

### **Utility of mechanism-of-injury-based assessment and treatment: Blast Injury Program case illustration**

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**Purpose of the Work.** While medicine typically proceeds in a sequential fashion based on primary symptoms, sometimes relying on a parallel, mechanism-of-injury-based approach is advantageous, particularly when the mechanism of injury is associated with a variety of known sequelae. This article describes an example of a mechanism-of-injury-based program, namely, a Blast Injury Program at the James A. Haley Veterans Hospital in Tampa, Florida. Case examples illustrate the use of this approach with regard to more comprehensive assessment and treatment, as well as the possibility for secondary prevention. **Subjects and Procedures.** Four case illustrations are presented, designed to demonstrate the use of the mechanism-of-injury-based approach to assessment and treatment. **Results.** Discussion focuses on possible advantages conferred in these patient cases with regard to comprehensive care and the possibility for secondary prevention. **Relevance to the Veteran Population.** Blast-related injuries have increased substantially in modern warfare. A mechanism-of-injury approach to assessment and treatment is arguably more efficient and efficacious in such cases. The case examples illustrate the improved quality of care given to our veterans with this approach.

*Heather G. Belanger, PhD*

### **Reliability of surface electromyographic measurements from subjects with spinal cord injury during voluntary motor tasks**

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**Purpose of the Work.** We assessed the reliability of surface electromyographic data (root-mean-square) for volitional motor tasks drawn from a standardized protocol. **Subjects and Procedures.** We examined three repetitions of each of 10 volitional motor tasks in 69 subjects with spinal cord injury (SCI) (American Spinal Injury Association [ASIA] Impairment Scale [AIS], classifications C and D: 34 AIS-C and 35 AIS-D) for short-term (within-

day) reliability. In 6 of the 69 subjects (3 each, AIS-C and AIS-D), the entire study was repeated after 1 week and results were assessed for intermediate-term (1 week apart) reliability. For each motor task, 5 s epochs of data were analyzed with a new method to generate a measure called the voluntary response index. **Results.** Good reliability was found for magnitude and for similarity index (SI) for three repeated tests (within-day). Significant difference was found for studies carried out 1 week apart for magnitude, but not for SI. In addition, SI showed less variation than magnitude. No significant difference between tasks was observed. **Relevance to the Veteran Population.** This new method would evaluate the residual motor control ability of patients with SCI more objectively and quantitatively.

*Hyun Kyoong Lim, PhD*

### **Smart wheelchairs: A literature review**

Richard C. Simpson, PhD, ATP

**Purpose of the Work.** This article surveys the body of research devoted to “smart wheelchairs.” These systems are intended to provide independent mobility to individuals with severe physical, perceptual, or cognitive impairments. **Procedures.** Relevant literature on smart wheelchairs was reviewed. **Results.** Several barriers exist that must be overcome before smart wheelchairs can become widely used. One significant technical issue is the cost versus accuracy trade-off that must be made with existing sensors. Another is the lack of a communication standard for wheelchair input devices and motor controllers. In addition, issues of clinical acceptance and reimbursement remain. This is not to imply; however, that smart wheelchair technology cannot be commercialized. Smart wheelchair technology is ready, today, for use in indoor environments that have been modified. The first smart wheelchair that is commercially successful in North America is likely to be marketed as a device that can be operated independently indoors, but must be controlled by an attendant outdoors or in unmodified indoor environments. However, as sensor technology improves, the environments in which smart wheelchairs can safely operate will continue to expand. **Relevance to the Veteran Population.** Both children and adults benefit from access to a means of independent mobility, but not all

veterans who need a power wheelchair are able to operate one, including veterans with low vision, visual field reduction, spasticity, tremors, or cognitive deficits. Veterans in this population often lack independent mobility and rely on a caregiver to push them in a manual wheelchair. To accommodate this population, researchers have used technologies developed for mobile robots to create "smart wheelchairs." This article presents a summary of the current state of the art and directions for future research.

*Richard C. Simpson, PhD, ATP*

### **Development of clinical methods for measuring geometric alignment of the thoracic and lumbar spines of wheelchair-seated persons**

Hideyuki Hirose, ME, PT

**Purpose of the Work.** This study investigated the use of the geometric alignment of two frontal lines (the sternum and abdominal) for predicting the alignment of the thoracic and lumbar spines and for measurement of wheelchair-seated posture. **Subjects and Procedures.** I compared the alignment of these two frontal lines in 10 normal subjects by examining the positions of the spinous processes of their thoracic and lumbar spines in 16 sitting postures. **Results.** Inclinations of the sternum and abdominal lines correlated with the thoracic and lumbar spines in the frontal and sagittal planes. The length of the abdominal line correlated with lumbar length, and the direction of curvature of the lumbar spine was either convex anterior or posterior. **Relevance to the Veteran Population.** Veterans who use a wheelchair can have posture problems, which can lead to physical and functional disabilities. Clinical methods to assess posture in wheelchair-seated persons could be one way to improve their health and quality of life.

*Hideyuki Hirose, ME, PT*

### **A kinetic analysis of manual wheelchair propulsion during start-up on select indoor and outdoor surfaces**

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**Purpose of the Work.** In this study, we conducted a kinetic analysis of manual wheelchair propulsion on select indoor and outdoor surfaces. **Subjects and Procedures.** Eleven manual wheelchair users participating at the National Veterans Wheelchair Games, Cleveland,

Ohio, 2002, were fitted with a SMART<sup>Wheel</sup>. The participants were asked to push at a comfortable pace on a course consisting of high- and low-pile carpet; tile; interlocking concrete pavers; smooth, level concrete; grass; hardwood flooring; and a sidewalk with a 5° grade. Peak resultant force, wheel torque, mechanical effective force, and resultant force rate of rise were analyzed during start-up for each surface and normalized relative to their steady-state values on the concrete flooring. Additional variables included peak velocity, distance traveled, and number of strokes that occurred in the first 5 s of the trial. We compared data between surfaces using repeated-measures mixed models and paired comparisons with a Bonferroni adjustment. **Results.** Force and torque variables on all surfaces were greater during start-up compared with steady-state propulsion on the smooth, level concrete. The greatest differences were noted between grass, interlocking pavers, and ramp ascent and tile, wood, low-pile carpeting, and smooth, level concrete. Users in this study adapted to changes in surface resistance at start-up by modifying their applied forces, torque, and number of times they struck the pushrim rather than altering their peak velocity. However, the average velocity for the more challenging conditions was slower, indicating greater deceleration of the wheelchair/user on these surfaces. **Relevance to the Veteran Population.** The differences noted between surfaces emphasize the importance of evaluating wheelchair propulsion ability over a range of surfaces that may not be readily available in a clinical setting. Moreover, the results may help indicate possible wheeling conditions that are responsible for overuse of the upper limbs in wheelchair users.

*Alicia M. Koontz, PhD, RET*

### **Comparison of low-vision reading with spectacle-mounted magnifiers**

Gale R. Watson, MEd, CLVT; Joseph Maino, OD;  
William De l'Aune, PhD

**Purpose of the Work.** Reading is the most common goal among persons with age-related macular degeneration and other retinal diseases that lead to macular loss, as well as the functional task most affected by the resulting central scotomas. This project was designed to determine whether reading ability is different when persons with macular loss read with a new hybrid-diffractive spectacle magnifier versus a refractive-aspheric spectacle magnifier and an aplanatic spectacle magnifier. **Subjects and Procedures.**

After subjects completed a low-vision examination, we assigned them to groups to compare different types of spectacle magnifiers and assessed their reading acuity, speed, critical print size (print size large enough to provide a subject's best fluent reading), accuracy, and comprehension. Subjects completed visual analog scales to indicate their perceptions of satisfaction with reading, comfort with reading, and cosmesis (comfort with allowing others to see them read) and were asked which of the compared spectacle magnifiers they preferred for prescription. We subjected data to paired *t*-tests to ascertain whether differences existed in subjects' reading ability and perceptions between the types of reading devices. **Results.** Subjects' reading comprehension, perception of satisfaction, and perception of cosmesis were significantly better with the hybrid-diffractive lens than with the refractive-aspheric lens. Subjects' critical print size was significantly better with the aplanatic lens than with the hybrid-diffractive lens, but functional reading ability was not significantly different. More subjects preferred the hybrid-diffractive lenses for prescription. The hybrid diffractive spectacle magnifiers are an important addition to the optical device armamentarium for reading with low vision. **Relevance to the Veteran Population.** Visually impaired veterans are served in the Department of Veterans Affairs (VA) system in local eye clinics, Visual Impairment Centers to Optimize Remaining Sight, and the regional Blind Rehabilitation Centers. Research of this type can inform both clinical low-vision professionals and the VA prosthetics department about the effectiveness of new low-vision devices that arrive onto the market.

*Gale R. Watson, MEd, CLVT*

### **Improving nighttime mobility in persons with night blindness caused by retinitis pigmentosa: A comparison of two low-vision mobility devices**

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**Purpose of the Work.** In this project, we evaluated and compared the ITT Night Vision Viewer and the Wide-Angle Mobility Lamp (WAML) to determine their effect on nighttime mobility in persons with retinitis pigmentosa (RP). **Subjects and Procedures.** Twenty-seven subjects with RP aged 30 to 60 were enrolled. Evaluations addressed engineering characteristics of each device and

subjects' functional performance in nighttime mobility. **Results.** Both devices improved nighttime travel for people with night blindness as compared with nighttime travel with no device. The WAML provided better travel efficiency—approaching subjects' performance in daytime travel with no device. **Relevance to the Veteran Population.** Restrictions in nighttime mobility in veterans with RP and other ocular diseases impact independence and safety. Nighttime low-vision mobility devices are of high interest to potential users as well as rehabilitation professionals. Engineering evaluation of available rehabilitation devices combined with functional evaluation with appropriate subjects provides the Veterans Health Administration with important information to guide both the delivery of rehabilitation care and policy.

*Rickilyn M. Mancil, MA*

### **Evaluating psychometric properties of a clinical and a self-report blind rehabilitation outcome measure**

Judi Babcock-Parziale, PhD; Patrick E. McKnight, PhD;  
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**Purpose of the Work.** This study determined the psychometric properties and compatibility of two blind rehabilitation outcomes measures with the use of the same sample of inpatient blind rehabilitation veterans. The instruments evaluated are the VA-13, a 13-item self-report instrument, and the Functional Assessment of Self-reliance on Tasks (FAST), an 11-item clinical measure. **Subject and Procedures.** The study sampled 190 legally blind veterans who were trained at a Department of Veterans Affairs (VA) inpatient blind rehabilitation center. Instructors assessed the participants at admission and discharge using the FAST. Veterans were called 6 weeks following training and asked to provide self-ratings on the VA-13. They were asked to rate how well they were currently functioning and to provide retrospective ratings regarding their functioning before blind rehabilitation training. We used a Rasch model analysis to assess the measurement model for both scales. **Results.** Both instruments function as screens and show signs of a ceiling effect. The VA-13 showed poor sensitivity and probably underestimated patient change. The FAST changes reliably over time, but item content needs improvement. **Relevance to the Veteran Population.** For more than two decades, veterans admitted to VA blind rehabilitation centers received individualized assessments, but no standardized measures were available for clinicians to determine the efficacy or effectiveness of the program.

This study examined a clinician-rated and a patient-rated instrument to determine if both were suitable measures of functional blind rehabilitation outcomes. Results indicate that the FAST is a suitable clinical screen that clinicians can use to identify veterans' training needs and to determine if their training goals are achieved. Administrators who use FAST results are able to accurately describe the efficacy of the training program, thereby providing an efficient feedback loop for patients and clinicians. At this time, the two instruments are not compatible (i.e., they can not be calibrated); however, both instruments can be improved with proper attention to scaling.

*Judi Babcock-Parziale, PhD*

#### **A comparison of word-recognition abilities assessed with digit pairs and digit triplets in multitalker babble**

Richard H. Wilson, PhD; Christopher A. Burks, MS;  
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**Purpose of the Work.** This work compares the ability of listeners with normal hearing and listeners with sensorineural hearing loss to understand digit pairs and digit triplets in a background noise of multitalker babble. Comparisons were also made with performance on single-syllable words that were also presented in background multitalker babble. **Subjects and Procedures.** Participants included 16 young adults with normal hearing and 32 listeners with high-frequency hearing loss. The average ages were 24 and 68 years. The digit pairs and digit triplets were listened to in conditions in which the digits were easy to understand (signal volume high, noise volume low) to hard to understand (signal volume low, noise volume high). After digits were presented, the listeners responded by repeating the digits that they heard. **Results.** Significant differences existed between performances on the digit pairs and digit triplets. About half the difference was attributable to the poor performance on the "5" digit that was included in the triplets and not in the pairs. When the data for "5" were omitted, the differences between the pairs and triplets were minimal. **Relevance to the Veteran Population.** The most common complaint of veterans with hearing loss is that they can hear someone talking but they often have problems understanding what the person is saying, especially in noise. The tests that we are developing are intended for use in evaluating a patient's ability to understand speech in noise. Because of the simplicity of the digit stimuli, the suggestion is that the digit pairs in multitalker babble can be used to screen

auditory function, especially in environments in which pure-tone testing is precluded.

*Richard H. Wilson, PhD*

#### **Effects of ischemic training on leg exercise endurance**

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**Purpose of the Work.** This study determined whether repetitive, low-load, dynamic leg-extension exercise training with marked reduction of blood flow (ischemic training) would increase exercise endurance of the legs more than the same exercise without ischemia. **Subjects and Procedures.** Ten healthy subjects volunteered, five men and five women, age 35 to 68 yr. Pre- and posttraining ramp and ischemic endurance tests were done on each leg, with subjects performing 20 leg extensions per minute. For the ramp test, after 2 min of exercise with a load corresponding to 9% to 14% of a single maximal voluntary contraction, a 2.3 kg weight was added each minute until subjects reached exhaustion. For the ischemic test, after 2 min, a cuff on the upper thigh was inflated to 150 mmHg to restrict blood flow for the remainder of the exercise. After pretesting, one leg was chosen for exercise plus ischemic training (cuff inflated to 150 mmHg during exercise) and the other for exercise training without ischemia, both with a 1.1 kg weight on each leg, 4 to 6 times for 3 to 5 min each per daily session, 5 days a week for 6 weeks. **Results.** The ischemic test showed that exercise time was increased significantly more (120%) for the leg trained by ischemia than for the opposite leg trained by exercise only and that the exercise ventilation was reduced for both leg exercises. Also, the blood pressure and heart rate recovered faster after training with ischemia. **Relevance to the Veteran Population.** Endurance training can be achieved with dynamic, low-intensity exercise with superimposed ischemia, and this may be a useful tool to increase regional muscle endurance to improve whole-body exercise capacity. This may be particularly useful in the rehabilitation of patients with heart failure and other diseases resulting in inactivity. A confirmation by future studies of improved functional exercise capacity in the veteran population by ischemic training will enhance the ability to train patients impaired by chronic diseases that limit systemic exercise training. Also, ischemic training could broaden the population of trainable patients because regional ischemic training could be implemented in patients not typically able to comply with rehabilitation programs requiring systemic training.

*Jack A. Loepky, PhD*

### **Electromyographic and kinematic nondisabled gait differences at extremely slow overground and treadmill walking speeds**

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**Purpose of the Work.** Recovery of optimum walking function is a major goal of rehabilitation. A variety of human neurological deficits may cause a substantial decrease in walking speed. Observational and quantitative gait analysis is often limited by lack of normal data at the extremely slow walking speeds seen in clients with upper-motor-neuron deficits. Further, gait analysis and training may involve both overground and treadmill conditions. This study compared kinematic (motion) and electromyographic (EMG) data of able-bodied subjects walking at self-selected and extremely slow speeds on a motorized treadmill and overground. The findings will help identify the effects of walking speed on the gait of our rehabilitation clients. **Subjects and Procedures.** EMG and kinematic gait analyses were performed on 18 nondisabled adult volunteers. Kinematic and EMG parameters were compared between natural (mean 1.45 m/s) and extremely slow walking speeds (0.30 m/s and 0.20 m/s) on overground and treadmill conditions. **Results.** The differences in gait patterns were more obvious with reduced walking (natural) speed than between overground and treadmill (extremely slow) walking speeds. Significant reductions in limb and trunk motion and substantial decrease in EMG amplitude and altered phasic timing were found at the slow walking speeds in contrast to the natural walking speeds. **Relevance to the Veteran Population.** A major goal of rehabilitation of veterans following a stroke, traumatic brain injury, or spinal cord injury is to maximize mobility and independence. Patients often adopt extremely slow walking speeds, which may further disrupt normal gait patterns. Understanding these expected altered patterns may help clinicians identify and treat the primary gait deficits with greater specificity.

*Jennifer R. Nymark, MScA, BScPT*

### **Walking speed predicts health status and hospital costs for frail elderly male veterans**

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**Purpose of the Work.** To evaluate the utility of walking speed as a functional assessment tool for acutely ill, hospi-

talized, older male veterans. **Subjects and Procedures.** Participants were 1,388 inpatients from 11 hospitals in a Department of Veterans Affairs study of geriatric evaluation and management. Elders who were identified as frail and at risk for functional decline were included in the study. We analyzed baseline walking speed and change in speed over 1 yr with health status, health service use, and costs during the same time period. **Results.** Each 0.10 m/s reduction in baseline gait speed was associated with poorer health status, poorer physical functioning, more disabilities, two additional rehabilitation visits and medical-surgical visits, 2.8 more hospital days, and higher costs. Each 0.10 m/s/yr improvement resulted in improved health status, improved physical function, 3.3 fewer basic and 0.7 fewer instrumental disabilities, 2.3 fewer hospitalization days, and 1 yr cost reductions of \$1,188. Walking speed is useful for the functional assessment of acutely ill, hospitalized older adults and may be useful for identifying those who will need the most care during the first year posthospitalization. Clinicians should consider the routine use of walking speed assessment in the hospital setting. **Relevance to the Veteran Population.** These findings suggest that screening of walking speed at admission could help clinicians identify hospitalized veterans who will need the most care in the first year posthospitalization.

*Jama L. Purser, PT, PhD*

### **Postural stability index is a more valid measure of stability than equilibrium score**

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**Purpose of the Work.** This article suggests a more valid measure of postural stability index (PSI) compared with the existing one, namely equilibrium score (ES) for veterans who suffer from balance problems. For this, the ground reaction forces using NeuroCom EquiTest System will be used for evaluating postural stability. **Subjects and Procedures.** Data from 30 subjects, 10 veterans with medically unexplained symptoms, 10 civilians with chronic fatigue syndrome, and 10 healthy people, were used to compare the composite ES computed with the NeuroCom EquiTest System and the composite PSI. **Results.** We found that PSI provides a more reasonable measure of standing anterior-posterior postural stability than ES. **Relevance to the Veteran Population.** The new PSI will be used to test whether a specific intervention is

beneficial in improving the balance or postural stability of the Veteran population, especially from the Gulf War.

*Hans Chaudhry, PhD*

**Glenohumeral subluxation in hemiplegia: An overview**

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**Purpose of the Work.** We provide an extensive overview on glenohumeral subluxation (GHS) to help understand its role in poststroke complications and to analyze the reliability and validity of clinical evaluations and the effectiveness of prevention and management. **Procedures.** We performed a systematic review using the

MEDLINE and EMBASE databases, Cochrane Collaboration's register of trials and reviews, reference lists, and bibliographies. **Results.** GHS can be considered a risk factor for the development of shoulder pain and other problems. Radiographic measurements are considered the best method of quantifying GHS; clinical evaluations can be useful as screening assessments. Functional electrical stimulation and strapping are effective in an acute stage of hemiplegia; some types of slings have been shown to be effective and may be used together with other strategies. **Relevance to the Veteran Population.** GHS is a frequent complication after stroke and its treatment can be an important factor in preventing other complications and reducing disability.

*Matteo Paci, PT, MSc*