

Clinical Relevance for the Veteran

The social organization in constraint-induced movement therapy

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Purpose of the Work. This study evaluated a qualitative methodology to capture the clinical meaningfulness of constraint-induced movement therapy (CIMT) for veterans who have had a stroke and to explore some of the psychosocial aspects of participating in CIMT. This study provides preliminary data to support future studies on the psychosocial aspects of participating in newly emerging therapies. **Subjects and Procedures.** We observed 12 subjects living with chronic stroke effects during the 2 weeks they participated in CIMT. All subjects signed informed consent forms before observations. Researchers took field notes as therapists and participants interacted within the rehabilitation setting and then typed and transported these notes into a qualitative database for detailed analysis. Data were coded, highlighting the major themes found in the social interaction processes of CIMT. **Results.** We constructed a conceptual framework focusing on how discourse on physical progress is socially organized in CIMT. This framework was constructed from the extensive field notes taken on what therapists and participants said during their face-to-face interaction. We find the conceptual framework on physical progress very intriguing and believe that it offers important theoretical insight into the interpersonal dynamics involved in physical rehabilitation, at least for participants with similar levels and types of impairment as those who participated in this study. **Relevance to the Veteran Population.** Using an impaired limb may cause problems for veterans in everyday life. However, therapists who are aware of a social pattern of participant/therapist communication and understand the nature of the social interaction between participants and therapists may be able to modify this pattern in ways that optimize the participant's commitment to using an impaired limb. That is, the outline of social interaction that we have provided may be used in forming a tool that therapists can use in establishing a relationship that optimizes veterans' self-efficacy and commitment to therapeutic protocol. Therapists can

also use such a tool to note changes taking place with the veteran that are not being captured by traditional quantitative measures. In this way, a tool used in establishing and noting the interaction between therapist and veteran can have the practical clinical significance of maintaining or improving the veteran's responsiveness to treatment and the scientific significance of capturing changes that are currently not being measured.

Craig Boylstein, PhD

Qualitative and quantitative measurement of depression in veterans recovering from stroke

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Purpose of the Work. This study describes early post-stroke emotional recovery in a population of veterans and explores the extent to which the Geriatric Depression Scale (GDS) agrees with narrative descriptions of negative mood in at-home interviews and clinical indicators of depression from patient records. **Subjects and Procedures.** Participants were 112 veterans who were discharged home from the hospital 1 month following a new stroke. Qualitative data from in-home interviews and quantitative data from the GDS were analyzed and compared with evidence of depression from patient records. **Results.** GDS scores indicated that 35 percent of the 112 veterans had depression. Analysis of qualitative data revealed that depressed respondents were struggling with low expectations of recovery and accepting the losses they were experiencing. Those who were not depressed maintained hope and found meaning in the experience. Some who fell below the GDS cutoff for depression described a depressed mood in their interviews. Few participants were diagnosed with a depressive disorder. **Relevance to the Veteran Population.** Screening with the GDS poststroke is a first step in the detection of depression. Listening to patients' descriptions of their emotional recovery for themes of pessimism and lack of acceptance can alert clinicians to the need for further evaluation for depression.

Christine L. Williams, DNSc, APRN, BC

Subjective stress in male veterans with spinal cord injury

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Purpose of the Work. This study of veterans with spinal cord injury (SCI) examined the effect of daily hassles and global perceived stress on psychological health outcomes as well as the direct and/or stress-buffering role of social support. **Subjects and Procedures.** Participants were 165 male veterans with SCI who completed a telephone survey assessing sources of stress (daily hassles), global perceived stress, social support, depressive symptomatology, anxiety, and satisfaction with life. **Results.** The hassles endorsed most frequently included “Your physical abilities” (endorsed by 70%), “Your health” (62%), “Money for extras” (59%), “Money for emergencies” (57%), “Money for necessities” (56%), and “Your medical care” (56%). Veterans had a significantly higher mean global perceived stress score (17.3) than a nonveteran community sample of persons with SCI (13.9) and the general population (12.1). Veterans with more hassles and/or more global perceived stress were likely to have more depressive symptomatology and anxiety and were less satisfied with their lives. The effect of stress on psychological well-being was particularly strong for persons with low social support. **Relevance to the Veteran Population.** These findings substantiate the need to identify and alleviate stress among veterans with SCI. Our data also suggest that a high percentage of veterans with SCI are experiencing significant depressive symptomatology. Given these findings, designing and making stress management programs widely available as well as depression self-management programs for veterans with SCI may be beneficial.

Diana H. Rintala, PhD

Effect of pamidronate administration on bone in patients with acute spinal cord injury

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Purpose of the Work. This study determined the effect of pamidronate, a bisphosphonate administered intravenously, upon bone and metabolic markers of bone activity in persons with acute neurologically complete spinal cord

injury (SCI). **Subjects and Procedures.** Eleven subjects with acute SCI participated in this study. We administered pamidronate (treatment) or normal saline (placebo) intravenously on average 44 ± 18 days after acute injury and then several times over the next 12 months. Follow-up tests were performed at 18 and 24 months. **Results.** Regional bone mineral density (BMD) was lost over time in both the treatment and placebo groups. In the treatment group compared with the placebo group, we noted a mild early reduction in loss of total leg BMD. Significant bone loss at the regional sites occurred earlier in the placebo group than in the treatment group. However, by the end of the treatment and follow-up phases, both groups demonstrated a similar percent bone loss from baseline. Despite an early reduction in bone loss, pamidronate failed to prevent major long-term loss of bone in persons with acute complete SCI. **Relevance to the Veteran Population.** A marked and rapid loss of bone in the legs and pelvis occurs in individuals after acute SCI. This loss of bone greatly increases the risk of fracture. Although delay was apparent, over time, we found no significant reduction of bone loss in the group receiving pamidronate. Because early administration of pamidronate in persons with acute SCI did not reduce bone loss, it is less likely to be efficacious in other conditions associated with immobilization, such as acute stroke with paralysis.

William A. Bauman, MD

A shear and plantar pressure sensor based on fiber-optic bend loss

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Purpose of Work. This study presents pilot work on a fiber-optic-based shear and pressure sensor. No commercially available, widely used shear sensor is available, and this technology has great potential to be developed as a shear sensor. A robust, validated shear sensor could be used as a clinical and research tool, providing information on the location and magnitude of shear forces. One could use such a sensor as a clinical tool to determine areas of increased risk for ulceration; one could use this sensor as a research tool to explore treatment modalities for reducing shear stress. **Procedures.** We constructed a prototype shear and pressure sensor consisting of two arrays (top and bottom) of fiber-optic cables sandwiched between three layers of gel insole. The device consisted of four pressure points. Using mechanical testing devices, we

applied well-controlled vertical and shear loads to the sensor and quantified the sensor's response (i.e., the change in light intensity). **Results.** We have demonstrated that the sensor responds to both shear and compressive loading in a repeatable manner and that it was sensitive to small displacements (0.5 mm). We compared the response of the pressure points loaded individually and all at once, which demonstrated the importance of isolating each sensor. **Relevance to the Veteran Population.** As the prevalence of diabetes in the United States and among veterans continues to increase, the ability to treat diabetic complications becomes more important. Shear is thought to play a role in the development of ulcers.

Wei-Chih Wang, PhD

The effects of static friction and backlash on extended physiological proprioception control of a powered prosthesis

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Purpose of the Work. Some extended physiological proprioception (EPP)-controlled elbows exhibited unexplained "jerky" behavior in both clinical fittings and bench-top operation. Additionally, limit cycles sometimes developed in bench-top use of these elbows. This study identified the factors that contributed to these behaviors to allow prosthetists to select components that would minimize the likelihood of these behaviors when EPP control is used in clinical fittings. The analysis could also benefit manufacturers in the design and development of higher performance prosthetic components. **Procedures.** Position step inputs were applied to an EPP-configured powered elbow system. We varied system parameters to determine the effects of these parameters on the development of limit cycle behavior. **Results.** We found that static friction and backlash were primarily responsible for limit cycle development in EPP-controlled powered elbows. Reduction of the magnitude of both backlash and static friction in the elbow was shown to reduce the likelihood of limit cycles developing and thus improved system performance. **Relevance to the Veteran Population.** Some prosthetic users are required to use powered prostheses because of the inability to produce the forces and excursions necessary to actuate body-powered devices. Other users require greater mechanical performance because they perform activities that require higher grip forces or lifting capacity than can be achieved with body-

powered prostheses. Most powered prostheses are controlled in a manner that does not provide useful feedback to the user regarding the position of the prosthesis. This requires users to rely on cognitively expensive visual feedback to effectively control their prosthesis. EPP allows this meaningful position information to be fed back to the user, but these configurations have not gained widespread acceptance in the clinical community. The results of this study indicate that clinical prosthetists and prosthetic component developers must select and design components that possess as little friction and backlash as possible to most effectively implement EPP control of powered prostheses.

Todd R. Farrell, MS

Kinematic analysis for determination of bioequivalence of a modified Hybrid III test dummy and a wheelchair user

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Purpose of the Work. This study determined if a modified 50th-percentile male Hybrid III anthropomorphic test dummy (HTD) (First Technology Innovative Solutions, Plymouth, MI) has a similar dynamic response to a wheelchair user with a spinal cord injury during low-speed, low-impact scenarios. **Subjects and Procedures.** An HTD typically used in vehicle crash testing was modified to simulate a person with lower-limb paralysis. The test dummy was placed in a Quickie P100 electrically powered wheelchair (Sunrise Medical, Inc., Phoenix, AZ). The wheelchair was driven at three speeds, and three braking conditions were used to slow the wheelchair to a stop. The trunk motion of the HTD was recorded and compared with the motion of a wheelchair user with T8 paraplegia under the same wheelchair braking conditions. A statistical method known as bioequivalence determined if the trunk motions were similar. **Results.** The results are mixed, based on the bioequivalence criterion selected. Average bioequivalence methods would tend to indicate that further modifications to the test dummy would be necessary for the accurate assessment of wheelchair user kinematics during tips and falls. Population and individual bioequivalence methods as well as qualitative data would suggest that the test dummy is a suitable surrogate. **Relevance to the Veteran Population.** The ability to move freely throughout society is essential to our social and psychological well-being. An accident involving a

power wheelchair can cause injuries leading to secondary disabilities and death. Such an accident may also equate to additional hospital and prolonged recovery times and decreased quality of life. It places an additional load on a healthcare system already trying to allocate funds appropriately to its patients. A test dummy developed with characteristics comparable to a wheelchair user population can be used in studies to reduce the frequency and severity of wheelchair accidents.

Michael Dvorznak, MS

Evaluation of insert earphones for high-frequency bedside ototoxicity monitoring

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Purpose of the Work. To improve the methodology for ototoxicity monitoring, we evaluated the use of insert earphones that would offer several advantages, primarily the attenuation of background noise, thus allowing the testing of patients at bedside for patients who are too ill or time-constrained to be transported to a sound booth for testing. The present study evaluated the use of insert earphones for reliability of responses. **Subjects and Procedures.** Eight subjects were tested in a sound booth and on the hospital ward during two separate sessions with KOSS Pro/4X Plus circumaural earphones (Milwaukee, Wisconsin), and Etymotic Research, Inc. (Elk Grove Village, Illinois) ER-4B MicroPro insert earphones. In the first session, behavioral thresholds were obtained in the sound booth in the right then left ears with the KOSS earphones followed by the ER-4B insert earphones. Subjects were then tested on the hospital ward with transducers counterbalanced so order effect would be prevented. For the second session, initial testing was conducted on the hospital ward. Test order for obtaining behavioral thresholds was again counterbalanced between the two transducers for both booth and ward setting for the prevention of order effect. **Results.** Behavioral threshold test-retest reliability was good for the KOSS circumaural and ER-4B insert earphones for both the ward and booth settings. The two earphones were equally reliable on the ward and in the booth. Therefore, if a patient is going to be tested in the same location, test-retest reliability will not be affected, no matter which earphone is used. However, the repeatability of the ER-4B insert earphones between booth and ward testing was superior to the KOSS circumaural ear-

phones, especially at 2 kHz. Therefore, the ER-4B insert earphones were shown to be reliable for ototoxicity monitoring at bedside. **Relevance to the Veteran Population.** One of the largest groups of veterans with service-connected disabilities is those with hearing disorders. When veterans require treatment with ototoxic drugs, such as aminoglycoside antibiotics and the chemotherapy agent cisplatin, their hearing potentially may be further impaired. Effective and efficient methods for detecting and monitoring ototoxicity is needed. The use of insert earphones such as the ER-4B would allow for the reliable testing of veterans by providing greater reduction in background noise at bedside for those veterans who are too ill or time-constrained by treatment to be tested in the sound booth.

Jane S. Gordon, MS

Effect of high-frequency spectral components in computer recognition of dysarthric speech based on a Mel-cepstral stochastic model

Prasad D. Polur, PhD; Gerald E. Miller, PhD

Purpose of the Work. A hidden Markov model (HMM)-based system was constructed for recognition of dysarthric speech to assist individuals with speech and motor disabilities. **Subjects and Procedures.** In particular, the effect of high-frequency spectral components (above 5.5 kHz) on the recognition rate of the system was investigated. A set of 15 words and 10 digits were recorded from three male cerebral palsy patients with moderate dysarthria. Mel-frequency cepstral coefficients extracted with the use of 15 ms frames served as training input to an ergodic HMM setup. **Results.** No significant useful information was available to the system above 5.5 kHz that would enhance recognition. The equivalent performance obtained at lower band-limiting has favorable cost-benefit implication in control applications. **Relevance to the Veteran Population.** The result of this study is relevant to not only cerebral palsy patients but also other individuals with speech impairment, such as people with neurogenic communication disorders. Application of speech recognition technology to impaired speech would enable the people so affected in control applications such as mobility, appliance control, etc. Thus, this study is part of an effort to develop an artificially intelligent communication/control tool for speech- and motor-impaired individuals, including veterans.

Prasad D. Polur, PhD

Tracking retinal motion with a scanning laser ophthalmoscope

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David Ross, MS; Paul Benkeser, PhD

Purpose of the Work. For one to study the effectiveness and efficiency of the visual tasks performed by people with low vision, knowing the movement patterns of their preferred retinal loci (PRL) used for fixation, saccade, and pursuit is critical. This paper reports on the development of techniques to improve the speed and accuracy of the analysis of retinal motion from scanning laser ophthalmoscope (SLO) image sequences. **Subjects and Procedures.** The new software technique was experimentally tested on both normal- and low-vision subjects and compared with the results obtained with manual techniques. **Results.** The findings indicate the new technique works very well for most subjects, fairing poorly only in subjects where the quality of the SLO images was substandard. **Relevance to the Veteran Population.** The number of veterans who are, or will become, severely visually impaired will account for almost 4 percent of all veterans within the next 10 years. The effective and efficient monitoring of PRL movement can improve the low-vision rehabilitation services by better evaluation and training procedures.

Paul Benkeser, PhD

Effects of adding weight to the torso on roll-over characteristics of walking

Andrew H. Hansen, PhD; Dudley S. Childress, PhD

Purpose of the Work. Most able-bodied persons can pick up objects of varying weights and walk around without difficulty. However, adjustments in their lower-limb systems must occur to accommodate the added weight to the body. This study examined how added weights to the torso affect the roll-over characteristics of walking in able-bodied subjects. **Subjects and Procedures.** Ten nondisabled persons (five men and five women) participated in the study. Each participant walked while carrying three different loads (0 kg, 11.5 kg, and 23.0 kg) and at three walking speeds for each loading condition. We measured roll-over shapes of the ankle-foot and knee-ankle-foot systems for each walking condition. The roll-over shape is a direct measure of the effective rocker that the lower-limb system conforms to between heel contact and opposite-foot heel contact. **Results.** The participants in the study adapted to the different loading conditions to maintain similar ankle-foot and knee-ankle-foot roll-over

shapes. Roll-over shapes were also unchanged when participants walked at slow and normal walking speeds. **Relevance to the Veteran Population.** The results of the study suggest constraints for designing and developing ankle-foot and knee-ankle-foot prostheses and orthoses that will more closely mimic the physiologic systems that these devices attempt to replace or augment. The use of these constraints in designing and developing future rehabilitation devices may lead to improved prostheses and orthoses for veterans with disabilities.

Andrew H. Hansen, PhD

Longitudinal study of quality of life in patients with localized prostate cancer undergoing radiotherapy

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Purpose of the Work. This study prospectively evaluated quality of life (QOL) and the relationship between QOL and depression, fatigue, and sleep disturbances in subjects diagnosed with prostate cancer and undergoing radiation therapy. **Subjects and Procedures.** Forty participants with a mean age of 67.8 undergoing 7 to 8 weeks of radiotherapy completed the Functional Assessment of Cancer Therapy for Prostate (FACT-P), Beck Depression Inventory (BDI), Piper Fatigue Scale (PFS), and Epworth Sleepiness Scale (ESS) preradiotherapy (PRT), midway through radiotherapy (MRT), at completion of radiotherapy (CRT), at 4- to 8-week follow-up radiotherapy (FRT), and at long-term (12 months or more) follow-up radiotherapy (FRT2). **Results.** Two subscale scores of FACT-P (Prostate Cancer Specific [PCS], reflecting bladder and bowel problems, and physical well-being [PWB]) were significantly lower at MRT and CRT than at PRT, with a further decline of PWB scores noted at FRT2 while PCS scores increased. PFS scores were significantly higher at CRT and FRT2 than at PRT. Higher PFS scores were associated with poorer QOL and PWB. BDI and ESS scores did not change significantly during the study. **Relevance to the Veteran Population.** Many older veterans will develop and need treatment for prostate cancer. Those who undergo radiation therapy should expect a decline in QOL and PWB, increased fatigue, and transiently worsening bladder and bowel problems. Understanding the negative impact of radiation therapy on various QOL domains will allow the development of rehabilitation interventions to minimize or negate it.

Anthony J. Kerrigan, PhD

