBI) has been defined by the World Health Organization as a head injury (for contusion, penetrating injury or by the acceleration-deceleration forces) with at least one of the following conditions: severe alteration of consciousness or posttraumatic amnesia, neurological or neuropsychological changes, diagnosis of skull fracture or intracranial lesions that can be attributed to brain trauma.

Epidemiological studies indicate that 75% of TBI occur in young people (<35 years), affecting mainly men [1]. The incidence of the TBI is estimated to be between 175 and 200 new cases per 100,000 inhabitants per year. Severe disability is estimated at 2/100.000 inhabitants/year, whereas moderate disability after head injury is estimated at 4/100.00 inhabitants/year [2]. TBI is the most common cause of neurological disability accompanied by a long life expectancy. The cost of disability resulting from the sequelae of that pathology is high, including medical costs, lost salaries and low productivity [3]. Most TBI patients have a set of physical, cognitive and emotional impairments which in severe cases can persist over time. Neuropsychological impairments are more likely to determine the quality of life of TBI patients than the physical deficit.
Deficits in attention, memory, learning and executive functions are the most common neuropsychological impairment after TBI, along with fatigue and lack of awareness. Follow-up studies in traumatic brain injury determine that cognitive and behavioural changes, rather than physical consequences, cause activity limitations and participation restrictions. Furthermore, neuropsychological impairment affects patients quality of life, limits their social re-integration and cause stress in the caregivers [4,5].

Cognitive rehabilitation aims to reduce the impact of disabling conditions, trying to improve the changes (deficits) caused by brain injury in order to reduce the functional limitations and increase the individual's ability to function in everyday life [3]. However, cognitive rehabilitation is costly and with limited resources. It is therefore inexcusable the need of optimization, in order to increase their effectiveness with maximum efficiency.

Objectives

The aim of this work is to validate a new way of providing cognitive rehabilitation services through telemedicine systems in the treatment of people with moderate or severe TBI.

For that purpose, a computerized platform of cognitive treatment (PREVIRNEC) was developed and implemented in order to improve the neuropsychological impairment following traumatic brain injury.

Methodology

Subjects

Eighty patients with cognitive impairment following TBI participated in the cognitive tele-rehabilitation program. All patients were older than 17 years old, they had suffered moderate to severe TBI (initial Glasgow Coma Scale [8] ranging from 3 to 13) and have recovered from posttraumatic amnesia (PTA; determined by two-consecutive score on Galveston Orientation and Amnesia Test (GOAT) ≥ 75). Patients presented impairment of attention, memory and / or executive functions. Patients with language impairment (aphasia), sensory disturbances and / or motor disabilities as well with those with psychiatric antecedents were excluded.

Half of the sample received intra-hospital treatment at Neurorehabilitation Hospital Institut Guttmann (Badalona), while the other 40 patients, received cognitive rehabilitation using the tele-rehabilitation platform in two remote centres.

Procedure

Neuropsychological assessment was carried out before and after the cognitive rehabilitation program. Digits forward WAIS-III [9], Trail Making Test part A [10] and the Stroop Test [11] were used to assess attention. Digit backwards WAIS-III [9] and the Rey Auditory Verbal Learning Test (RAVLT) [12] were memory measures, while executive functions were evaluated by Trail Making Test part B [10], Letter and Number Sequencing WAIS-III [9], phonological verbal fluency PMR [13] and Wisconsin Card Sorting Test [14].

Direct scores obtained in each neuropsychological test were stratified into five levels (4: very severe impairment, 3: severe impairment, 2: moderate impairment, 1: mild impairment; 0: normal). Afterwards, a mean measure of each function was defined.

After treatment, the degree of daily competence was assessed by the Patient Competency Rating Scale (PCRS) [15], a 30-items scale were the patient and a caregiver informs about the difficulty he or she may have on every-day activities (1: you can not do; 5: it can be done easily). Patients were divided in two groups according to the caregiver PCRS answers, where scores lower than 120 indicate impairment in daily functioning, whereas higher punctuations represents good performance.

The study was approved by the board of teaching, research and the ethics committee of the Institut Guttmann Neurorehabilitation Hospital.

Statistical analysis

Measures of central tendency and dispersion were used to determine demographic and clinical information. Nonparametric Wilcoxon test was used to analyse changes on cognitive functioning between the pre and post-treatment assessment. Specific analyses were performed on attention, memory and executive functions. Mann-Whitney U test was used to compare patients according to their daily competition rating. All statistical analyses were performed with Statistical Package for Social Sciences (SPSS) version 15.0 for Windows. p values <0.05 (bilateral) were considered to be significant.

Technology Description

The clinical program of cognitive telerrehabilitation for TBI patients was implemented using PREVIRNEC, a tele-rehabilitation platform that combines cognitive computerized neuropsychological rehabilitation. Intensive, customized and monitored therapeutic plan were design taking in consideration each patients cognitive profile.

PREVIRNEC comprises two interfaces, the user (patient) and the professional interface (neuropsychologist). Through the user interface, the patient receives the prescribed treatment; while the neuropsychologist uses the professional interface to, in one hand, select each patient's task for the rehabilitation sessions and, in the other hand, monitor their performance.

Depending on the percentage of accuracy, the results of the task are grouped into three ranges: the therapeutic range, infratherapeutic range and supratherapeutic range. Generically, it is considered that the patient

has completed a task within the therapeutic range if the percentage of accuracy is between 65 and 85%, in infratherapeutic range if the percentage of correct answers is less than 65% and in supratherapeutic range if this percentage is higher than 85%.

Developments

The software application is developed on the J2EE (Java Enterprise Edition) multilayer distributed architecture. J2EE allows the development of applications in a simple, efficient, sustainable way and aims for the development of products based on GNU software.

The goal of this architecture is to ensure technological independence, allowing quick and easy adaptation to other systems, products and components. The independence of the proposed layers facilitates the specialization of working groups to achieve greater productivity. The multi-layer architecture for this system consists of clients, servers, components and container resources. The client requests services to components, the components need resources to provide the service, a container is software that manages the component. The independence of layers and their limited overlap facilitates the implementation of changes to any of them. The cooperation of this layers results in improvements in sustainability, extensibility and reusability.

Client Layer 1 (therapists and patients) is a Web client that consists of dynamic Web pages (generated by Web components running in Layer 2), a web browser that presents the pages received from the web application server and client applications that runs on the virtual machine installed in the end user client. Layer 1 software will also serve as a graphical interface for end users to interact with the application, requiring (e.g.) the identification information of the patient.

The Layer 2 components running on the Application Server is responsible for processing requests from therapists via HTTP (eg preparation of weekly exercise plans to provide the different profiles of patients). A component of Layer 2 is identified by a URL that is associated with a link found on the web page that presents to the therapist a schedule and a list of exercises identifiers.

Layer 3 implements those rules obtained from the functional analysis of the application (ie a patient is not supposed to perform exercises assigned to another scheduled patient). It should be completely independent of any aspect related to the graphical interface presented on Layer 1. This layer interacts with systems database management system (Layer 4) and / or other business information systems, providing flexibility to the application, allowing to integrate legacy systems, third party systems, DBMSs through technology connectors, which defines all the elements necessary to establish communication between application software and external databases (patient histories, demographics, etc.) including rules to connect with each other and to perform secure transactions.

Results

All 80 patients suffered cognitive impairment following moderate-to-severe traumatic brain injury, with a mean age of 36.1 (SD: 18.19). As described in methodology, sample was divided in two groups according to place where the patient was receiving the cognitive treatment, the intra-hospital group and extra-hospital group. Demographic and clinical data both groups are included in Table 1.

	Intra-hospital treatment	**Extra-hospital treatment**
Total n (male/female)	40 (29 / 11)	40 (30 / 10)
Age (Range)	Mean: 34.1 (SD: 14.19) (18 – 64)	Mean: 38.1 (SD: 22.2) (19 – 63)
TBI severity Severe (GCS 3-8) Moderate (9-12)	 88 % 12 %	 80 % 20 %
TBI cause Traffic accident - motorcycle - car - run over Precipitation Other	 75 % - 25 % - 37.5 % - 12.5 15.6 % 9.4 %	 70 % - 20 % - 42.5 % - 7.5 % 20 % 10 %

TABLE 1. Demographic and clinical description of intra and extra-hospital treatment groups.

Each patient participated in a 10-week cognitive rehabilitation using PREVIRNEC platform, five (45-60 minutes) sessions per week (Monday to Friday). A total of 3972 rehabilitation sessions were completed, with 28012 tasks performed, with an average of seven tasks per session.

Figure 1 shows the profile of cognitive impairment pre-and post-treatment of patients following intra-hospital treatment, depending on the stratification of the scores for each cognitive function. Figure 2 shows profile of cognitive impairment pre-and post-treatment of patients who remained extra-hospital treatment. By applying the nonparametric Wilcoxon test was verified that there were significant differences between the neuropsychological pre and post-processing functions for the group studied intra-hospital [attention: $Z = -4.152$ ($p < 0.001$), memory: $Z = -4.387$ ($p < 0.001$), executive functions: $Z = -3.697$ ($p < 0.001$)], allowing to reject the hypothesis of equal means and compared to solve the variables differed significantly. Significant differences were also obtained in the extra-hospital group [attention: $Z = -4.423$ ($p < 0.001$), memory: $Z = -2.842$ ($p = 0.004$), executive functions: $Z = -2.060$ ($p = 0.039$)].

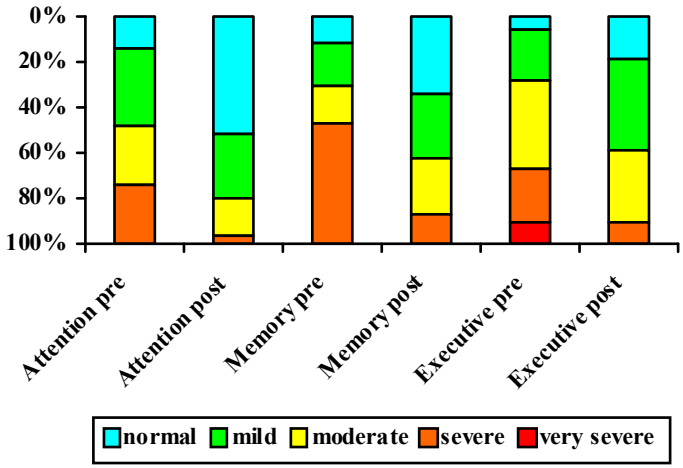

FIGURE 1. Profile of cognitive impairment pre-and post-treatment intra-hospital patients

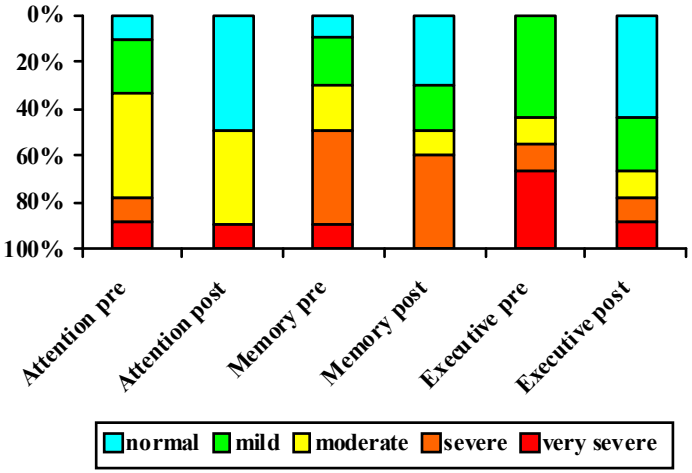

FIGURE 2. Profile of cognitive impairment pre-and post-treatment extra-hospital patients.

In a second analyses, the total sample (n=80) was divided into two groups according to the caregiver PCRS score: 37.5% of the sample (n = 30) had scores on the PCRS <120, while 62.5 % remaining (n = 50) scores at or above 120. Among both groups showed no statistically significant differences (p> 0.05) for the initial GCS, posttraumatic (PTA) duration, age at the time of injury and gender. Similarly, no significant differences in the cognitive pre-treatment assessment were observed.

On the other hand, significant differences were obtained in the post-treatment summary measures (p = 0.036) and in executive functions (p = 0.040). Figures 3, 4 and 5 show the correlation between the two groups for the tasks of attention, memory and executive functions (depending on the ranges generated from the accuracy, percentage of correct answers). Differences were observed between groups in the percentage of tasks of attention in highly-performed range (p = 0.026): patients with an adequate daily competition (PCRS ≥ 120) performed a greater number of care tasks in highly-performed range (tasks performed with a accuracy rate over 85%). Similarly, differences were statistically significant in the percentage

of tasks of executive functioning at highly-performed range (p = 0.036): patients with everyday competence appropriate to make a greater number of tasks of executive functions in highly-performed range that patients with daily competition inadequate.

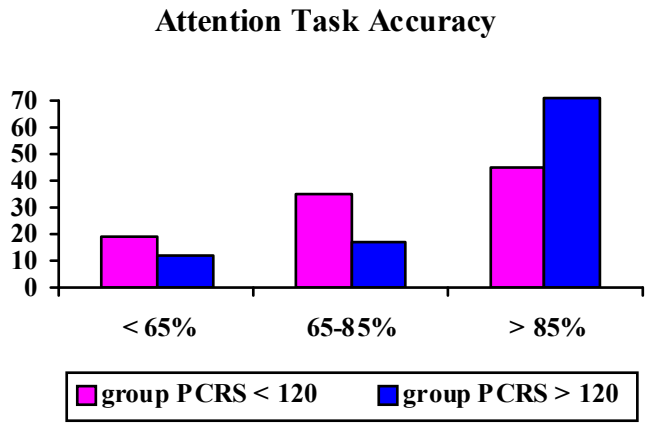

FIGURE 3. Accuracy differences in attentions tasks pre- and postreatment, according to PCRS groups

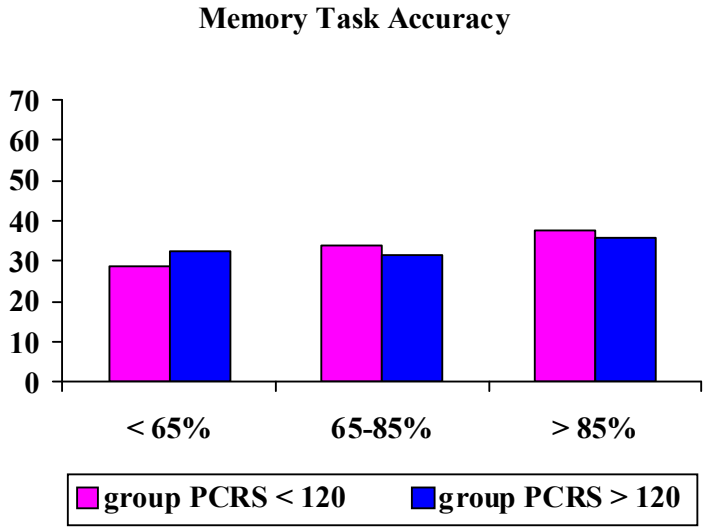

FIGURE 4. Differences pre and post-treatment memory tasks.

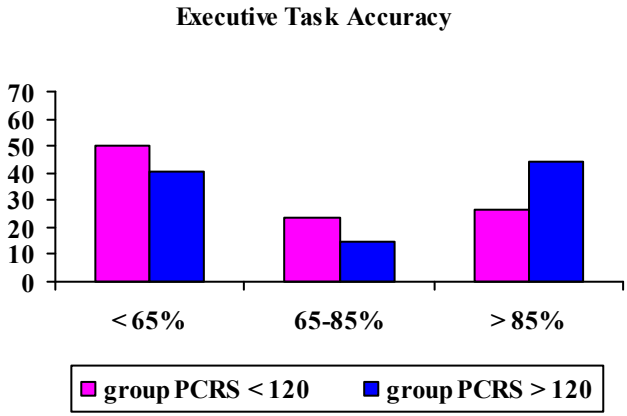

FIGURE 5: Executive functioning differences pre and post-treatment.

Business Benefits

Several advantages of utilizing computer-assisted treatment have been shown, including the computer's ability to provide highly structured and standardized presentation of stimuli and to accurately and consistently record and store data. It allows presenting a variety of tasks according to the patient's needs and abilities and provides accurate and immediate feedback. Moreover, computer-assisted interventions are cost and time effective. It is also possible to treat a large number of patients with a limited number of professionals, thus reducing the amount of intensive one-to-one effort required by the therapist. To achieve the customization level offered in this service, presential rehabilitations sessions are required. This highly increases the rehabilitation services costs / per patient avoiding consolidated services to settle down, our efforts, therefore are oriented to promote the accessibility to rehabilitation services extending potential users and beneficiaries.

Discussion and Conclusions

The clinical program of cognitive tele-rehabilitation for TBI patients was successfully implemented for the treatment of cognitive impairment due

to a traumatic brain injury. Besides the application in our hospital, we have also tested in two other settings and in two different cities, 100 km far away. No major technological problems interfered with the development of the treatment.

Using an intensive (5 days per week) therapeutic treatment, improvement on neuropsychological functioning was found in moderate-to-severe TBI patients. Treatment, provided during a 10 week period, was customized based on each patient's cognitive impairments detected on the initial neuropsychological assessment. Each therapeutic plan was constantly monitored in order to adjust the level of difficulty. Afterwards, significant improvement on their cognitive impairments was observed. This study is the first, to our knowledge, to describe the benefits of providing cognitive treatment using this new approach, through a telerehabilitation platform.

A cognitive tele-rehabilitación clinical program was applied to patients admitted to the neurorehabilitation center (intra-hospital group) and patients attending health centers (extra-hospital group). The results obtained indicate that in both groups the use of PREVIRNEC cognitive tele-rehabilitation platform has a direct effect on the treated cognitive functions (attention, memory and executive functions).

Frequently, usefulness of a treatment is only based on deficit measures, ignoring the effect of treatment on patients' functional capacity (ecological validity of treatment). Cognitive rehabilitation main objective is that patient achieves the higher personal independence. Thus, it is essential to assess the usefulness of a rehabilitative tool, in this case the PREVIRNEC platform, using measures to assess their effects on functional abilities involved in activities of daily living.

Although PCRS was originally designed as an instrument for measuring awareness of deficits, it also provides information about patient's competence level on daily living activities [16,17]. Patients were divided into two groups according to post-treatment PCRS score. Despite that both groups obtained equivalent scores on the pre-treatment neuropsychological assessment, attention and executive performance differed on the post-treatment summary measure, suggesting the patients with adequate daily competence showed higher neuropsychological functioning, at the end of the rehabilitation.

It was also noted that there were differences between groups in the results obtained in the tasks executed during rehabilitation of the Attention and Executive Functions. These findings raise an interesting question: Would the number of patients with PCRS's total scores ≥ 120 increase if they undertake the maximum number of possible tasks in supratherapeutic range? Or, would their daily competences's level improve if they performed the Attention and Executive Functions tasks with success rates above 85%? It is necessary to to study thoroughly this issue in order to increase the effectiveness and efficiency of neuropsychological intervention in daily clinical practice.

Neuropsychological Rehabilitation aims to reduce patients' functional limitations and to increase the subject's ability to develop activities of daily life and, consequently, improving his quality of life. Focusing on cognitive intervention the objective is to improve performance and/or compensate the impairment. Despite the introduction of new therapeutic tools, a considerable number of patients show sequelae as a result of the injury. It is necessary, therefore, to enhance therapeutic innovation tools currently applied in neuropsychological treatment. In this regard, PREVIRNEC platform is a clear example of innovation in the field of neuropsychological rehabilitation in brain damage, the result of translational biomedical research based in new technologies.

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Pre-surgery and post-Surgery Tele-rehabilitation for Hip and Knee Replacement

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Abstract

Osteoarthritis (OA) is among the five most disabling diseases. Aims of this study were to review treatment options for patients suffering hip or knee osteoarthritis and to assess patients' attitudes toward telerehabilitation over the Internet at the beginning of practical implementation of telerehabilitation platform. The study group consisted of hip osteoarthritis patients at the end stage of their disorder after admission for Primary Total Hip Arthroplasty. Fifty four patients (38 females and 16 males) aged 60,83 y.a. with average VAS pain score 4,98, lower extremities discrepancies and Range of Motion restrictions in affected hips participated in this study. Symptoms, functional status and Computer skills, E-mail and the Internet significantly influence on patients willingness to participate telerehabilitation were evaluated. Rehabilitation modalities, protocols, effectiveness were discussed in literature search. Hip and/or knee OA pre- and postoperative rehabilitation protocols, exercises and versatile conditions of their implementations for target population were discussed. Computer skills, using the Internet and e-mail are the most important factors influencing patient's willingness to participate telerehabilitation.

Keywords: osteoarthritis, hip, knee, total hip replacement, exercise, telerehabilitation

Introduction

Osteoarthritis (OA) is among the five most disabling diseases, having a remarkable public health impact of 4.76106 disability adjusted life years (DALYs) in the developed countries [40]. The prevalence of OA has been assessed at 12% in the American population [33]. Symptomatic hip osteoarthritis (OA) occurs in 3% of the elderly [11]. Treatment options for OA are pain relief with analgesics and non-steroidal anti-inflammatory drugs (NSAIDs) [59], exercise [7,10,14,27,54], patient education, and finally, joint arthroplasty [32, 48]. Total hip replacement (THR) is an effective and cost-effective procedure for people with severe hip osteoarthritis (OA), unresponsive to conservative therapy [34, 47]. Total joint replacements are procedures and treatment of choice for patients suffering with intractable joint pain and disability arising from osteoarthosis (OA) of the hip or knee [30]. Physiotherapy is considered integral to the outcome of joint replacement. Total hip replacement (THR) is an effective and cost-effective procedure for people with severe hip osteoarthritis (OA), unresponsive to conservative therapy [9,27,34,47]. Literature search of hip replacement indicates that hip replacement patients experience persistent functional and physical limitations at least one year postoperatively [2]. The study is designed to find the way for rationale telerehabilitation application as the intervention on patients with OA of the hip or knee prior or after Total Joint Replacement. Population of patients with hip and knee total replacement is large and rises yearly [8]. Models of rehabilitation after TJR contain stationary and home care at present. Most effective approach seems to be multidisciplinary [30]. The multidisciplinary rehabilitation approach can be achieved by telemedicine measures, however a little is known about telerehabilitation in orthopaedics [1,4,19-22,25,49].

Objectives

Aims of this study were to:

1. review treatment options for patients suffering hip or knee osteoarthritis including Internet-based exercise and telerehabilitation
2. to assess patients' attitudes toward telerehabilitation over the Internet at the beginning of practical implementation of telerehabilitation platform.

Methodology

The study has an observational prospective cohort design approved by Bioethical Committee accordingly to Declaration of Helsinki. The clinical preparation phase of this home based exercise program implementation study begun in January, 2010. Patients admitted to the Department were invited to participate in the study. The preliminary protocol for the rehabilitation program was designed. The clinical assessment was provided immediately after enrolment. Preliminary assessment consists of questionnaires and functional assessment. The study group consisted of hip osteoarthritis patients at the end stage of their disorder after admission for Primary Total Hip Arthroplasty. Patients were asked to answer following questionnaires: Harris Hip Score (HHS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Short Form – 36 (SF-36), Hip disability and Osteoarthritis Outcome Score (HOOS), Visual Analogue Scale of Pain (VAS). They were interviewed on Internet use, computer skills, email use and attitude toward telerehabilitation. Finally, patients were invited to home therapy accordingly to study protocol. Physical examination included leg length discrepancies measurements, Range of Motion (ROM) and muscular strength. Descriptive statistics, paired samples t-test and Kruskal-Wallis ANOVA were calculated for statistical significance. Statistical analysis was performed using STATISTICA 9.0 (StatSoft. Inc.).

Results

The study group consisted of fifty four patients (38 females and 16 males) who agreed voluntarily join the study. The average age of the study group was 60,83 y.a. (30 - 83; Std 11,07; females - 59,1; males - 64,93). Visual Analogue Scale (VAS) for pain was used to express symptomatic pain score. Arithmetic mean of VAS score was 4,98 (range 0-9, Std 1,75). Leg length discrepancies were noted by patients as limp. Paired samples t-test for affected versus nonaffected lower extremity length have shown significant difference (Test statistic t - 2,484; Two-tailed probability P = 0,0163). Mean difference was 0,89 cm, Std 2,5993). Range of motion was restricted significantly in affected hips as seen in Table 1.

Movement	t-test	p-value	mean difference	Std
Flexion	5,99	P < 0,0001	26,92	26,92
Abduction	7,209	P < 0,0001	8,39	8,48
Internal rotation	5,586	P < 0,0001	7,98	10,3
External rotation	5,667	P < 0,0001	6,92	8,81

Table 1: Paired samples t-test for affected versus nonaffected lower extremity ROM

Patients self-assessed their computer skills. Good skills declared 5 patients, one excellent and three sufficient. Nine patients use the Internet but only three of them do it daily. Emailing was confirmed only by 5 patients (9,43%). Fortunately, more patients presented positive attitude towards telerehabilitation. Willingness to attend telerehabilitation was declared by 23 patients (41,5%). Computer skills, emailing and Internet use were found as independently influencing on willingness to attend telerehabilitation in the study group. Kruskal-Wallis ANOVA by Ranks was calculated for E-mail [Fig.1], Computer skills [Fig.2], and the Internet use grouped by willingness to participate telerehabilitation and results were statistically significant (respectively H =9,451666, p =0,0021; H =7,632576; p =0,0057 and H =8,487351; p =0,0036). No other items mentioned in questionnaires, symptoms or signs influenced on attitude towards telerehabilitation. Similarly previous experience with preoperative home or outpatient rehabilitation did not affect this attitude.

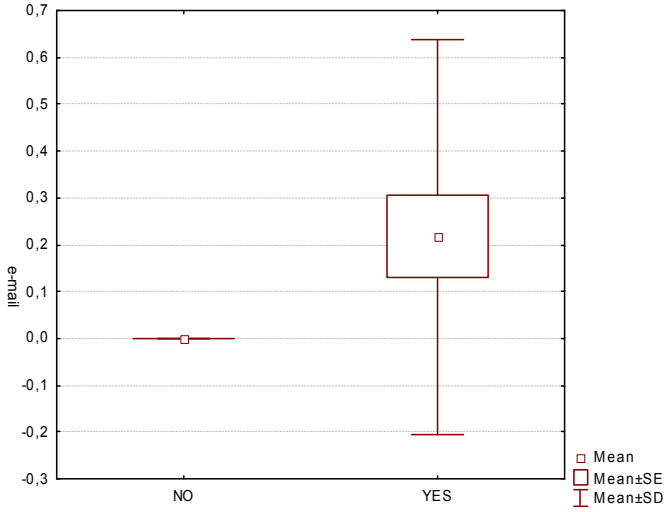

Figure 1: E-mail access influence on attitude to attend telerehabilitation

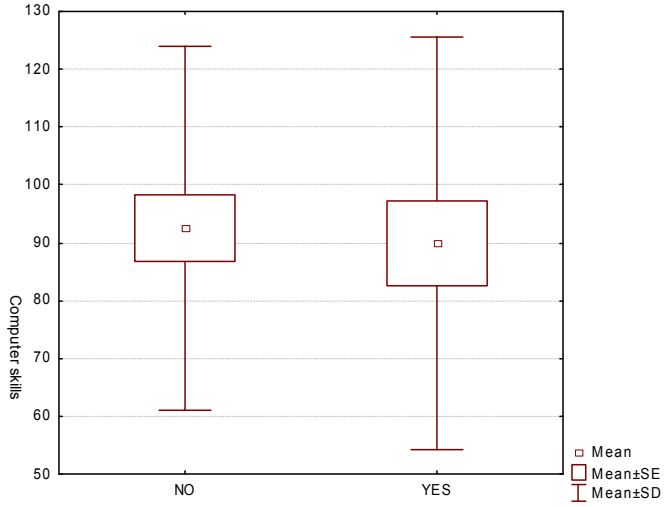

Figure 2: Computer skills influence on attitude to attend telerehabilitation

Discussion

Many questions are asked while implementing eHealth solutions designed for patient's empowerment. The one is the potential participation and willingness to participate novel treatments on remote using the Internet. Rehabilitation modalities, protocols, and effectiveness need to be addressed and well elaborated. The objectives of home-based, telemedicine oriented exercise programs should follow established home or outpatients protocols. Protocols should be validated and based on effective, reliable exercises. Adequately powered studies evaluating exercise programs specifically designed for people with symptomatic hip OA need to be conducted. Therapeutic exercise treatment guidelines for patients with symptomatic hip OA are based on expert opinion mostly. Little is known whether land-based therapeutic exercise is beneficial for people with hip OA in terms of reduced joint pain and/or improved physical function. The results of the literature search by Fransen et al. [16] demonstrated a small treatment effect for pain in randomized controlled trials exclusively recruited people with symptomatic hip OA. Non-pharmacological, non-surgical interventions, such as the treatments offered by physiotherapists, are recommended as the first line of treatment for hip and knee osteoarthritis (OA) [28,42]. Physical fitness and computer skills are not often seen among elderly patients. The majority of hip OA patients prior the primary THR are in their 6th or 7th decade [8] what we have observed also in our study group.

Optimal management of patients with OA hip or knee requires a combination of non-pharmacological and pharmacological modalities of therapy. The efficacy of some modalities of therapy was confirmed by OARSI recommendations for the management of hip and knee osteoarthritis published in 2007 [62]. OARSI evidence-based, expert consensus guidelines published in 2008 [63] recommended the use of 12 non-pharmacological modalities: education and self-management, regular telephone contact, referral to a physical therapist, aerobic, muscle strengthening and water-based exercises, weight reduction, walking aids, knee braces, footwear and insoles, thermal modalities, transcutaneous electrical nerve stimulation and acupuncture. These recommendations covered five surgical modalities: total joint replacements, unicompartmental knee replacement, osteotomy and joint preserving surgical procedures; joint lavage and arthroscopic debridement in knee OA, and joint fusion as a salvage procedure when joint replacement had

failed. OARSI recommendations 2010 [64] among non-pharmacological therapies, effect size for pain relief was unchanged for self-management, education, exercise and acupuncture.

Regarding OA of the hip, there have been very few randomised controlled trials of exercise therapy, however what data there are indicate the benefits may be similar to those found for knee OA [3,43,44,51]. Minns Lowe et al. [38] performed systematic review to evaluate the effectiveness of physiotherapy exercise after discharge from hospital on function, walking, range of motion, quality of life and muscle strength, for osteoarthritic patients following elective primary total hip arthroplasty. They found that physiotherapy exercise after discharge following total hip replacement has the potential to benefit patients. Whether postoperative physiotherapy exercise can improve physical and functional status remains an important question to adequately address. Traditional physiotherapy following lower limb joint replacement, consisting of range of joint motion and isometric muscle strengthening exercises plus transfer and gait/walking aid practice, may be less effective than programmes incorporating a more functional, weight bearing approach to rehabilitation [17,52,53]. Insufficient evidence is available to establish the effectiveness of physiotherapy exercise following primary hip replacement for osteoarthritis [38]. More, well designed trials are required to determine the value of post discharge exercise following this common surgical procedure. Vignon et al. [58] attempted to determine which activities in four domains, daily life, exercises, sports and occupational activities, should be recommended, in favour or against, for the patient suffering from knee or hip OA. They stated with a high level of scientific evidence that exercises and other structured activities pursued with a goal of health improvement, have a favourable effect on pain and function in the sedentary knee OA patient. The OASIS group recommended the practice of exercises and other structured activities for the sedentary patient with knee OA. Static exercises are not favoured over dynamic exercises, availability, preference and tolerance being the criteria for the choice of an exercise. Exercises should be performed at a frequency of between one and three times per week because results deteriorate when exercises are stopped. Professional assistance can be useful in improving initial compliance and perseverance. There is no scientific argument to support halting exercise in case of an OA flare-up. Hopman-Rock and Westhoff [26] evaluated a self-management program for patients with osteoarthritis (OA) of the hip or knee. The program, which consisted of 6 weekly sessions

of 2 hours, included health education by a peer and physical exercises taught by a physical therapist. They found significant time effects of the program for pain, quality of life, strength of the left M. quadriceps, knowledge, self-efficacy, BMI, physically active lifestyle, and visits to the physical therapist. Pisters et al. [46] studied the long-term effectiveness (>/=6 months after treatment) of exercise therapy on pain, physical function, and patient global assessment of effectiveness in patients with osteoarthritis (OA) of the hip and/or knee. They concluded the positive post-treatment effects of exercise therapy on pain and physical function in patients with OA of the hip and/or knee are not sustained in the long term. Galea et al. [18] examined the physical function, gait, and quality of life of patients after total hip replacement (THR) randomly assigned to either a targeted home- or center-based exercise program. Their study confirmed effectiveness of targeted strengthening program for both the home- and center-based groups. THR patients can achieve significant improvements in quality of life, stair climbing, walking speed increase, cadence, step length and step length symmetry through a targeted strengthening program delivered at a center or at home. Tak et al. [51] mentioned the possibility for altering the course of hip OA among older adults with osteoarthritis of the hip after exercise program. The intervention was the eight-week program that included eight weekly one-hour sessions of strength training using fitness equipment under supervision of a physical therapist; a home exercise program; individualized occupational therapy consult; and dietary advice. The hip function rated with the Harris Hip Score improved significantly in the experimental group at the posttest ($p<0.05$) but dropped back toward baseline at the follow-up assessment. Although it is well established that various forms of exercise are effective in reducing pain and increasing physical function in people with knee OA, there is still little knowledge about effectiveness of exercise forms and how the environment and their execution modalities may influence on their effectiveness [1,13,15,16,19,21,23,25,29, 30,36,37,41,45,49,56,58].

Home-based care can improve rehabilitation outcomes. McCarthy et al. [35] studied the elative effectiveness and cost of providing a home-based exercise programme versus home-based exercise supplemented with an 8-week class-based exercise programme. Patients from the supplemented group demonstrated significantly greater improvement in locomotor function and decrease in pain while walking at all follow-ups. The supplemented group also demonstrated smaller but significant improvements in balance, strength, WOMAC score, and the physical

function and pain dimensions of the Short Form-36. The supplementation of a home-based exercise programme with a class-based exercise programme led to superior improvement in the supplemented group. Home-based multidisciplinary care improved functional gain and quality of life (QoL) and reduced hospital stay in the medium term (six months).

Early multidisciplinary rehabilitation can improve outcomes at the level of activity and participation following hip or knee joint replacement [30]. Fernandes et al. [12] proposed detailed exercise programs specifically for patients with hip osteoarthritis (OA) based on case report of the use of a therapeutic exercise program for a patient with hip OA. Home care can be delivered over the Internet. The Internet is a relatively new tool for delivering physical activity interventions. An Internet-based physical activity intervention can be more effective than [55] a waiting list and more effective than doing little or nothing. The literature suggests that long-term changes in physical activity behaviour can only be accomplished by studies with long-term follow-up [50]. There is limited number of randomized controlled trials on the effectiveness of Internet-based physical activity interventions. The advanced step of Internet – based physical activity interventions is called telerehabilitation (TR). Internet based videoconferences opened wide spectrum of telerehabilitation implementations [19]. Telerehabilitation of knee or hip OA is rarely described in the literature. Hoffmann and Russell [25] suggested the feasibility and accuracy of conducting occupational therapy at the homes of 40 patients using the Internet. The online therapist conducted the visit via a low-speed, dial-up Internet connection using a specially developed telerehabilitation system (combination of real-time videoconferencing - 320 x 240 pixel resolution with a suite of calibrated assessment tools). Russell et al. [49] have developed a low-bandwidth, Internet-based telerehabilitation system to provide outpatient rehabilitation to patients who have undergone total knee arthroplasty. The preliminary physical and functional objective outcome measures efficacy of the treatment programme was assessed on 21 patients. A six-week telerehabilitation programme or the usual face-to-face program outcomes were similar. There was a non-significant trend for greater improvements in the telerehabilitation group for most outcome measurements. Patients received their telerehabilitation programme well. The results of their study provided evidence for the efficacy of low-bandwidth telerehabilitation consultations. Questions surrounding the validity and reliability of outcome measures obtained during telerehabilitation remain. Cabana et

al. [5] described that clinical variables typically measured in face-to-face evaluations can be measured successfully under telerehabilitation conditions with moderate reliability. They assessed patients after discharge from an acute care hospital for lower limb orthopaedic surgery. Telerehabilitation evaluations were conducted with a videoconference link between either the participant's home or a clinical environment and a remote clinical station over residential DSL lines at 512 kbps. The home-based, telemedicine oriented exercise program should focus on clinical orthopaedic rehabilitation and outcomes including user satisfaction, clinical effectiveness, and economy of designed procedures. Group tele-exercise home program of structured, interactive, and supervised exercise through a videoconferencing system for balance impaired elders improves balance and reduce fear of falling [61]. Elderly subjects can participate in the Internet-based videoconferencing at home, allowing real-time video and audio communication with the exercise instructor. Studies have demonstrated that the group tele-exercise program is acceptable and welcomed by elders for various medical problems. The average compliance can reach up to 98%. The self-administered, home-based exercise rehabilitation programme was an effective way to help women immediately following surgery for a modified radical mastectomy and axillary node dissection during the immediate 2-week recovery period following surgery to improve and regain shoulder mobility and ROM [31]. Collins at al. [6] found that patients with peripheral arterial disease may benefit from the use of an educational video to increase the use of unsupervised physical activity. Home-based exercise is a viable solution for frail elderly individuals with difficulties in reaching exercise facilities outside home. Vestergaard et al. [57] conducted the study was to determine the effects of a home-based video exercise program on physiological performance, functional capacity and health-related quality of life. Participant's adherence to the training protocol was on average 89.2%. They concluded that home-based training for frail older women using an exercise video induces lasting health-related quality-of-life (EQ-5D). Moore et al. [39] investigated whether a home exercise video programme could improve exercise tolerance and breathlessness in patients with moderate to severe chronic obstructive pulmonary disease. The study suggested that participation in a home exercise video programme may benefit people with chronic obstructive pulmonary disease. The Internet has the potential for delivering innovative, interactive physical activity (PA) interventions to large numbers of people. The study by Napolitano et al. [41] have shown that a theoretically based

PA Web site and weekly e-mail tip sheets can have a short-term impact on PA motivation and behaviour. Systematic review by Vandelanotte et al. [56] have reported positive behavioural outcomes of a little over half of the controlled trials of website-delivered physical activity interventions. Prior to the Internet Web 2.0 websites Miller et el. [37] explored how patients with shoulder and back pain perceived videotaped exercises and instructions to support their routine physiotherapy and how the videotape was used. They confirmed that videotape supported patients with a variety of different needs as it enhanced their ability to complete exercises correctly. Videotapes (or DVDs) are useful for patients and could be adopted as a tool to support treatment [23]. Wu et al. [60] compared the adherence to and effectiveness of Tai Chi exercise program through a live, interactive, telecommunication-based exercise with that of a similar program through a community center-based exercise and a home video-based exercise among community-dwelling elders who are at risk for falls. The telecommunication-based exercise and community center-based exercise groups were better in exercise compliance, fall reduction and balance and health improvements compared with the home video-based exercise group. Telecommunication-based exercise was found as an effective, affordable, and acceptable choice of exercise for elders.

Conclusions

The orthopaedic preliminary study for the CLEAR project has reviewed and identified hip and knee OA pre- and postoperative rehabilitation protocols, exercises and versatile conditions of their implementations for target population. Our review confirms that exercises are constantly recommended for the nonoperative treatment option for patients suffering osteoarthritis. Telerehabilitation exercise expands currently as an effective, affordable, and acceptable choice of exercise for all ages patients including elders. Our study shows the group of patients interested in telerehabilitation among suffering hip or knee osteoarthrosis. More than 40% of patients presented attitude toward telerehabilitation regardless physical signs, symptoms or disabilities. Computer skills, using the Internet and e-mail are the most important factors influencing patient's willingness to participate telerehabilitation. Teaching the elderly how to navigate technology (computers, internet) can be the eChallenge for telemedicine oriented rehabilitation future participation.

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