BACKGROUND

Traditional perspectives of aphasia rehabilitation suggest that the most significant language recovery occurs during the first six months following a stroke and minimal language improvements are expected beyond one year (Lendrem & Lincoln, 1985; Sarno & Levita, 1979). However, recent studies challenge the belief that significant language recovery is improbable for patients with chronic aphasia. Studies show that observable gains can be made and maintained in the expressive language abilities of patients with chronic aphasia following intensive constraint induced language therapy (CILT) (Maher et al., 2006; Pulvermüller et al., 2001; Meinzer et al., 2005). Whether constraint or intensity is responsible for such improvement is still under investigation, but evidence increasingly suggests that therapeutic gains are greater with intensive therapy schedules (Basso & Caporali, 2001; Bhogal et al., 2003; Hinckley & Craig, 1998).

Despite the success of CILT in the rehabilitation of individuals with aphasia, there are limitations to the application of this approach and the maintenance of acquired language skills. In CILT treatment studies, improvements were strongly correlated with the intensity of the treatment (Maher et al., 2006; Pulvermüller et al., 2001; Meinzer et al., 2005). Unfortunately, our current health care system limits the provision of intensive treatment for patients with chronic aphasia. Furthermore, access to specialized, intensive treatment is not readily available to most chronically aphasic individuals.

For people living in rural communities, numerous barriers interfere with participation in intensive rehabilitative services. The lack of service providers limits a patient's access to treatment and community-based services. Funding for specialty services and advanced technological supports are restricted in rural communities. Furthermore, transportation to distant facilities places a greater burden on the patient's caregivers and limits the clinician's ability to provide services in the patient's home (Demiris et al., 2005; Helm-Estabrooks & Ramsberger, 1986). Therefore, an alternative to a traditional service delivery model should be considered for patients living in rural communities.

Telerehabilitation offers an approach to intensive treatment that bypasses many of the aforementioned obstacles to treatment. Two-way audiovisual telecommunication technology allows the clinician to provide in-home treatment on a more frequent basis without the added cost of transportation. Additionally, this design promotes patient participation and facilitates generalization of learned skills to the home environment (Pickett et al., 2007). Given the increasing number of patients in rural communities in need of intensive rehabilitative services, there is a greater demand for alternative service delivery models, such as those offered through telecommunication technology.

The goal of the present case study was to evaluate the effectiveness of an internet-based telerehabilitation program in facilitating the maintenance of language gains made by the participant during intensive, clinic-based constraint induced language therapy.

METHODS

Participant

The participant (ACL), a 56-year-old right-handed male, was recruited for this single-subject study based on his motivation and interest following participation in ongoing research comparing

the effects of intensive CILT and Promoting Aphasic Communicative Effectiveness (PACE) (Davis & Wilcox, 1985). ACL had recently completed two two-week phases of intensive CILT and PACE therapy. During each phase, he was trained to produce the names of objects and actions using playing cards made from black and white line drawings (Szekeley et al., 2005). ACL was three years post a single left hemisphere CVA at the time of this study and presented with chronic Wernicke's aphasia as indicated by his performance on the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass et al., 2001): 27th percentile on the mean of three auditory comprehension tasks; 40th percentile on word repetition and 30th percentile on sentence repetition tasks; 28th percentile on responsive naming; and 13/60 on the Boston Naming Test. He did not present with any other neurologic or motor impairments.

Procedure

ACL completed pre-treatment training in telerehabilitation procedures at the Center for Language, Speech, and Hearing at the University of Massachusetts Amherst during two, one-hour sessions. He was provided with a Mac laptop and taught to initiate, participate in, and terminate iChat videoconferencing, and he was assisted in setting up high-speed internet access at home.

Treatment was carried out over the course of six weeks. During week one, treatment was scheduled for 30 minutes day, Monday through Friday. Total treatment time was tapered over the following five weeks to Monday, Wednesday, and Friday for 30 minutes during week two, 15 minutes during weeks three through five, and 10 minutes during week six.

The treatment stimuli and procedures used during this study were adopted from the CILT treatment procedures previously referenced. The picture cards included 12 object and 12 action targets (from a set of 48 CILT targets), and five previously untrained pictures. During a dual-card task, ACL was encouraged to use complete sentences to request the pair to each target picture. For erroneous responses, a hierarchy of verbal cues was used to ensure errorless learning for his retrieval of each target word.

RESULTS

Gains in naming that were achieved via CILT treatment (29 correct of 48 targets - half of which were then practiced for six weeks via iChat videoconferencing) were maintained and improved upon (36 correct) three months post-treatment; gains made via PACE (36 correct - none of which were practiced afterword), were not so well maintained (16 correct) (Fig. 1). Of the 24 CILT objects and actions targeted via videoconferencing, McNemar tests between post-treatment (58% accurate) and three months post-treatment (96% accurate) were statistically significant ($p<.01$); there were no statistically significant differences in accuracy between the unpracticed words post-treatment (42% accurate) and three months post-treatment (54% accurate). Four of the five previously untrained targets were also accurately named at this time.

DISCUSSION

The present case study demonstrates that telerehabilitation via accessible, available personal computing equipment may be an effective mode of treatment delivery for the maintenance of language gains for a person with chronic Wernicke's aphasia. For individuals living in rural communities with limited access to follow-up treatment, telerehabilitation provides access to

continued treatment, which is reportedly related to the maintenance of language gains (Meinzer et al., 2005; Demiris et al., 2005; Helm-Estabrooks & Ramsberger, 1986). Additionally, telerehabilitation administered via a videoconferencing retains features of treatment correlated with success, including modeling of speech production by the clinician, the provision of visual cues, and observation of the participant's nonverbal behavior. As greater emphasis is placed on the participant's quality of life in relation to treatment, telerehabilitation provides face-to-face interaction for the participant, which reduces social isolation often observed in rural communities. Furthermore, this approach may facilitate generalization of learned behaviors to the participant's home environment, as he is engaged in treatment activities outside of a hospital or clinic setting.

Despite the advantages of telerehabilitation, certain drawbacks to this method of treatment delivery were encountered during this study. First, treatment procedures had to be highly structured for successful administration. All materials were provided to the participant in advance, and treatment was administered in a predictable routine to allow for relative participant independence. Second, the technology used significantly affects the quality of treatment provided. Limited access to high-speed internet service and a program capable of supporting videoconferencing can result in frequent video disconnections, negatively influencing treatment delivery. Ultimately, if these variables are addressed, the use of accessible, low-tech audio-videoconferencing appears to be a promising delivery method for maintenance treatment to patients with chronic aphasia living in rural communities.

REFERENCES

Basso, A. & Caporali, A. (2001). Aphasia therapy or the importance of being earnest. *Aphasiology*, *15*(4):307-32.

Bhogal, S.K., Teasell, R., & Speechley, M. (2003). Intensity of aphasia therapy, impact on recovery. *Stroke, 34*(4):987-93.

Davis, G.A. & Wilcox, M.J. (1985). Adult aphasia rehabilitation: Applied pragmatics. San Diego, CA: College Hill Press.

Demiris, G., Shigaki, C.L., & Schopp, L.H. (2005). An evaluation framework for a rural home-based telerehabilitation network. *Journal of Medical Systems, 29* (6), 595-603.

Goodglass, H., Kaplan, E. & Barresi, B. (2001). *The assessment of aphasia and related disorders*, 3rd Ed. Austin, TX: ProEd.

Helm-Estabrooks, N. & Ramsberger, G. (1986). Aphasia treatment delivered by telephone. *Archives of Physical and Medical Rehabilitation, 67,* 51-53.

Hinckley, J.J. & Craig, H.K. (1998). Influence of rate of treatment on the naming abilities of adults with chronic aphasia. *Aphasiology, 12*(11):989-1006.

Lendrem, W. & Lincoln, N.B. (1985). Spontaneous recovery of language in patients with aphasia between 4 and 34 weeks after stroke. *Journal of Neurology, Neurosurgery, and Psychiatry, 48*, 743-748.

Maher, L.M., Kendall, D., Swearengin, J.A., Rodriguez, A., Leon, S.A., Pingel, K., Holland, A., & Gonzalez Rothi, L.J. (2006). A pilot study of use-dependently learning in the context of Constraint Induced Language Therapy. *Journal of the International Neuropsychological Society, 12,* 843-852.

Meinzer, M., Djundja, D., Barthel, G., Elbert, T., & Rockstroh, B. (2005). Long-term stability of improved language functions in chronic aphasia after constraint-induced aphasia therapy. *Stroke, 36,* 1462-1466.

Pickett, T.C., Fritz, S.L., Ketterson, T.U., Glueckauf, R.L., Davis, S.B., Malcolm, M.P., & Light, K.E. (2007). Telehealth and constraint-induced movement therapy (CIMT): An intensive case study approach. *Clinical Gerontologist, 31*(1), 5-20.

Pulvermüller, F., Neininger, B., Elbert, T., Mohr, B., Rockstroh, B., Koebbel, P., & Taub, E. (2001). Constraint-induced therapy of chronic aphasia after stroke. *Stroke, 32*, 1621-1626.

Sarno, M.T. & Levita, E. (1979). Recovery in treated aphasia during the first year poststroke. *Stroke, 10*, 663-670.

Szekeley, A., Damico, S., Devescovi, A., Federmeier, K., Heron, D., Iyer, G., Jacobsen, T., Arvalo, A., Vargha, A., & Bates, E. (2005). Timed action and object naming. *Cortex, 41*, 7-26.

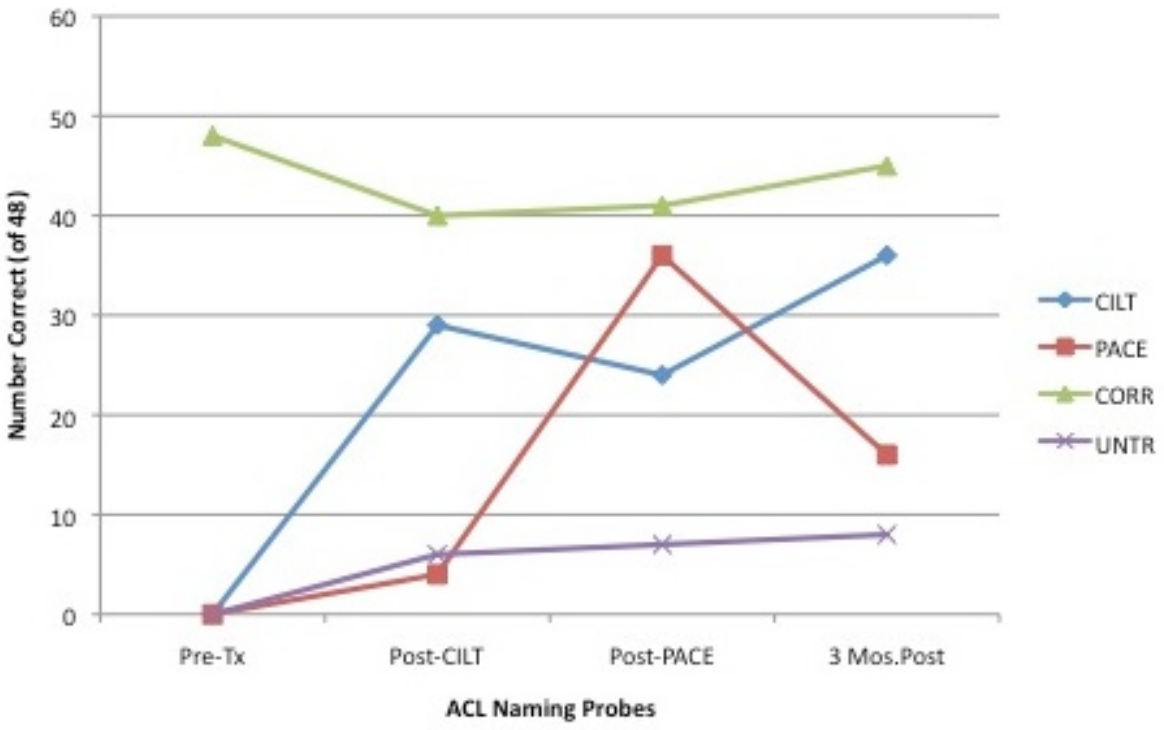

Figure 1. Naming accuracy during probes at four time points: pre-phase I treatment (CILT); post-phase I treatment; post-phase II treatment (PACE); and 3 months post-phase II treatment. CORR=words named consistently correctly during baseline testing; UNTR=untrained words. Each condition associated with a set of 48 black and white line drawings - half objects, half actions.