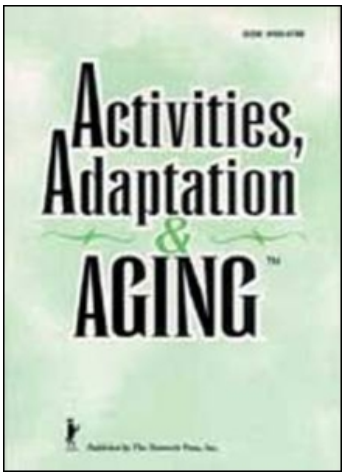

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Videoconference-Based Physiotherapy and Tele-Assessment for Homebound Older Adults: A Pilot Study

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Videoconference-Based Physiotherapy and Tele-Assessment for Homebound Older Adults: A Pilot Study

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Tele-rehabilitation may be one alternative for addressing the growing demand for rehabilitation among older adults because it may offer quality home-based care and promote autonomy among older adults. This pilot study assessed the effectiveness of videoconference-based physiotherapy to improve strength and range of motion in the old-old elderly, using a previously validated Videoconference Goniometer®. Seventeen homebound older adults (mean age 82.4, ±7.2) participated in a 10-week exercise program. Strength and range of motion were assessed at baseline and after 10 weeks. Significant improvements were found in measures of strength and range of motion following the 10-week program. This study demonstrates the feasibility of delivering and monitoring videoconference-based physiotherapy with this population of homebound older adults.

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As the older adult population grows, the prevalence of chronic diseases and incapacitation rises and only 40% of seniors age 65 and older are completely autonomous (Harwood, Prince, Mann, & Ebrahim, 1998). Effective and cost-efficient methods are required for maintaining health and monitoring and providing care to individuals who have a chronic disease, live in remote areas, prefer home-based care, or experience a loss of their independence. Telemedicine may address issues of accessibility and cost and may also be a potential solution for the increased need for home health services. *Telemedicine* is the use of telecommunications for medical diagnosis and patient care (Scannell, Perednia, & Kissman, 1995). It involves the use of telecommunications technology as a medium for providing information and medical services to patients at sites that are at a distance from the provider (Perednia & Allen, 1995; Scannell et al., 1995). Telemedicine has been implemented into health care services in many forms including consultations, transmissions of electrocardiograms and radiological images, provision of emergency expertise, remote fetal monitoring, and education for health care professionals (Currell, Urquhart, Wainwright, & Lewis, 2000). It is one potential solution for health servicing when face-to-face care is not possible.

Systematic reviews of telemedicine assessments have examined the feasibility of telemedicine interventions to provide patient care (Currell et al., 2000; Hailey, Ohinmaa, & Roine, 2004; Jones & Brennan, 2002). These reviews reported no significant difference in outcome of care between telemedicine and face-to-face interventions, suggesting that telemedicine may be an equivalent alternative to face-to-face interventions. Telemedicine interventions were also shown to be less costly than face-to-face interventions. Furthermore, the acceptability of such interventions was high among both health care providers and patients. There are a range of methodological weaknesses in the existing literature, which limit generalization. First, most of the reviewed studies were limited by their small sample size and generally examined short-term outcomes. Furthermore, most studies relied on volunteer participation, which may bias outcomes; self-selection sampling may not represent the experiences of people with a lack of experience with or a marked aversion to new technology. This may be particularly the case for older adults in rehabilitation.

The demand for rehabilitation services is growing steadily among the older adult population (Brandt & Pope, 1997; Piron, Tonin, Trivello, Battistin, & Dam, 2004). Considering this growing need for rehabilitation, tele-rehabilitation may be an important method by which to provide care. *Tele-rehabilitation* is the application of telecommunication technologies to provide distance support, assessment, and intervention to individuals with disabilities (Ricker et al., 2002). It is one strategy by which to impact the health and functional capacity of the aging population, and may be particularly valuable for alleviating the difficulties of older adults who live in rural areas, or who have functional

limitations that prevent them from accessing health care and rehabilitation services (Schopp, Johnstone, & Merrell, 2000).

Tele-rehabilitation appears to be an effective method by which to deliver therapy, and many studies demonstrate positive outcomes in terms of improving physical functioning (Burdea, Popescu, Hentz, & Colbert, 2000; Lai, Woo, Hui, & Chan, 2004; Piron et al., 2004; Reinkensmeyer, Member IEEE, Pang, Nessler, & Painter, 2002; Russell, Buttrum, Wootton, & Jull, 2003, 2004; Sveistrup et al., 2003); with no significant differences found between face-to-face and tele-rehabilitation interventions (Guilfoyle et al., 2003; Russell et al., 2003, 2004; Sveistrup et al., 2003). As with telemedicine interventions in general, tele-rehabilitation was well received by both patients and caregivers (Lai et al., 2004; Reinkensmeyer et al., 2002; Russell et al., 2003, 2004; Sveistrup et al., 2003), and was easy to use even among patients with low computer literacy (Russell et al., 2003, 2004).

While these reviews revealed that the effects of tele-rehabilitation among older adults were positive, it is noteworthy that the participants of these studies were generally young-old. According to the literature, older adults between age 65 and 74 are classified as young-old, while those between age 75 and 85 are classified as old-old (Volkert, Kreuel, Heseker, & Stehle, 2004). In speculating on the effectiveness of tele-rehabilitation among older adults, possible functional differences between young-old and old-old adults may prevent generalizations from the existing literature because functional limitations may be less severe among the young-old. Additionally, the level of comfort of young-old elderly (Wong, Hui, & Woo, 2005) in working with technology may be greater than that of old-old elderly. Therefore, it is possible that the effectiveness of tele-rehabilitation may differ for participants based on their age group. The purpose of this pilot study was to examine the potential of a videoconference-based physiotherapy intervention to improve strength and range of motion (ROM) in a group of homebound older adults classified as old-old.

METHODS

Subjects

Thirty-three adults were invited to participate in a 10-week videoconference-based exercise program performed in three community settings in a point-to-point (center-to-center) videoconferencing connection. Two long-term care institutions, The Perley & Rideau Veteran's Health Center (P&RVHC) and Centre d'accueil Champlain (CAC), and one private seniors' residence on Walkley Road (WR) in Ontario, Canada, joined the exercise program. Participants were recruited through presentation demonstrations in their respective institutions.

Exercise Intervention

The program was designed by a local physiotherapy center and conducted via videoconferencing using a point-to-point (center-to-center) videoconferencing connection. The point-to-point videoconferencing connection was utilized rather than a multipoint one in which three centers participate simultaneously. Preliminary testing indicated that multipoint videoconferencing sessions yield a poor display of large groups, thus limiting opportunities to interact with and monitor participants. Participants at P&RVHC participated in two sessions per week and those at facilities CAC and WR participated in one session per week. In addition to the videoconferencing sessions, participants at P&RVHC participated in one face-to-face session each week, which was already being provided within an existing physiotherapy program. Each session lasted 60 minutes and included approximately 35 minutes of activity. The program, which was delivered by a kinesiologist from a remote location, consisted of a chair-seated warm-up (e.g., shoulder abduction and flexion; neck flexion, rotation, and side flexion), strengthening exercises (3 sets of 10 repetitions with 1–5 pound weights including, for example, shoulder flexion and knee extension), and a cooldown.

Student volunteers assisted the participants into a common room within each location where the videoconferencing equipment was set up. The volunteers (named "intergenerational coordinators") also stayed to provide any assistance during each session. Participants at facilities CAC and WR were positioned so that they could view the television screen on which the kinesiologist from facility P&RVHC was displayed while delivering the exercise program. A video camera was positioned primarily on the kinesiologist, and these images were transmitted via videoconferencing to CAC and WR where participants similarly gathered in a common room and participated in the exercise program. A second camera was set up to capture and transmit images of the participants from CAC and WR to the kinesiologist, who could view these on a large television screen.

Assessment Procedures

Outcome assessments for ROM and strength were conducted at baseline and after 10 weeks using the Videoconference Goniometer® (VG). The VG measures ROM via videoconferencing, thereby enabling assessments to be conducted from a remote location. Previous studies indicate that the VG used in this study is a valid and reliable tool for measuring shoulder and knee ROM (Bernard, Fruhwirth, Meunier-Norman & Grabowski, 2005; Charlebois et al., 2000; Meunier-Norman & Létourneau, 2001). It has satisfactory intra- and inter-tester reliability, and is interchangeable with the Universal Goniometer (UG) while offering some additional features, such as a centralized library of historical assessments for each investigator and patient. The VG consists of

a personal computer, a videoconference hardware codec, a video camera with an integrated microphone, a software application, and interface designs of two modes: (a) a hospital mode with VG at the workstation and (b) a patient mode, which is more user-friendly for participants. The hospital mode includes a health worker–operated computer workstation, which is used for goniometric analysis of still images captured during live interaction with a remote videoconference station. The patient mode is located in the subject's residence and is equipped with a computer attached to a television and an easy-to-use track ball, which is specifically designed for seniors with arthritis. Videoconference Goniometer® measurements are performed automatically once the participant's landmarks are identified onscreen. Snapshots and measurements are stored and secured in the hospital mode and are not accessible to the participants' network.

While the program included exercises using both the upper and lower limbs, only the upper body motion was assessed because of limited human resources. Outcome measurements for ROM included right and left arm flexion, right and left arm abduction, and for strength, number of repetitions of right and left arm dumbbell lifts. Measurements were taken by positioning participants at a standard distance from the camera where they were instructed to raise one arm at a time, keeping it as high and as straight as possible, and ensure that no other parts of their body were lifted. Joint angle was measured from the midaxilla to the greater trochanter of the femur to the raised arm. Each measurement was taken three times and the images were saved to a file on the computer for future VG analysis. Once the patient's landmarks were identified either by a physiotherapist or a technician, the VG automatically measured the range of motion remotely. Descriptive statistics (means and standard deviations) were calculated for both assessment points, and differences in outcome were assessed using paired *t* tests.

RESULTS

Thirty-three old-old adults were recruited for the study. Eleven participants dropped out of the study for various reasons including advanced dementia, physical injury, illness, noncompliance, and technical difficulties. Twenty-two homebound older adults (mean age = 81, ± 7) completed both baseline and postprogram assessments. All participants reported having at least one chronic disease. The most common chronic diseases were osteoarthritis, cardiovascular diseases, hemiplegia, Parkinson's, diabetes, and early Alzheimer's (advanced dementias were part of secondary exclusions). Two participants at CAC had recently suffered a stroke and hemiplegia. Among the 22 participants, 17 (8 male, 9 female) underwent assessments of range of motion at baseline and at the end of the project.

Five of 22 participants did not complete at least one evaluation for various reasons. The primary reason was absence from the program or illness on the scheduled assessment day. For the 17 older adults who complied with both baseline and final VG assessments, 12 were from P&RVHC, 2 were from CAC, and 3 were from WR. Mean attendance for participants at P&RVHC was 17.2 sessions out of 30 (57%), with lowest attendance to the additional face-to-face session. Participants at CAC and WR attended all of the videoconferencing sessions. Only the 17 completers were included in the analysis, which is a recognized limitation. Results are presented in Table 1.

Significant improvements in measures of both ROM and strength were observed in the entire sample. Participants displayed improved right and left arm abduction (ROM) and increased number of dumbbell lifts (strength) with both right and left arms. The improvements in arm flexion did not reach significance. When analyzed by site, the smaller sample size limits significance, however, mean improvements were observed in every motion, with left and right arm abduction presenting the greatest improvement at every site.

TABLE 1 Pre- and Postintervention Scores Using the Videoconference Goniometer®

	Preintervention	Postintervention	Difference
Perley and Rideau Veteran's Health Center (n = 12)			
Right arm flexion	110.1 (±30.7)	115.6 (±18.7)	+5.5 (±19.4)
Left arm flexion	88.3 (±37.9)	100.0 (±38.6)	+11.7 (±33.5)
Right arm abduction	101.8 (±35.8)	125.9 (±39.0)	+24.2 (±25.9)**
Left arm abduction	90.9 (±44.6)	123.0 (±42.5)	+32.1 (±40.7)*
Right arm dumbbell lifts	32.6 (±25.0)	62.8 (±54.5)	+30.1 (±43.8)*
Left arm dumbbell lifts	31.7 (±26.6)	66.5 (±64.5)	+34.7 (±44.9)*
Centre d'accueil Champlain & Walkley Road (n = 5)			
Right arm flexion	115.8 (±29.60)	131.8 (±16.20)	+16.0 (±5.76)*
Left arm flexion	129.6 (±17.10)	138.0 (±15.00)	+8.4 (±2.00)
Right arm abduction	84.2 (±71.00)	130.8 (±40.00)	+46.6 (±42.42)
Left arm abduction	97.6 (±71.88)	141.8 (±36.12)	+44.2 (±35.76)
Right arm dumbbell lifts	42.4 (±21.10)	57.0 (±43.50)	+14.6 (±27.20)
Left arm dumbbell lifts	56.0 (±25.30)	68.8 (±40.70)	+12.8 (±26.80)
All participants combined (n = 17)			
Right arm flexion	111.8 (±29.6)	120.4 (±24.7)	+8.6
Left arm flexion	100.5 (±37.9)	111.2 (±37.4)	+10.7
Right arm abduction	96.6 (±51.6)	127.4 (±38.2)	+30.8**
Left arm abduction	92.9 (±51.7)	128.5 (±40.6)	+35.6**
Right arm dumbbell lifts	35.7 (±23.6)	61.0 (±50.0)	+25.3*
Left arm dumbbell lifts	39.3 (±28.0)	67.2 (±56.7)	+27.9*

*$p < 0.05$.

**$p < 0.01$.

Note: Flexion and abduction measured as range of motion (degrees). Dumbbell lifts denote number of repetitions.

The CAC and WR groups presented the largest variability in VG results. Notably, this group of participants included two individuals who had no functional limitation at baseline, and three who had severe functional limitations that were the result of a recent stroke and hemiplegia. Participants in the latter group (ages 72, 75, and 83) recovered arm mobility during the trial. One patient had such functional limitation at baseline that it prevented her from accessing her closet. She participated in the tele-physiotherapy program and avoided institutionalization and steadily improved her ability to engage in these activities of daily living.

Overall, participants reported favorable outcomes as a result of the tele-physiotherapy program. The significant improvements in ROM and strength indicated by arm abduction and dumbbell lifts suggest some potential for improved functional performance, particularly with tasks that involve reaching and lifting. Further, the physiotherapy program was rated very favorably by all of the participants (mean 9.1, ± 2.4, on a scale of 0–10).

DISCUSSION

As far as we are aware, this is the first study to evaluate a physiotherapy-based, tele-rehabilitation program among a sample of old-old adults. Our results confirm that improvements in strength and range of motion are feasible in this population when the physiotherapy intervention is largely delivered via videoconferencing. There was less convincing evidence regarding changes in flexion, although the reasons for this are not clear. A possible factor is the predominance of abduction exercises carried out in the program over fewer arm flexion exercises. Overall, the pilot study provides preliminary support for videoconference-based physiotherapy. Furthermore, the weekly tele-physiotherapy sessions have continued and have become a highly anticipated social event at CAC and WR. Yet caution is required in interpreting the results given the pilot nature of the study and several important limitations.

Participants in this study were volunteers recruited through information sessions and their numbers showed significant attrition at the recruitment phase. Interestingly, no dropout occurred during the program at the CAC and WR centers. Because multipoint videoconferencing sessions were not ideal for large groups, the interventions were not standardized across the three sites. Participants at P&RVHC were offered more sessions of videoconference-based physiotherapy (two weekly sessions versus one weekly session at CAC and WR), and also one additional face-to-face session per week. The overall attendance was 1.7 sessions per week at P&RVHC, and 1 session per week at the CAC and WR centers. Improvements in outcome measures were likely moderated by these differences. A dose-response relationship

between outcome and number of sessions (from one to three weekly sessions) would still require investigation in old-old adults.

A more rigorous evaluation randomizing a standardized intervention to a control (face-to-face care) group is now required. Identifying the optimal dose of intervention in terms of required sessions and the possible combination of videoconferencing and face-to-face contact would be an important step. Concerns have been expressed that tele-rehabilitation may prevent direct professional contact and interfere with recovery (Piron et al., 2004). Our observation is that tele-rehabilitation is efficient, as measured by the Videoconference Goniometer®, and that it triggers the request for additional face-to-face sessions. We speculate that a combination would be optimal.

Overall, this study complements previous research regarding tele-rehabilitation (Demeris, Shigaki, & Schopp, 2005) by suggesting that it is also a feasible strategy for delivering rehabilitation to adults in an old-old age group. This study suggests that age is no longer a limiting factor for the adoption of videoconference-based rehabilitation and remote assessments in a home setting. With the growing need for affordable and innovative ways of delivering therapy to older adults who are homebound, tele-rehabilitation appears to be an acceptable mode of delivery in potentially delaying the need for institutionalized care and assisting older adults to remain independent as they age. Further research is required before wide implementation of this mode of rehabilitation.

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