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A Comparison of TeleVideo and Traditional In-Home Rehabilitation in Mobility Impaired Older Adults

Sanford, J.A., Hoenig, H., Griffiths, P., Butterfi

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A Comparison of Televideo and Traditional In-Home Rehabilitation in Mobility Impaired Older Adults

Jon A. Sanford, M. Arch
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ABSTRACT. This paper reports on a randomized controlled trial to evaluate the effectiveness of using interactive video conferencing technology to diagnose problems, prescribe interventions, and implement solutions for six mobility and transfer tasks in comparison with traditional home visits. Thirty-two community-dwelling adults with new
mobility devices were randomized into either traditional in-home (n = 16) or telerehab (n = 16) intervention group. Each group received weekly, one-hour therapy sessions for four consecutive weeks. There were no significant differences in the number of problems identified, recommendations made, or number of recommendations implemented for five of the six tasks. The only task for which there were significant differences, moving from room to room, is likely attributable to the nature of the protocol which did not accommodate an inherent limitation in the technology, rather than a fatal flaw in the technology itself.

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KEYWORDS. Assistive technology, home modification, in-home rehabilitation, occupational therapy, physical therapy, telerehabilitation

BACKGROUND

Over the past several decades, in-home care has assumed an increasingly important role in the provision of many primary care services. In-home rehabilitation resources, although fairly limited (Garber et al., 1991; Pope & Tarlov, 1991), are generally successful at preventing or reversing ADL impairment and decline (Leveille et al., 1998; Phelan et al., 2004) as well as facilitating recovery of ADL functioning and locomotion (Gill et al., 2002; Stuck et al., 2002). Besides, rehabilitation patients typically receive outpatient therapy in facilities far from both their homes and the therapists who provided inpatient treatment. Unfortunately, environmental barriers and mobility impairments predict lower odds of any medical visit and fewer total visits to outpatient facilities (Hoenig et al., 2003). As a result, many people with a mobility limitation do not receive follow-up therapy because travel is often too far, too difficult, too expensive, or not possible (Pope & Tarlov, 1991).

Travel time and distance also pose significant challenges to provision of in-home rehabilitation services. Local specialists capable of providing in-home care may be scarce, particularly in rural areas, and the cost associated with practitioners traveling long distances typically restricts the provision of in-home services to relatively small geographic areas. When in-home rehabilitation is provided, the continuity of care is often
compromised because the therapist providing care is seldom the same individual who provided inpatient services.

New tele-technologies offer the opportunity to provide in-home rehabilitation from a remote location. Yet, while tele-technologies have the potential to overcome many of the obstacles inherent in providing on-site in-home rehabilitation, the efficacy of these technologies has not been fully investigated for this application. Moreover, few telehealth applications have investigated the use of real time, interactive communication between the patient and health care provider that is characteristic of rehabilitation therapy.

Most applications have used Internet-based store-and-forward (S&F) technologies to share visual information such as digital images and video recordings. S&F technologies are independent of time and place. They work by temporarily storing data that has been received and then forwarding it on demand to the recipient (e.g., e-mail). S&F methods have been widely used to monitor and evaluate health conditions and physiological status, such as transmission of ultrasound testing for high-risk pregnancies (Dawson et al., 1999); monitoring of congestive heart failure and electrocardiogram data (Mehra et al., 2000); review of radiology tests (Malone et al., 1998); and adherence with medication (Hunkeler et al., 2000). Even in instances where interactive technologies have been used, such as in dermatology consultations (Loane et al., 2000), neurological assessments (Craig et al., 2000), and eye assessments (Tuulonen et al., 1999), store-and-forward technologies might have been clinically adequate, if less personal, to provide the necessary results.

In contrast, the provision of most rehabilitation interventions depends on real time, two-way observation, communication, and interaction between the therapist and the patient. Such real-time interaction permits observation of patients’ functional performance and their immediate response to therapeutic recommendations. Typically, therapists test their clinical reasoning and therapeutic plan on an iterative basis, where the immediate results of the action and/or the patient’s reaction guides and informs the therapist’s subsequent response (Fleming, 1991).

Providing rehabilitation interventions through personal observation, interaction, and improvisation is perceived as the only reliable way to understand the complex person-environment interactions that characterize activities of daily living (ADL) and personal task performance and to develop ecologically based, individualized interventions (Morris et al., 1999; Resnick & Nigg, 2003). Observation of performance enables the therapist to break an activity down into its task components
(e.g., approaching the tub, turning on the water, getting into the tub, etc.) and to prescribe rehabilitation interventions accordingly (Bean et al., 2002). Reciprocal interaction between the therapist and patient provides the integral opportunity for immediate feedback on task performance and positive reinforcement of appropriate task-related behaviors.

In addition, many interactive telehealth applications require high-quality video images, which necessitate a high-resolution, integrated services digital network (ISDN) communications technology, set up in a centralized location. Such technology is neither cost-effective nor necessary for in-home rehabilitation, where access to patients in their own environments is more important and low resolution images of activity performance using POTS (plain old telephone system) based video teleconferencing equipment is sufficient. Low bandwidth video teleconferencing equipment has only been reported in a few telerehabilitation applications to assess or improve task performance in ADLs (Dreyer et al., 2001; Hoenig et al., 2006; Nakamura et al., 1999; Sanford et al., 2004; Sanford & Butterfield, 2005).

 Nonetheless, these studies suggest that relatively inexpensive POTS-based video teleconferencing technology, which permits real-time, two-way voice and video interaction between the provider and the patient, has the potential to reduce the need for providers to travel to the home, maintains the continuity of care and permits didactic communication between the therapist and the patient. This paper reports the results of a randomized-controlled trial that evaluated the effectiveness of remote interactive video teleconferencing technology to diagnose problems, prescribe interventions, and implement solutions aimed at improving mobility and transfer ability of older adults in their homes in comparison with traditional in-home therapy.

**METHODS**

**Experimental Design.** The findings reported in this paper represent a subset of data extracted from a four-year, multi-site randomized clinical trial of in-home and telerehabilitation interventions for new mobility device users conducted in a VA hospital in North Carolina and a private rehabilitation hospital in Georgia. Patients enrolled in the study were randomized to either a usual care or one of the two intervention groups. The usual care group (UCG) received no therapy as part of the study. All subjects in the intervention groups (IG) received the same four-week, one-hour therapy intervention to improve performance in six mobility
and transfer tasks. Intervention Group 1 received therapy through an in-home visit (In-Home Group), whereas intervention Group 2 received the intervention via a remote telerehabilitation visit (Tele Group). All protocols were approved by the IRB at each collaborating site.

Study Sample. The sample comprised community-dwelling older adults with a prescription for a new mobility aid (i.e., walkers and wheelchairs) and who had not used the same type of mobility aid for more than one month in the preceding year. Eligibility was contingent upon permission granted by each prospective subject’s primary care physician or the physician prescribing the new mobility aid. Further eligibility criteria included: geographic proximity to the medical center (approximately one-hour driving time for home visits and data collection), sufficient cognitive ability to follow directions and complete self-report items (Short Portable Mental Status Score greater than six out of ten), and life expectancy of greater than the six-month duration of participation in the study.

Intervention. Patients in the two intervention groups received one-hour therapy sessions for four consecutive weeks. The therapy targeted both the underlying organ system impairment via exercise interventions as well as the home environment through selected strategies that compensated for extant disability. Based on the nature and number of problems identified during the baseline in-home or televideo visit, individualized “adaptive prescriptions” were scripted for each subject and included adaptive strategies/methods and assistive technologies designed to increase functional abilities as well as home modifications chosen to reduce environmental demands. The exercises and recommendations were similar to contemporary PT/OT practices for home health care patients with non-specific functional decline and/or impaired mobility. The interventions focused on six ADLs—three mobility tasks and three transfer tasks.

The first therapy session for both groups was used to assess general level of transfer and mobility skills. Performance based on a single chair rise and a side-by-side stance was used to classify subjects into one of four mutually exclusive skill levels (i.e., unable to sit, able to sit but unable to stand, able to stand but unable to walk, able to walk), which, in turn, determined the recommendations for exercises and adaptive techniques and technology. Over the course of the first three therapy sessions, patients were also asked to perform six standardized mobility and transfer tasks using their “usual and customary methods.” Performance was viewed live by the therapists either in the home or via video teleconference. Based on the patient’s task performance, individualized
treatment plans were developed that made recommendations for assis-
tive technologies and equipment, home modifications, and adaptive strategies. These recommendations were implemented each week of the four-week intervention.

Equipment. The mobile, wireless televideo system used in this study consisted of "off-the-shelf" technology that used POTS lines to transmit real-time, two-way audio and video between the patient's home and the therapist in a clinic. The basic system that enabled a remote camera to move freely throughout the house was developed for a previous study (Sanford et al., 2004; Sanford & Butterfield, 2005). Direct patient-provider interaction was not required in the prior project. To accommodate this need for the current study, the equipment was adapted to permit this interaction through a wireless four-inch flat-screen monitor that could be held by the patient or mounted on his/her walker or wheelchair.

Variables. All data were collected by trained research staff. Subject characteristics (socio-demographic information, self-reported physical functioning, self-efficacy, and health status) were obtained via telephone interviews after each telerchab or in-home visit made by the therapists. In addition, key variables reported in this paper included: (1) problems identified by the therapist, (2) recommendations made by the therapists, and (3) implementations made by the patient. Data on problems and recommendations were recorded by the therapist at the time of each therapy session. In addition, implementation of recommendations from a previous session was recorded during each subsequent session.

Data Analysis. Primary data collected at each site were entered into the Statistical Package for Social Sciences (SPSS) for analyses and verified by inspection, cleaning, and double entry of approximately 10% of the data. Univariate descriptive statistics were computed to describe the groups at baseline and at the six-week follow-up. The chi-square test was used to determine the significance of differences for categorical variables, and the analysis of variance (ANOVA) $F$-test was used for continuous variables. Descriptive statistics were used to compare the two groups at baseline and at the post-intervention follow-up at Week Six. Chi-square tests were used for categorical data and independent $t$-tests for continuous data.

RESULTS

Findings reported in this paper are limited to the practicality of using tele-technologies as means of providing in-home rehabilitation. More
detailed descriptions of methods and self-reported intervention outcomes are currently in press elsewhere. Changes in performance outcomes, pre- and post-intervention, are in the process of being analyzed.

Sample Description. A total of 689 patients in both hospitals were referred to the study for eligibility. Of the referrals, 178 were eligible and consent was obtained from 86 (48% of those eligible). Reasons for ineligibility included geographic location greater than one hour from the hospital (52%), health status (18%), hospitalization or institutionalization rather than discharge to the community (12%), unable to contact (12%), and other personal considerations (6%). Sixty-seven of the 82 randomized subjects (four consented subjects were not randomized) completed all four interventions (17 in each of the two intervention groups and 33 in the UCG). Of these, 65 subjects completed the week six follow-up data collection.

The sample (see Table 1) reflects the veteran population from which the vast majority of subjects (90%) were drawn. Approximately 84% of the participants were male. The average age was 62 years (ranging from 42 to 86 years). Half of the sample (50%) were Caucasian, 45% were African American, 2% Hispanic, and 2% American Indian. Over 75% reported having at least a high school diploma and 87% reported living with at least one other person. All of the subjects were able to walk independently or with assistance some of the time and the majority in both groups were using walkers. Sixty-four percent of the sample used more than one mobility aid at week one, while 51% were still using more than one aid at Week Six.

Importantly, there were no significant differences in self-reported task difficulty or dependence on another person for help with the transfer and mobility tasks between the two intervention groups. At baseline, no subjects were totally independent and all reported some difficulty in some of the tasks. On average, all subjects needed help from another person with at least one out of the six tasks (range = 0-6) and reported experiencing difficulty in performance for three tasks (range = 0-6). Finally, there were no significant differences in average dependency or difficulty as a function of time or group (F = .458, P = .501).

Problems Identified. Across the six tasks, 279 (mean = 17.4 per subject, SD = +11.4) and 193 (mean = 12.4 per subject, SD = +9.9) problems were identified in the Trad and Tele Groups, respectively (see Table 2). All subjects had at least one problem related to an environmental barrier (e.g., irregular floor surface, poor lighting, inadequate floor space, and lack of support devices) or a personal limitation (e.g., poor strength, stamina, or transfer technique). About 72% of the total
### TABLE 1. Subject Characteristics at Baseline

<table>
<thead>
<tr>
<th></th>
<th>UCG (n = 33)</th>
<th>IG (n = 32)</th>
<th>(p^+)</th>
<th>Tele (n = 16)</th>
<th>Trad (n = 16)</th>
<th>(p^{++})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>62.67 ± 16.34</td>
<td>6.181 ± 12.91</td>
<td>.817</td>
<td>57.81 ± 11.72</td>
<td>66.07 ± 13.15</td>
<td>.076</td>
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<tr>
<td>Male sex (%)</td>
<td>83.9</td>
<td>84.4</td>
<td>.956</td>
<td>83.9</td>
<td>84.4</td>
<td>.956</td>
</tr>
<tr>
<td>White race (%)</td>
<td>56.3</td>
<td>43.8</td>
<td>.317</td>
<td>56.3</td>
<td>31.3</td>
<td>.154</td>
</tr>
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<td>High school graduate (%)</td>
<td>63.8</td>
<td>80.6</td>
<td>.278</td>
<td>93.3</td>
<td>68.8</td>
<td>.083</td>
</tr>
<tr>
<td>Lives alone (%)</td>
<td>12.5</td>
<td>12.5</td>
<td>1.00</td>
<td>12.5</td>
<td>12.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Income &lt; $15,000 (%)</td>
<td>50.0</td>
<td>44.8</td>
<td>.721</td>
<td>40.0</td>
<td>50.0</td>
<td>.588</td>
</tr>
<tr>
<td>Number of chronic conditions (mean ± SD)</td>
<td>2.91 ± 1.49</td>
<td>3.00 ± 1.24</td>
<td>.790</td>
<td>2.94 ± 1.13</td>
<td>3.06 ± 1.38</td>
<td>.935</td>
</tr>
<tr>
<td>Hospitalized in last 6 months (%)</td>
<td>69.7</td>
<td>71.9</td>
<td>.847</td>
<td>68.8</td>
<td>75.0</td>
<td>.910</td>
</tr>
<tr>
<td>W/Self-Reported depression (%)</td>
<td>45.5</td>
<td>46.9</td>
<td>.909</td>
<td>50.0</td>
<td>43.8</td>
<td>.933</td>
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<tr>
<td>Number of dependent ADLs (mean ± SD)</td>
<td>1.30 ± 1.93</td>
<td>1.31 ± 1.91</td>
<td>.984</td>
<td>1.00 ± 1.63</td>
<td>1.50 ± 2.19</td>
<td>.860</td>
</tr>
<tr>
<td>Number of difficult ADLs (mean ± SD)</td>
<td>3.06 ± 2.32</td>
<td>3.25 ± 2.44</td>
<td>.749</td>
<td>3.56 ± 2.25</td>
<td>2.93 ± 2.64</td>
<td>.797</td>
</tr>
<tr>
<td>Total Difficulty Score (0-12) (mean ± SD)</td>
<td>3.85 ± 3.35</td>
<td>4.43 ± 3.66</td>
<td>.501</td>
<td>4.75 ± 3.39</td>
<td>4.12 ± 3.99</td>
<td>.705</td>
</tr>
<tr>
<td>Type of mobility aid prescribed (%)</td>
<td></td>
<td>.512</td>
<td></td>
<td></td>
<td></td>
<td>.496</td>
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<tr>
<td>Cane</td>
<td>15.2</td>
<td>9.4</td>
<td>6.3</td>
<td>12.5</td>
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<td></td>
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<tr>
<td>Crutches</td>
<td>0</td>
<td>3.1</td>
<td>0</td>
<td>6.3</td>
<td></td>
<td></td>
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<tr>
<td>Walker</td>
<td>66.7</td>
<td>59.4</td>
<td>56.3</td>
<td>62.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheelchair</td>
<td>18.2</td>
<td>28.1</td>
<td>37.5</td>
<td>18.8</td>
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</table>

*Note: \(^a\)UCG = Usual Care Group, \(^b\)IG = Combined Intervention Group, \(^c\)Tele = TeleRehab, \(^d\)Trad = Traditional In-Home Group, \(^e\)SD = Standard Deviation, \(p^+\) = Significance level UCG and IG, \(p^{++}\) = Significance level UCG, Tele and IG.*

Problems reported in each group (201/279 problems in the Trad Group and 138/193 problems for the Tele Group), were due to environmental barriers (see Table 2). For the Trad Group, environmental barriers accounted for a mean of 12.6 problems per subject (SD = 8.3), whereas person limitations accounted for a mean of 4.9 problems per subject.
TABLE 2. Comparison of Environmental Barriers, Person Limitations and Total Number of Problems Identified for the Telerehabilitation and In-Home Rehabilitation Intervention Groups

<table>
<thead>
<tr>
<th>Task</th>
<th>Environmental Barriers Mean ± SD</th>
<th>Person Limitations Mean ± SD</th>
<th>Total Number of Problems %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trad (n = 201)</td>
<td>Tele (n = 138)</td>
<td>p</td>
</tr>
<tr>
<td>All Tasks</td>
<td>12.6 ± 8.3</td>
<td>8.6 ± 4.4</td>
<td>.104</td>
</tr>
<tr>
<td><strong>Transfer Tasks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet Transfer</td>
<td>2.3 ± 1.8</td>
<td>1.6 ± 1.4</td>
<td>.191</td>
</tr>
<tr>
<td>Tub Transfer</td>
<td>2.3 ± 1.5</td>
<td>2.8 ± 1.3</td>
<td>.357</td>
</tr>
<tr>
<td>Bed Transfer</td>
<td>1.2 ± 1.8</td>
<td>.75 ± 1.2</td>
<td>.422</td>
</tr>
<tr>
<td><strong>Mobility Tasks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room to Room</td>
<td>2.7 ± 1.8</td>
<td>.81 ± .91</td>
<td>.001</td>
</tr>
<tr>
<td>In/Out of Home</td>
<td>3.1 ± 2.3</td>
<td>2.3 ± 1.7</td>
<td>.263</td>
</tr>
<tr>
<td>Kitchen Mobility</td>
<td>.94 ± 1.3</td>
<td>.44 ± .51</td>
<td>.160</td>
</tr>
</tbody>
</table>
(SD = +4.1). For the Tele Group, environmental barriers accounted for an average of 8.6 problems per subjects (SD = +4.4) and person limitations 3.4 problems per subject (SD = +3.6). There were no significant differences in the number of environmental barriers (p = .104), personal limitations (p = .297), or total number of problems identified (see Table 3) as a function of intervention group (p = .127). Similarly there were no significant differences between the groups by mobility and transfer tasks, with the exception of environmental barriers for moving from room to room (p = .001) and overall problems moving room to room (p = .003). In both instances, a greater number of problems were identified for the in-home group.

Trends showed a greater number of problems identified by the tele-assessment for tub transfers, whereas the traditional in-home assessment identified more problems for the other five tasks. However, two of the mobility tasks (moving from room to room and entering and exiting the home) accounted for largest inter-group differences in means (> 1.2 problems per subject). These two tasks also had the highest mean number of problems for both environmental barriers (> 2.7 problems per subject) and person limitations (> 1.0 problems per subject) in the Trad Group.

Recommendations (Adaptive Prescriptions). A total of 462 recommendations (270 Trad and 192 Tele) were made for the two intervention groups. Recommendations included equipment and assistive technologies (e.g., tub bench, shower seat); home modifications (e.g., rearrange space, grab bars, lever handles); and adaptive strategies (e.g., instructions not to use a towel rack during transfers in and out of the tub, correcting the length of crutches so they fit correctly, and instruction in correct usage of a cane while going up and down the stairs). The Trad Group had an average of 16.9 recommendations (SD = +12.6) across all tasks whereas the Tele Group had an average of 12 recommendations (SD = +7.7). This difference was not statistically significant (p = .196). The average number of recommendations for the Trad Group ranged from a low of 2.1 for getting in and out of bed to a high of 3.4 recommendations for getting on and off the toilet as well as getting in and out of the tub or shower. The average number of recommendations for the Tele Group ranged from a low of 1.3 for getting in and out of bed and for moving from room to room to a high of 3.1 for getting on and off the toilet. Like problem identification, the only significant difference between the two groups were the mean number of recommendations for room to room mobility (p = .005).
TABLE 3. Comparison of Problems Detected, Recommendations Made, and Recommendations Implemented for the Telerehabilitation and In-Home Rehabilitation Intervention Groups

<table>
<thead>
<tr>
<th>Task</th>
<th>Problems' Mean ± SD</th>
<th>Recommendations Mean ± SD</th>
<th>Implementations %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trad (n = 279)</td>
<td>Tele (n = 193)</td>
<td>p</td>
</tr>
<tr>
<td>All Tasks</td>
<td>17.4 ± 11.4</td>
<td>12.1 ± 7.5</td>
<td>.127</td>
</tr>
<tr>
<td><strong>Transfer Tasks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet Transfer</td>
<td>3.0 ± 2.5</td>
<td>2.1 ± 1.4</td>
<td>.233</td>
</tr>
<tr>
<td>Tub Transfer</td>
<td>3.1 ± 1.9</td>
<td>3.4 ± 1.5</td>
<td>.685</td>
</tr>
<tr>
<td>Bed Transfer</td>
<td>1.8 ± 2.0</td>
<td>1.4 ± 1.9</td>
<td>.531</td>
</tr>
<tr>
<td><strong>Mobility Tasks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room to Room</td>
<td>3.8 ± 2.5</td>
<td>1.4 ± 1.5</td>
<td>.003</td>
</tr>
<tr>
<td>In/Out of Home</td>
<td>4.1 ± 2.8</td>
<td>2.9 ± 2.1</td>
<td>.216</td>
</tr>
<tr>
<td>Kitchen Mobility</td>
<td>1.6 ± 1.7</td>
<td>.81 ± .98</td>
<td>.109</td>
</tr>
</tbody>
</table>
Further examination of the recommendations by prescription type (equipment and AT, home modifications, and adaptive strategies) yielded no significant differences between the two intervention groups in the average number of recommendations for equipment and assistive technologies, home modifications, or adaptive strategies. There were trends toward a greater number of recommendations for home modifications Trad Group in four of the mobility and transfer tasks, with two of the four tasks (getting in and out of bed and moving room to room) approaching significance ($p = .055$ and $.052$, respectively).

Implementation of Adaptive Prescriptions. Because implementation of recommendations is dependent on the number of recommendations prescribed, statistically significant group differences were tested as a function of the percentage of recommendations implemented.

At the post-intervention Week Six data point, 57% of the recommendations had been implemented by the subjects (59% and 56% in the Trad and Tele Groups, respectively). Frequency of implementation was fairly high for all interventions, ranging from a low of 36% (getting in and out of the home) to a high 76% (getting in and out of the tub) for the Trad Group. Interestingly, home mobility had the lowest rate of implementation in both groups.

For the Trad Group, 80% of the recommendations for adaptive strategies, 81% for equipment and AT, and 41% for home modifications were implemented. For the Tele Group, 78% of the adaptive strategies were implemented in contrast to 57% for each of the equipment and 43% AT and home modification. The groups did not differ in the average percentage of implementations by equipment and AT ($p = .142$), home modifications ($p = .451$), or adaptive strategies ($p = .306$).

**DISCUSSION**

The intervention protocol resulted in numerous problems being identified and recommendations made for the mobility-impaired patients, both for the telerehabilitation group as well as the in-home rehabilitation group. As we had hoped, we found no significant differences between the two intervention groups for number of problems, recommendations for adaptive prescriptions, or implementation of the recommendations for almost all of the tasks. Mobility throughout the home, where therapists performing the traditional home visit identified significantly more problems and consequently made more recommendations,
was the only task for which this did not hold true. Despite the lack of statistical significance, however, more problems were identified in the Trad Group across all tasks, except for the tub transfer.

While this finding might begin to cast doubt on the efficacy of televideo as an intervention modality, closer examination of the data point more to a limitation in our protocol than a fatal flaw with the equipment. Clearly, the data show that the group differences in problems (and subsequently recommendations) are due to the significantly greater number of environmental barriers ($p = .001$) identified in the traditional home visit. These differences are likely attributable to differences in the amount of environmental information available to therapists conducting each type of intervention. In-home therapists have visual access to the entire home environment. Therapists using televideo, however, only have access to the field of view available through the lens of the video camera. Thus, the wider the angle of the lens, the greater the field of view afforded to the therapist. Unfortunately, with the camera trained and often zoomed-in on a patient and his/her engagement in mobility and transfer tasks, the therapist’s view of the surrounding environment can be limited. This is less likely to pose a problem for tasks that occur within confined or clearly defined spaces, such as the bathroom, the kitchen, and an entrance where the other five mobility and transfer tasks occurred. As a result, we found no significant differences between the two groups for any of the other tasks.

The restricted field of view can have both positive and negative consequences. On the one hand, it focuses the therapist’s attention on the patient, without external distractions of the environment; on the other hand, it limits access to other potential barriers in the environment that may impact task performance. For example, there might be insufficient floor space for a wheelchair to make a 360-degree turn. If the patient did not engage in this maneuver during a therapy session, the lack of space would be less obvious to tele-intervention therapist than to the traditional in-home intervention therapist. Therefore, it is not surprising that teleconferencing is more effective for analyzing predictable sequences of events in well-defined spaces, such as toilet and tub transfers; but is less effective in analyzing mobility tasks that are less predictable and occur in larger, less-defined spaces.

While this problem is inherent in the technology, it is not insurmountable. We were so concerned about focusing our attention on the patient, that we neglected the immediate environment. As a result, the in-home therapist had access to environmental information that the teletherapist did not. While a complete home evaluation, rather than the six
isolated tasks included in the study might overcome the problem, there is no guarantee that every evaluation will cover the entire home.

A wider angle lens could ameliorate this problem, but would tend to distort the view of the patient and lose some of the close up capability needed to provide detail. An alternative solution is to adapt the intervention protocol to use a panning technique to provide the remote therapist with as much detail of the surrounding environment as possible, including the floor and adjacent spaces. This would provide the remote tele-therapist with visual access to the home environment that is more equivalent to what the in-home therapist would experience.

The most surprising finding was the frequency of implementations for both groups at Week Six. Whereas we expected the number of adaptive strategies to be high since they were the main focus of the four-week interventions, we expected home modifications to be low as they typically take more time to implement. We also expected the frequency of equipment/AT to fall somewhere in between adaptive strategies and home modifications since it was being provided by the VA without cost to the subject, but subjects had to accept it and use it. Nonetheless, we found 91% of the Trad Group using the AT, which was 12% more than those who elected to adopt the adaptive strategies. In addition, almost 40% of the Trad Group and more than half of the Tele Group had modified their homes. More surprisingly, the frequency of home modifications in the Tele Group, which was paid for by the subjects themselves, matched that of the equipment and AT, which was provided by the VA. These data are significant as they tell us that people are not only willing to implement the adaptive prescriptions, they are willing to pay for them. Moreover, they are equally willing to implement the prescriptions regardless of whether they are made by an on-site or remote therapist, suggesting that face-to-face contact is not a critical factor in engendering trust between patient and therapist.

Despite the shortcomings of the technology, to the best of our knowledge, none of the 193 problems, 192 recommendations, and 99 implementations made in the 16 Tele Group subjects would have been made without participation in this project. Since usual care for this population involves no in-home therapy at all, even if a few more problems were detected by in-home therapists, the tele-technology provided access to the patient in his or her own home and enabled therapists to observe and assess patients performing tasks in order to make adjustments, change and provide new prescriptions for numerous adaptive methods, modifications, and assistive technologies that otherwise would not have been possible. From a practical standpoint, the technology promotes
continuity of care by enabling therapists that provided inpatient rehabilitation to continue to provide care after patients are discharged to their homes. From a cost standpoint, it can eliminate the cost of travel to provide in-home therapy, although someone would still have to set up and operate the televideo equipment (e.g., local home health providers during routine home visits).

RECOMMENDATIONS

It is also important to understand that tele-technology is a tool to facilitate and maximize the effectiveness of rehabilitation services. It is not intended to replace inpatient, outpatient, or on-site in-home therapy. Rather, it can facilitate continuity of care between the inpatient and outpatient therapists; provide more efficient care by the home health therapist; and enables expert consultation. Tele-technology can also be used to identify and provide more expensive, in-home therapy to patients who need it the most. Televideo could increase efficiency and effectiveness of in-home therapy by helping home health therapists prepare ahead of time so they might direct their attention to the most critical areas when they are in the home. Last, but not least, the video recording enables consultation with experts that may not be readily available to a home health agency (e.g., a rehabilitation architect, rehabilitation engineer, or certified assistive technology provider).

CONCLUSIONS

Clearly, this study demonstrated that televideo can provide information similar to that of a traditional on-site assessment as well as permit therapeutic interventions to be delivered without requiring a therapist to be physically in a client’s home. However, this only demonstrated the technical capability of the televideo. The intervention was provided by our research team and we did not attempt to provide in-home rehabilitation through an established health care delivery system. Moreover, while we can argue that telerehabilitation is less costly and a more efficient use of scarce resources because it will reduce therapist travel time and permit the therapist to see more clients in a day, the study did not reduce travel time or distance because we sent our own (albeit, less-expensive) technician to each home. As a result, we cannot reliably
determine the costs of the intervention on the service delivery system. The next step, which is expected to begin in the Fall 2006, is a multi-site trial in which the tele-technology will be integrated into existing home health service delivery systems. To determine efficacy and cost-effectiveness, community-based home health practitioners will use televideo technology to connect their clients with centrally based project therapists, who will provide the same in-home rehabilitation interventions used in the current study. In addition, the new study should demonstrate the types of clients, health conditions, transfer and mobility tasks, and under which teleconferencing is most effective.

REFERENCES


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