

Automated Constraint-Induced Therapy Extension (AutoCITE) for movement deficits after stroke

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Purpose of the Work. At least 600,000 strokes occur every year in the United States, and stroke is the leading cause of disability. Stroke-related motor deficits and disabilities result in compromised quality of life, lost independence, and enormous healthcare costs. Numerous studies have shown that Constraint-Induced Movement therapy, or CI therapy, increases the amount of use of the more-affected upper limb in activities of daily living in patients with mild to moderately severe chronic stroke. However, CI therapy is an intensive intervention that involves a great deal of one-on-one therapist time and is therefore too expensive to be available for many individuals who would benefit from it. We report progress in the development of AutoCITE, a workstation that delivers the task practice component of upper-limb CI therapy, which can potentially be used in the clinic or the home without the need for one-on-one supervision from a therapist. **Subjects and Procedures.** AutoCITE incorporates a computer and eight task devices arranged on a modified cabinet. Task performance is automatically recorded, and several types of feedback are provided. In preliminary testing, nine chronic stroke subjects with mild to moderate motor deficits practiced with AutoCITE for 3 h each weekday for 2 weeks. Subjects wore a padded mitt on the less-affected hand for a target of 90% of their waking hours. **Results.** In terms of effect sizes, gains were large and significant on the Motor Activity Log, and moderate to large on the Wolf Motor Function Test. These gains were comparable to the gains of a matched group of 12 subjects who received standard CI therapy. **Relevance to the Veteran Population.** Development of a workstation that delivers the task practice portion of CI therapy without the need for one-on-one supervision from a therapist would substantially reduce the cost of CI therapy because patients could perform the exercises at home, and one therapist could treat four or more patients simultaneously in the clinic. The reduced cost would provide access to CI therapy for many veterans who currently cannot afford the treatment but would benefit from it.

Peter S. Lum, PhD

The experience of time in the transition from hospital to home following stroke

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Purpose of the Work. This preliminary study defined and described the transition from hospital to home during the first month after discharge following acute stroke. **Subjects and Procedures.** Fifty-one male veterans discharged home with a caregiver after acute stroke are included in this ongoing preliminary study. Qualitative data were obtained from in-depth, semistructured interviews with stroke survivors and field observations recorded during home visits at 1 month postdischarge. Interviews were tape recorded, transcribed verbatim, and entered into N6, a software application designed to assist with qualitative data analysis. **Results.** Findings indicate that changes in the temporal order of life are related to functional impairments and disruption in the taken-for-granted body. At 1 month postdischarge, survivors struggled with establishing routines in their day and coped with an increased amount of idle time. Strategies for managing increased idle time were “passing time,” “waiting on time,” and “killing time.” **Relevance to the Veteran Population.** The transition from hospital to home following a stroke is a critical period in the recovery trajectory. When stroke survivors go home from the hospital or a rehabilitation center, they have to learn how to manage functional limits within the context of their home and family. The transition process involves three areas related to the experience of time: changes in the temporal order of life, changes in one’s sense of self, and the development of strategies to manage time during the transition to fill idle time. Three implications for rehabilitation therapists charged with the responsibility for preparing patients for discharge can be defined from the study: First, the transition process may be less chaotic if stroke survivors and their caregivers have information about the importance of establishing a routine to their lives after they get home. They need to anticipate the disruption in the temporal order of their lives and to understand that reordering their lives is part of the recovery process that will help to reestablish a sense of normalcy. Caregivers need help in planning to reestablish routines as a way of decreasing the

chaos during the transition period. Second, caregivers and other family members may benefit from understanding that as the stroke survivor manages the transition period, not only is he/she testing functional capabilities, but one's sense of self is changing at the same time. Family members and caregivers need to support the stroke survivor as old roles are shed and new roles are established. One's self-worth and self-respect hang in the balance as the survivor experiences the losses and struggles to regain participation in a meaningful role in the family. Third, attention is needed to help stroke survivors find meaningful ways to manage time within the context of their own homes during the transition period. Many survivors will benefit from careful consideration of activities that are available for managing time. Hobbies and interests could be nurtured so that the survivor develops an activity that has meaning in his/her life. Family members and caregivers need to be encouraged to gradually introduce new or reestablish old hobbies and activities that are possible for the survivor to accomplish.

Maude Rittman, PhD

Why ethnic designation matters for stroke rehabilitation: Comparing VA administrative data and clinical records

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Purpose of the Work. The reliability of ethnic reporting in Department of Veterans Affairs (VA) administrative data is a matter of concern in the review of rehabilitation outcomes. This study examined agreement in ethnic designation between administrative and medical rehabilitation data sources. The variant characterizations of ethnicity were then compared with rehabilitation outcome indicators to examine the results for different designations. **Procedures.** Ethnic designations from an FY 2001 stroke cohort drawn from medical rehabilitation records were compared for reliability with ethnic identifiers in the main VA administrative records. Two separate reclassifications of the race variable from the administrative data were compared. Unadjusted, complete-subject analyses examining differences among black, Hispanic, and white veterans in rehabilitation assessments and outcomes were then compared with the different codings for ethnicity. **Results.** Overall strength of agreement for ethnic identification between

medical rehabilitation records and administrative data was good, irrespective of small variations in reclassification ($\kappa = 0.78\text{--}0.79$), with reliability for individual ethnic groups ranging from moderate to very good ($\kappa = 0.44\text{--}0.89$). However, statistical significance of results comparing differences among ethnic groups for dichotomous admission severity and length of stay differed notably. The decrease in power resulting from missing values, misclassification, and reassignment from condensing ethnic identifiers was less noticeable in analyses of ordinal admission severity assessments, and significant ethnic variation in discharge disposition remained relatively unaffected by changes to ethnic assignment. **Relevance to the Veteran Population.** Clinically meaningful and policy-relevant ethnic variations in veterans' stroke rehabilitation indicators may be masked in secondary analyses depending on how ethnicity is identified, even in studies that appear to have adequate sample sizes. Results underline the importance of improving the quality of demographic reporting in VA administrative data and the advantages of self-identified ethnic information.

James P. Stansbury, PhD

How strong is the relationship between functional status and quality of life among persons with stroke?

Gregory P. Samsa, PhD; David B. Matchar, MD

Purpose of the Work. This study explored the quantitative relationship between functional status and self-reported quality of life among patients with stroke. **Subjects.** Subjects were participants in the Department of Veterans Affairs (VA) Stroke Study, an observational study of persons with stroke at eight VA medical centers, and were interviewed at 1, 6, and 12 months poststroke. **Results.** Although higher functional status was associated with better quality of life, this relationship was relatively weak. The improvement in quality of life over time after stroke is modest at best. Patients with similar levels of disability reported quite different qualities of life. **Relevance to the Veteran Population.** Quality of life after major stroke may not necessarily be as low as previously reported. Individual response to stroke differs markedly, and quality of life depends on more than just level of physical function.

Gregory P. Samsa, PhD

Stepping over obstacles to improve walking in individuals with poststroke hemiplegia

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Purpose of the Work. We evaluated two training interventions to improve gait velocity and stepping distance in individuals with poststroke hemiplegia whose walking ability has been compromised. **Subjects and Procedures.** Twenty subjects with poststroke hemiplegia completed six intervention sessions in which they were asked to step over either virtual objects while walking on a motorized treadmill or real objects on a 10 m walkway. **Results.** Overall, the subjects showed clinically meaningful changes in gait velocity, stride length, walking endurance, and obstacle clearance capacity as a result of either training method. **Relevance to the Veteran Population.** Improvements in these conditions should enhance the ability to walk, step over obstacles, and reduce injuries due to falls. Enhanced walking mechanics decrease the energy needed to walk and reduce injuries due to gait abnormalities such as hyperextension at the knee. These improvements in walking also enhance the ability of persons with poststroke hemiplegia to negotiate real-world ground environments (steps, obstacles, and uneven surfaces) and walk independently and confidently. Decreasing the training time and preventing falls will reduce health costs. Greater walking ability is a prerequisite for returning to the workforce and regaining the ability to perform routine activities necessary for an independent lifestyle. Finally, the ability to walk safely and at a functional speed promotes increased involvement with family and community events.

David L. Jaffe, MS

Weakness and strength training in persons with poststroke hemiplegia: Rationale, method, and efficacy

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Purpose of the Work. We reviewed the currently available literature discussing the relationship between weakness and motor dysfunction and effects of strengthening persons with hemiplegia following stroke. **Subjects and Procedures.** At present, the literature reporting assessment of strength and effects of strengthening in persons

with poststroke hemiplegia is severely limited. Because of this limitation, we included all available intervention studies independent of treatment protocol or subject inclusion criteria. **Results.** Nine studies published between 1973 and the present report results of strengthening for hemiparetic persons. Four of these involved randomized controlled clinical trials and three involved nonrandomized, preexperimental designs, while two involved quasi- or preexperimental designs. Because of the preliminary nature of these studies, it is premature to formulate clinical practice guidelines. However, the collective evidence indicates that (1) strengthening in adults with poststroke hemiparesis does not produce deleterious effects, (2) hemiparetic persons can produce significant strength gains in response to even short periods of resistance training, and (3) strength gains appear to transfer to functional movements including sit-to-stand, gait, and reaching. **Relevance to the Veteran Population.** Stroke is the preeminent cause of physical disability in Western Industrialized nations, affecting over 750,000 persons in the United States and accounting for over US\$30 billion in healthcare costs annually in both the civilian and veteran healthcare systems. Because of marked improvements in the acute management of stroke, there are now over four million living stroke survivors, a third of whom experience significant disability. Because the risk of stroke doubles with each decade of chronological age, stroke and stroke-related disability tend to be considered a problem of an aging population. The greatest proportion of the current veteran population comprises persons aged 65 and older who are at significant risk for stroke. This proportion will continue to increase, from 43% in year 2010 to 51% in 2020, as the Vietnam Era cohort of veterans ages. Improving the outcomes of stroke rehabilitation and reducing stroke-related disability are thus high priorities in the Department of Veterans Affairs. Strength training holds promise for significantly improving the rehabilitation outcomes of persons with poststroke hemiparesis. This review paper reports the current state of our understanding and proposes several lines of potential investigation to advance this area of rehabilitation practice.

Carolynn Patten, PhD, PT

Application of adaptive filters to visual testing and treatment in acquired pendular nystagmus

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Purpose of the Work. Acquired oscillation of the eyes (acquired pendular nystagmus [APN]) is visually disabling and usually difficult to treat. Vision might be improved with spectacle-mounted visual aids that either gate vision through a shutter or optically shift the seen world in lockstep with the involuntary eye movements. A key technological hurdle to developing either device is to create a control mechanism that selectively tracks the oscillation so that the shutter can be synchronized to the oscillation, or so that the image-stabilizing device counteracts the oscillation without simultaneously defeating normal eye movements.

Procedures. We implemented an adaptive filter algorithm on a desktop computing platform and tested the capability of this filter, when coupled to either a shutter mechanism or a simulated image-shifting mechanism, to restore acuity in normal subjects in whom the visual effects of APN were simulated by oscillating visual targets. We also assessed whether a shutter could improve vision even without the use of the filter algorithm to time its openings. **Results.** Subjects' acuities were markedly degraded by oscillating the acuity testing images. A randomly triggered shutter improved acuity only minimally. Both the synchronized shutter and image stabilization improved acuity appreciably. Image stabilization was superior, restoring acuities to within an average of 0.10 logMAR (range 0.03–0.16) of the subjects' values without the simulated nystagmus. We conclude that the adaptive filter algorithm, when coupled to image stabilization optics, is a promising new strategy for alleviating visual disability in patients with APN. **Relevance to the Veteran Population.** APN most frequently arises as a complication of multiple sclerosis and stroke, which are also two of the most commonly encountered diagnoses in VA neurology clinics. While the immediate goal of this research is to develop a visual aid for patients with APN, the basic strategy of computer-controlled image-shifting optics may ultimately be applicable to other eye movement disorders.

John S. Stahl, MD, PhD

Image-shifting optics for a nystagmus treatment device

Ryan M. Smith, BSEE; Brian S. Oommen, MS;
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Purpose of the Work. This study describes research aimed at developing a visual aid for patients suffering acquired pendular nystagmus (APN), a particularly disabling form of ocular oscillation. The device is based on the observation that visual function can be improved in APN patients if the image of the world is shifted in lockstep with the ocular oscillations. An essential component of such a device is the image-shifting optical mechanism, which must be light and accurate and capable of operating over the oscillation frequencies and amplitudes seen in APN. In this study, we assessed the suitability of a three-lens mechanism used in commercial image-stabilizing lenses. **Procedures.** A prototype image-shifting mechanism was built from elements salvaged from a commercial image-stabilizing lens and integrated with nystagmus-tracking software previously developed in our laboratory. The accuracy of the image-shifting optics was assessed by quantifying harmonic distortion and position errors as the device was commanded to move in a circular trajectory. Subsequently, we assessed the capability of the image-shifting optics and software to enhance acuity in normal subjects in whom the deleterious effects of circular-trajectory APN were simulated by oscillating acuity testing targets. **Results.** The prototype image-shifting optics exhibited characteristics suitable for use in a future APN treatment device, requiring low current, generating minimal waste heat, and exhibiting low degrees of distortion over the frequency range relevant to APN. In combination with software designed to track nystagmus, the optical mechanism proved capable of improving acuity in normal subjects experiencing simulated two-dimensional nystagmus. Acuity was restored to within an average of 0.12 logMAR (range 0.0–0.22) of the subjects' values without the simulated nystagmus. **Relevance to the Veteran Population.** APN most frequently arises as a complication of multiple sclerosis (MS) and stroke, which are also two of the most commonly encountered diagnoses in VA neurology clinics. MS is prevalent because it usually strikes people when they are young, produces chronic difficulties requiring ongoing medical care, and is generally compatible with long life. For some patients, restoring good vision may translate to the ability to retain gainful employment. For patients who are already disabled by multiple other neurological complaints, improving vision may enhance quality of life by restoring the ability to read, use a

computer screen, or enjoy television, important diversions in patients for whom so many activities are physically impossible. While the immediate goal of this research is to develop a visual aid for patients with APN, the basic strategy of computer-controlled image-shifting optics may ultimately be applicable to other eye movement disorders.

John S. Stahl, MD, PhD

Mobility function in older veterans improves after blind rehabilitation

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Purpose of the Work. The Department of Veterans Affairs (VA) invests considerable resources in blind rehabilitation services. One area of focus in blind rehabilitation is orientation and mobility training, which strives to improve the ability of visually impaired veterans to move safely and efficiently through the environment. This present study evaluated the effectiveness of this training. **Subjects and Procedures.** One hundred twenty-eight legally blind veterans rated how difficult they found each of 34 mobility situations at the beginning of their blind rehabilitation program and again 2 months after they had completed it. They also rated their confidence in different travel situations and provided information about falls and fear of falling before and after rehabilitation. The average age of the veterans participating was 71 years, and over half of them had macular disease. **Results.** Veterans reported significantly less difficulty performing 26 of 34 mobility tasks following rehabilitation. They also reported higher levels of confidence in their mobility and fewer falls following rehabilitation. **Relevance to the Veteran Population.** The results indicated that the training veterans received effectively improved their ability to move about in the environment. The training also enhanced their confidence when traveling and may have reduced the number of times they fell. Gains were made by older veterans, predominately those with macular disease; a form of sight loss usually associated with only mild-to-moderate mobility limitations.

Thomas Kuyk, PhD

Relationship of retinal structural and clinical vision parameters to driving performance of diabetic retinopathy patients

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Purpose of the Work. This study identified clinical vision measures and retinal structural measures associated with the driving performance of diabetic retinopathy patients. **Subjects and Procedures.** Twenty-five licensed drivers with diabetic retinopathy completed clinical vision tests, retinal structural examinations, and driving performance assessment. **Results.** Increased retinal thickness was significantly correlated with a higher frequency of simulator accidents and near accidents. Laser scar grades significantly correlated with steeper brake response slopes, increased brake pressure standard deviation, and longer response times. Subjects with focal laser scars had significantly higher average brake-pedal pressure and brake-pressure standard deviation than subjects without focal laser scars. **Relevance to the Veteran Population.** Diabetic retinopathy is the second leading cause of blindness among the veteran population, affecting over 15% of veterans with vision problems.

Janet P. Szlyk, PhD

Multidimensional visual field maps: Relationships among local psychophysical and local electrophysiological measures

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Purpose of the Work. This study measured the visual capabilities of the peripheral retina. **Subjects and Procedures.** Four normally sighted, healthy adults looked at the center of a computer monitor while patterns of different sizes, contrasts, and durations were presented at many places on the screen. **Results.** We found that although the peripheral retina was never as good as the central retina in seeing patterns, some areas of vision were relatively better than others. **Relevance to the Veteran Population.** Data yielded from this study could be used to measure the effectiveness of rehabilitation programs that train patients with central vision loss to use other areas of the retina to read.

William Seiple, PhD

Use of auditory brainstem responses for early detection of ototoxicity from aminoglycosides or chemotherapeutic drugs

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Purpose of the Work. This study compared two test methods of auditory brainstem responses (ABRs) for the early detection of ototoxic hearing loss before it progresses into the speech range. **Subjects and Procedures.** Method 1 was the high-frequency (HF) click comparison. For this method, 20 adult human subjects (15 females and 5 males), ranging in age from 21 to 43 years, mean age of 27, participated in this study. Method 2 was the comparison of single tone bursts (STBs) and tone-burst trains. Twenty adult human subjects (11 females and 9 males), ranging in age from 21 to 34 years, mean age 26, were tested. **Results.** In Method 1, ABRs elicited by

STB stimuli were compared with those elicited by conventional and HF clicks. HF clicks produced a larger, more robust response and were more time-efficient than STBs. In Method 2, single as well as trains of tone bursts elicited ABRs. The trains of stimuli allow the more efficient data collection. All stimuli tested produced reliable responses both within and across sessions. **Relevance to the Veteran Population.** Veterans hospitalized with various infections, spinal cord injuries, and cancers are routinely administered drugs that have ototoxic potential. Last year, the VA Pharmacy Service estimated that about 40,000 veterans were administered these drugs annually. The current study can potentially minimize or prevent debilitating hearing loss in these patients by the early detection of hearing deficits before they impinge upon the speech reception area.

Curtin Mitchell, PhD