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Feasibility of Post-Acute Hip Fracture Telerehabilitation in Older Adults

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Abstract. Recent studies demonstrated potential of home-based telerehabilitation in older adults and individuals with mobility impairment. However limited evidence exists on feasibility of home-based telerehabilitation in older adults after hip fracture. The aims of this study were: (1) to assess impact of home-based telerehabilitation of community dwelling older adults in post-acute phase of recovery after hip fracture on mobility, psycho-behavioral factors, quality of life, and satisfaction with care; (2) to estimate acceptance of the telerehabilitation system and adherence to the exercise program. We found statistically significant improvements in exercise self-efficacy, mobility, quality of life, and patient satisfaction after 30-day hip fracture telerehabilitation. Home-based telerehabilitation may be a viable model for post-acute hip fracture recovery and it is warranted for further evaluation in clinical trials.

Keywords. Telerehabiliation, hip fracture, older adults

Introduction

About 300,000 individuals, the majority of whom are 65 years of age or older, suffer a hip fracture each year in the U.S. [1]. Previous studies [2] reported that the majority of older persons did not recover their pre-fracture level of functioning. Older age and poorer pre-fracture physical and cognitive functioning have been associated with a poor prognosis for functional recovery [2]. Rehabilitation services are essential for full scale recovery in this population however access to physical therapy facilities is frequently limited by mobility impairment, lack of transportation, and insurance coverage [1-2].

Recent studies demonstrated potential of home-based telerehabilitation in older adults and individuals with mobility impairment [3-4] however limited evidence exists on feasibility of home-based telerehabilitation in older adults after hip fracture. In previous studies we demonstrated high acceptance of Home Automated Telemanagement (HAT) system by individuals with minimal computer experience including older adults with limitations in cognition, vision, and locomotion [5-6]. The HAT system provides multidisciplinary support for individualized self-management plans, facilitates patient adherence to exercise regimen, and promotes patient-provider communication [7-8]. The system was shown to improve outcomes in patients with hypertension, asthma, chronic obstructive pulmonary disease, multiple sclerosis, inflammatory bowel disease and other chronic conditions [8-9]. In this study we seek to establish feasibility of this system in supporting physical telerehabilitation in older

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adults after hip fracture. The aims of the project are: (1) to assess impact of home-based telerehabilitation of community dwelling older adults in post-acute phase of recovery after hip fracture on mobility, psycho-behavioral factors, quality of life, and satisfaction with care; (2) to estimate acceptance of the telerehabilitation system and adherence to the exercise program.

1. Methods

1.1. Design of the Hip Hat System

We used an existing Home Automated Telemanagement (HAT) system [3-5] as a prototype for development of a comprehensive telerehabilitation system to support individualized exercise program for the hip fracture patients. The HAT system has been described previously [6-9]. Briefly, it consists of a home unit (HU), HAT server, and a clinician unit. The home unit guides patients at home in following their exercise program in a safe and effective way. Patients report information about their daily exercise regimen using a HU. Immediately thereafter, the HU sends this information through a landline or wireless connection to the HAT information system. The HAT system is able to automatically monitor patient adherence and analyze self-testing results according to the exercise regimen as prescribed by the physical therapist. Patient results could be reviewed by any web-enabled device that can serve as a clinician unit.

In instances of patient's non-adherence the system provides tailored feedback to the patients to motivate them based on their behavioral profile, and notifies the patient's physical therapist / clinician and/or a nurse. The HAT system also empowers patients with self-paced interactive multimedia education on the major aspects of the hip fracture rehabilitation program. This education module could be individualized to each patient's specific needs and is based on the concepts of social cognitive theory. The HU interface was developed in accordance to the recommendations of the User-Centered Design Workshop at the Participatory Design Conference (PDC) [10]. An iterative review of the HAT interface components conformed to the principles of usability testing described by Nielsen [11].

1.2. Evaluation of the Hip HAT system

The study employed quasi-experimental pre/post design. Consecutive community dwelling older adults were enrolled into the study from orthopedic clinics and physical therapy centers during post-acute phase of hip fracture recovery. We made an attempt to ensure that patients' recruitment had a socio- demographic diversity in relation to their social background, gender, ethnicity, and education. Patient's computer skills were surveyed however computer literacy was not prerequisite to the study. Those patients who gave their consent to participate in the study were then contacted by the physical therapist. The physical therapist was responsible for baseline patient evaluation and prescription of an individualized exercise plan. The exercise plan was then uploaded to the patients' HU. The patients were asked to do their exercises once a day according to the exercise plan for 30 days. Data collection was carried out at the baseline and at the exit from the study.

1.3. Instruments description

A 36-item short-form (SF-36) was used to survey health status [12]. Center for Epidemiologic Studies Depression Scale (CES-D) [13] was used to assess general psychological impairment, primarily depression. The lower extremity functional scale (LEFS) was used to evaluate the functional impairment [14].

Yale Physical Activity Survey (YPAS) was an interviewer-administered questionnaire [15] to assess different types of activities. Client Satisfaction Questionnaire (CSQ-8) was used to assess clients' satisfaction with services [15]. The Mini Mental State Examination (MMSE) was used for assessing cognitive mental status [16]. Exercise self-efficacy [15] was used to reflect how confident a subject was to exercise. Modified Barthel Index [16] was aimed to establish degree of independence. Adherence to the exercise regimen was assessed using real-time exercise logs. Acceptance and feasibility of the telerehabilitation system was assessed by an attitudinal survey used in previous studies [4-9].

2. Results

Overall, 14 patients with confirmed diagnosis of the hip fracture were recruited to test the telerehabilitation system at their homes. One patient withdrew from the study and three patients moved out of town. The remaining 10 patients completed the thirty-day follow-up. The final analysis was based on comparison of results from these 10 patients before and after they used the telerehabilitation system at home.

The average age of the subjects was 77 ± 9 years old ranging from 65 to 88 years. Majority of the subjects were white (90%) females (60%) with average education of 11 ± 4 years. Most of the subjects (70%) considered their hip fracture surgery to be either a moderate or a severe problem; 60% of the subjects perceived their hip fracture to be somewhat healed. More than half of the patients (50%) never had any computer experience in their lifetime; 30% of the subjects claimed they had very limited knowledge about their hip fracture surgery. Majority of the subjects (82%) had the main source of information about the hip surgery from their medical personnel followed by brochures (73%). The average number of days since the enrolled patients had the hip fracture surgery was 159 ± 143 .

The telerehabilitation system was successfully used by the hip fracture patients at their homes regardless of their socio-economic or computer literacy background. The system provided automatic capture of patient self-reported exercise diary allowing physical therapist (PT) remotely evaluate their progress with exercise plan and then accordingly adjust their exercise plans when necessary. Patients were able to review their exercises and receive the interpretation and feedback on their progress by PT. Patients also received information about hip fracture rehabilitation from the education modules implemented in the form of FAQ (frequently asked questions). During the telecommunication sessions, patients received tailored messages aimed to enhance their adherence to individualized exercise plan and improve their self-efficacy. The HAT system also generated automatic reminders to the patients about their program. The patient settings were individualized and were adjusted by PT at the HAT website based on patient performance. Patient progress reports were sent to their respective providers. Whenever the exercise plan was modified by the physical therapist, the new plan was automatically downloaded to the Home Unit. The HAT system generated alerts in

response to the patient non-adherence to the exercise plan. Alerts were checked by PT case manager on a daily basis. The patients for whom the alerts were generated were contacted by PT by phone to address their issues.

The impact of hip fracture telerehabilitation on socio-behavioral factors, patient satisfaction and quality of life are presented in Table 1. Assessment of mobility before and after the program is given in the Table 2. Patient adherence to exercise regimen during the 30-day telerehabilitation program is presented in the Table 3.

Variables	Pre	Post	T-statistics	p-value
Depression (CES-D)	9 ± 10	8 ± 9	-0.80	0.45
Mini Mental Status Examination (MMSE)	27 ± 2	28 ± 2	1.12	0.29
Exercise Self-Efficacy	6 ± 3	9 ± 1	3.16	0.01
SF-36 (Health Related Quality of Life)				
Physical Functioning	38 ± 27	71 ± 31	3.48	0.009
Role limitations due to physical health problems	6 ± 10	17 ± 12	2.03	0.05
Role limitations due to emotional problems	22 ± 6	23 ± 6	0.43	0.68
Vitality	64 ± 20	74 ± 25	1.58	0.15
Mental Health	83 ± 15	88 ± 12	0.93	0.38
Social Functioning	54 ± 31	85 ± 28	3.27	0.01
General health	78 ± 18	86 ± 18	1.60	0.15
Health Transition	47 ± 40	22 ± 18	-2.12	0.05
Modified Barthel Index	95 ± 6	99 ± 2	1.87	0.10
Lower Extremity Functional Scale (LEFS)	55 ± 16	63 ± 13	2.58	0.03
Client Satisfaction Questionnaire-8 (CSQ-8)	27 ± 4	$31\pm\ 0.46$	2.47	0.04

Table 1. Study outcomes at the baseline (pre) and at the end of 30-day telerehabilitation (post)

Table 2.	Yale Physical	Activity	Survey	results after	30-day	telerehabilitaion
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Parameter	Pre	Post	T-Statistics	p-value
Activities Checklist				
Energy Expenditure from YPAS (kcal/d)	80 ± 45	92 ± 52	0.73	0.5
Total Time (hours/wk)	24 ± 14	31 ± 14	2.49	0.04

Table 3. Adherence to the Telerehabilitation over a 30-day program

Parameters	Average Frequency Adherence (%)
Adherence to Exercises per Day over a 30 day monitoring	89
Adherence to Sessions per day over a 30 day monitoring	88
Adherence to Exercises per session per day over a 30 day monitoring	87
Adherence to number of Sets per exercise per day over a 30 day monitoring	97
Adherence to number of repetitions per set per exercise per session per day over a 30 day monitoring	91

3. Discussion

The purpose of this study was to assess impact and the patient's acceptance of hip fracture telerehabilitation. We found that this intervention protocol targeting individualized impairments was feasible, safe and effective for use in home-based rehabilitation of older adults after hip fracture. The physical therapists were able to document the changes in the exercise regimen of these patients on a timely basis. It was also noted that they identified and intervened on a broader range of impairments than as compared to their regular practice. Adherence to the exercise regimen was excellent.

In addition to high adherence to the exercise regimen, there was a significant improvement in the functional outcomes including the lower extremity functional scale. This result is similar to other studies [17]. There is strong evidence that high intensity training is effective in increasing force production in elderly people [17]. A recent systematic review of progressive resistive training in elderly people has shown a strong positive effect on leg extensor muscle force with moderate to high intensity training [18].

There was improvement in the SF-36 quality of life domains including the physical function, role limitations due to the physical health problems, social functioning and health transition. The limitation of the study was a relatively small sample size and a short duration of follow-up. A study with longer duration of follow-up and with larger sample size needs to be done to measure hip fracture recovery outcomes including functional and psychological parameters as well as the subjects' adherence to the exercise regimen with the assistance of the telerehabilitation system.

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