In-Home Telerehabilitation as an alternative to face-to-face treatment: Feasability in post-knee arthroplasty, speech therapy and Chronic Obstructive Pulmonary Disease

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ABSTRACT

The purpose is to show three technological innovations used in in-home telerehabilitation and results regarding the efficacy pilot studies. Telerehabilitation systems in enhanced by TERAS software, externals sensors and control of the camera. Based on our experience, residential Internet network is of sufficient quality to make in-home teletreatment feasible. Innovative technologies improve teletreatment sessions. Telerehabilitation seems to be a practical alternative for home visits by a physiotherapist for dispensing rehabilitation services.

Keywords

in-home telerehabilitation, teleconsultation, elderly, total knee arthroplasty-TKA

INTRODUCTION

In-home telerehabilitation, defined as the provision of remote rehabilitation services to individuals with persistent and significant disabilities via information technologies and telecommunications in their home [1], is growing as a complementary or alternative intervention to traditional face-to-face therapy in home care and outpatient services. The rationale for in-home telerehabilitation is to expand and facilitate the delivery of rehabilitation services to people who cannot access them due to a shortage of or lack of access to services, long waiting lists for home care services or problems getting to and from the clinic [2]. Clinical care that can be provided via in-home telerehabilitation encompass active treatment and follow-up [3] as opposed to diagnosis and evaluation by teleconsultation.

PURPOSE OF THE PAPER

The purpose of this presentation is to show three technological innovations used in in-home telerehabilitation. Moreover, we present preliminary results regarding the efficacy of in-home telerehabilitation as an alternative to conventional rehabilitation services provided following an acute illness.

TECHNOLOGICAL INFRASTRUCTURE FOR TELEREHABILITATION SERVICES

Based on experience from two previous studies [4, 5], a telerehabilitation platform was developed and refine. The platform includes various components in order to provide a user-friendly experience to both the clinician and the patient at home. While being similar in many ways, two different systems were used to provide telerehabilitation services: an "in-home" system and a clinician system. The telerehabilitation platform and software interface for both systems are illustrated in Figure 1.

The core of these systems is the videoconferencing system (Tandberg 550 MXP), which uses a h.264 video codec and integrates a pan-tilt-zoom (PTZ) wide angle camera and an omnidirectional microphone. The system is mounted over a 20-inch LCD screen, which displays the video received from the other end. Audio can be played using external speakers placed on both sides of the screen (the internal LCD screen speakers are rarely sufficient to provide a satisfactory experience).

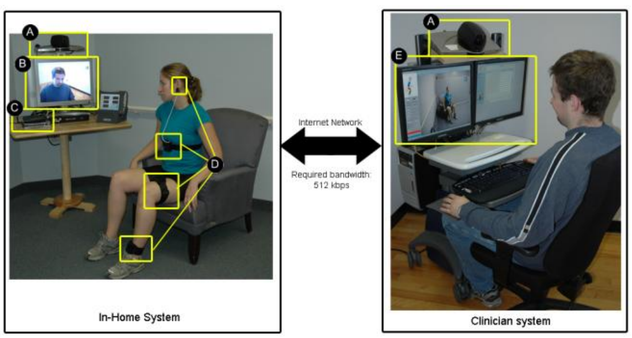


Figure 1 - Telerehabilitation systems. Components of both systems are identified: A) Videoconferencing system, B) LCD screen, C) Router and modem connecting to the internet, D) Sensors and external devices, E) Clinician computer and screen display.

Video and audio data is encrypted and transmitted over a high-speed internet connection, allowing communication using a maximum bandwidth of 512 kbps for both upload and download. The system is also resilient to packet loss and ensures that audio and video are correctly synchronized. The in-home system can include external wireless sensing devices such as oxymeters, respiratory belts, instrumented soles and inertial measurement units (figure 2). These sensors provide additional information in real time to the clinician such as oxygen saturation level, heart rate and anatomical angles. The bandwidth will vary accordingly to the numbers and type of sensors included in the setup.

The clinician system adds a computer to the in-home system. A software interface (TeRA), running on this computer, provides user-friendly control and monitoring of videoconferencing sessions, cameras control, built-in clinical tests, photo and video recording and external sensors and devices support [6]. TeRA workflow is represented in Figure 2. The platform was developed to ensure that interactions between clinicians and clients during the telerehabilitation sessions were not impeded by technology, but facilitated with user-friendly interfaces. A special effort was made to provide a mouse-based interface to intuitively control, from a unique screen through point-and-click or area zoom, PTZ camera functions at both sites. This functionality is represented in the Figure 3.

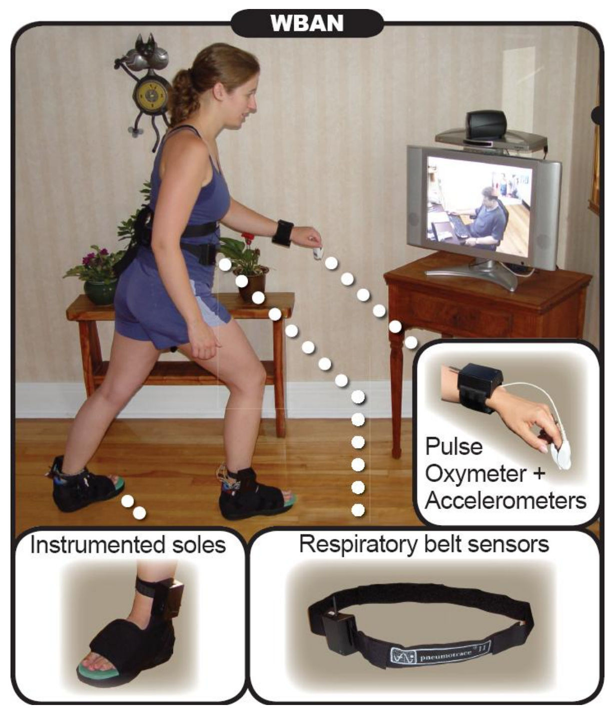


Figure 2 – Externals sensors. A computer can be included in the in-home system to accommodate several external sensors. The computer is wirelessly connected to the router and the sensor network is connected to the computer. Sensors illustrated in the picture include: inertial measurement units, respiratory belts, pulse oxymeters and instrumented soles.

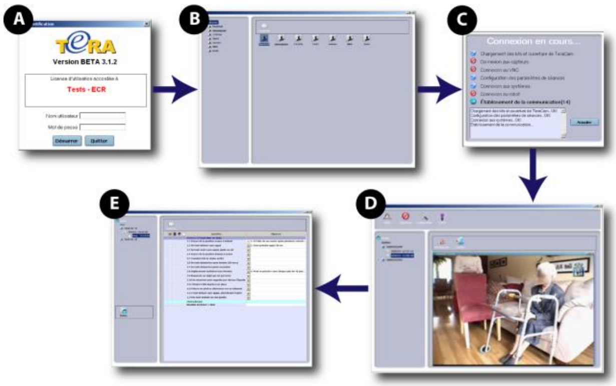


Figure 3 - TERA software. When the software is launched, the A), login screen, appears where access privileges can be controlled as each user has a unique login ID. On a successful login, the B), main screen, is displayed, where the user can select a client and easily connect to it by double-clicking the connect button, bringing in the C) interface displaying the connection process. When the connection is complete, the D) interface display the remote video and provides camera control and E) test completion directly into the software.

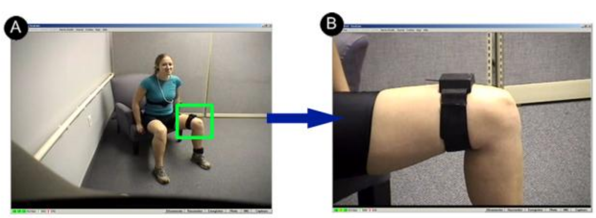


Figure 4 - Camera Control. Camera control is entirely done with the mouse. On a click, the camera centers on that point. In A), the users select an area with the mouse and release the mouse button. The camera moves and centers on the area as shown in B.

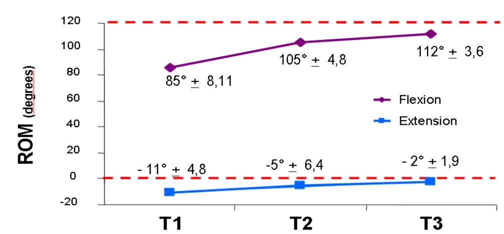
CLINICAL PILOT STUDES USING INNOVATIVE TECHNOLOGY

Post-knee arthroplasty [4]

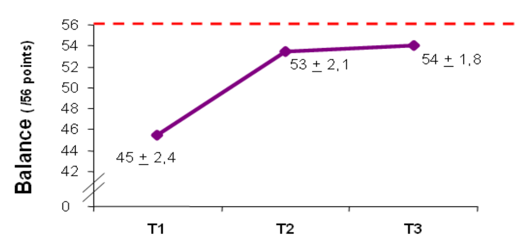
Purpose: The purpose of this study was to investigate the efficacy of in-home telerehabilitation provided following knee replacement surgery (Total Knee Arthroplasty-TKA). Setting was a service center linked to the home of the patient by high speed residential internet service.

Method: A pre/post-test design without a control group was used for this pilot study. Five community-living elders who had knee arthroplasty were recruited prior to discharge from an acute care hospital. Telerehabilitation treatments (16 sessions) were conducted by two trained physiotherapists from a service center to the patient's home. Disability (range of motion and balance) and function (locomotor performance in walking) were measured in face-to-face evaluations prior to and at the end of the treatments by a neutral evaluator. The satisfaction of the health care professional and patient was measured by the use of questionnaires.

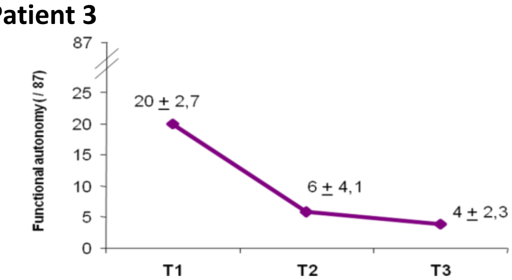
Knee range of motion



Balance



Patient 3



Results: Technology was robust despite some loss of connection in the sessions. Indeed, the satisfaction of the health care professionals regarding the technology and the communication experience during the therapy sessions was similar or slightly lower. One participant was lost during follow-up, which was not due to the technology. Clinical outcomes improved for all subjects and these improvements were sustained two months post-discharge for in-home telerehabilitation. The satisfaction of the participants with in-home telerehabilitation services was very high.

SPEECH THERAPY (NOT PUBLISHED)

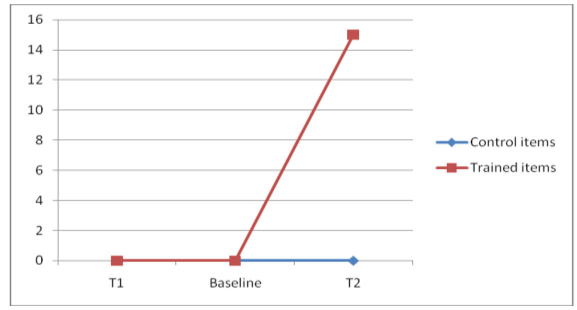
Purpose: The purpose of this study was to investigate the efficacy of speech therapy teletreatment for rehabilitation services provided following a cerebral vascular accident. The setting was a service center and a simulated home (inside the service center) using high-speed residential internet services.

Technology related to speech therapy: The telerehabilitation platform was adapted for the purpose of speech therapy treatment. Indeed, patients must react to visual cues presented by the clinicians. Therefore, an interactive computer was inserted in the platform.

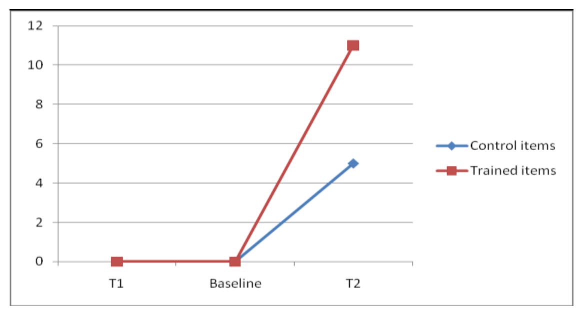
Method: The design used for this study was a pre-post test with a baseline such that the patient is his own control. The in-home speech therapy teletreatment was delivered over a period of two months. Three patients (two women and one man) who have had a cerebral vascular accident (CVA) with language problems were recruited. They were at different stages of their rehabilitation: 2, 6 and 8 months post-CVA. Subjects, depending on failed items in the recognition task at the assessment,, weredivided in two groups for the treatment: half was trained in the in-home teletreatment and the other half was not trained (control). The comparison between the number of successful items before and after treatment served as outcome measures.

Results: Despite the frailty of patients, technology was considered very satisfactory for their treatment. Clinical outcomes improved for the three subjects: they showed huge improvement of the trained items compared to the not trained items

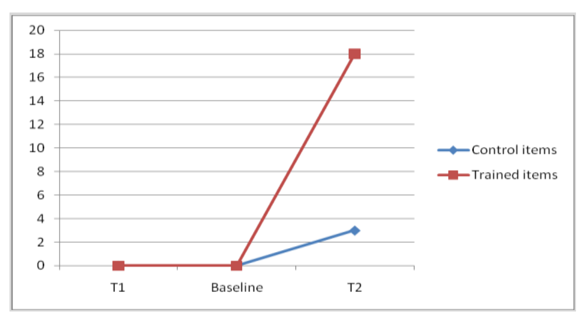
Patient 1



Patient 2



Patient 3



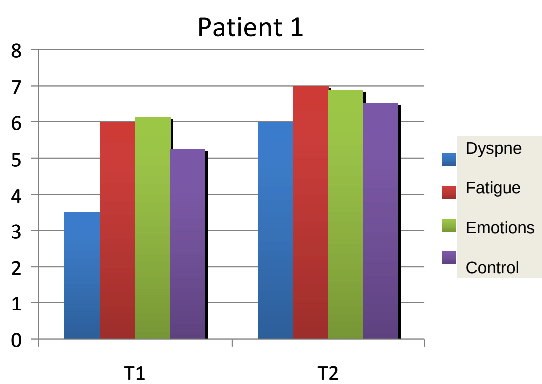
CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) (NOT PUBLISHED)

Purpose: The purpose of this study was to investigate the efficacy of in-home physiotherapy teletreatment for rehabilitation services provided for COPD patients.

Technology related to cardiopulmonary rehabilitation: The telerehabilitation platform was adapted for the purpose of treatment of cardiopulmonary rehabilitation. Indeed, some physiological data must be controlled in direct time, like cardiac frequency and oxygen saturation. Thus, a Nolin probe was inserted in the platform.

Method: A pre/post-test design without a control group was used for this pilot study. One community-living elder with COPD was recruited prior to discharge from his rehabilitation program. Telerehabilitation treatments (16 sessions) were conducted at the patient's home by two trained physiotherapists from the service center. Function (locomotor performance in walking) and quality of life were measured in face-to-face evaluations prior to and at the end of the treatments by an independent evaluator.

Results: Locomotor performance did not change between T1 and T2. However, the four aspects of quality of life improved over time.



CONCLUSION

A residential Internet network is of sufficient quality to make in-home teletreatment feasible. Innovative technologies improve teletreatment sessions. Telerehabilitation seems to be a practical alternative for home visits by a physiotherapist for dispensing rehabilitation services.

ACKNOWLEDGMENT

P. Boissy, H. Corriveau, H. Moffet, N. Marquis, L. Dechêsne, F. Cabana

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