

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

A Preliminary Investigation of Pelvic Obliquity Patterns During Gait in Transtibial and Transfemoral Amputees

Stephanie B. Michaud, MS;
Steven A. Gard, PhD;
Dudley S. Childress, PhD (*p. 1*)

Purpose of the Work. The purpose of this study was to compare and contrast the patterns of pelvic obliquity between small groups of transtibial amputees, transfemoral amputees, and able-bodied subjects. Pelvic obliquity is like the side-to-side listing of an ocean ship; it is the rotation (list) of the pelvis that is observed when viewing a person from the front or back as they walk. **Subjects/Procedures.** Pelvic obliquity was measured in six transtibial and three transfemoral male amputees as they walked over a range of speeds, and were compared with similar data obtained from three able-bodied, adult male ambulators. **Results.** Pelvic obliquity waveforms in both groups of amputees were different from normal patterns. Generally, the amplitude of the pelvic obliquity motion was observed to decrease with higher amputation levels. Most of the amputees exhibited a compensatory action—"hip-hiking"—in which the hip on the prosthetic side was raised above the stance-side hip during prosthetic swing phase. The transfemoral amputees exhibited this hip-hiking pattern for both legs. **Relevance to the Veteran Population.** The slower speeds of walking typically exhibited by persons walking on prostheses may be related to decreased shock absorption. Because pelvic obliquity appears to play a key role in shock absorption during normal walking, restoring a normal pattern of pelvic obliquity may significantly improve the gait of some lower-limb amputees. *Steven A. Gard, PhD*

An Analysis of the Input-Output Properties of Neuroprosthetic Hand Grasps

William D. Memberg, MS
and Patrick E. Crago, PhD (*p. 11*)

Purpose of the Work. A neuroprosthetic hand grasp system gives an individual control over grasp opening and grasp force by means of a voluntarily generated command signal. The purpose of this study was to document quantitatively the quality of this control, which varies with different methods of control and different grasping conditions. **Subjects.** These measurements were made on fourteen individuals with spinal cord injuries at the C5/C6 level who were using a hand grasp neuroprosthesis. **Results.** Grasp forces were greater when grasping larger objects and when using the lateral grasp. Grasp opening was larger when the wrist was flexed. The force-command relationship was more linear than the position-command relationship. Grasp opening decreased over a one year period, while grasp force did not change significantly. **Relevance to the Veteran Population.** These measurements will allow researchers to document changes in hand grasp function as different control methods or conditions are tested, making it easier to identify improvements in the neuroprosthetic hand grasps of veterans with spinal cord injuries.

William D. Memberg, MS

Trends in lower limb amputation in the Veterans Health Administration, 1989-1998

Jennifer A. Mayfield, MD, MPH;
Gayle E. Reiber, PhD, MPH;
Charles Maynard, PhD;
Joseph M. Czerniecki, MD;
Michael T. Caps, MD, MPH;
Bruce J. Sangeorzan, MD (*p. 23*)

Purpose of the Work. The purpose of this study is to assess trends in lower-limb amputations in VHA facilities. **Subjects/Procedures.** All lower-limb amputation records for 1989-1998 were analyzed using hospital discharge as the unit of analysis to assess lower limb amputation trends. **Results.** Between 1989-1998 there were 60,324 veterans discharged having had lower-limb amputations in VHA facilities. The major causes were diabetes and peripheral vascular disease. **Relevance to the Veteran Population.** It is critical to apply effective management strategies to reduce diabetes related amputations to decrease the number of amputations necessary due to diabetes and/or peripheral vascular disease.

by the Editor, for, and in the absence of, the author

Assessment of the Diabetic Foot Using Spiral Computed Tomography Imaging and Plantar Pressure Measurements: A Technical Report

Kirk E. Smith, AAS; Paul K. Commean, BEE;
Michael J. Mueller, PhD,PT;
Douglas D. Robertson, PhD,MD;
Thomas Pilgram, PhD; Jeffrey Johnson, MD (p. 31)

Purpose of Work. The purpose of this study was to combine spiral x-ray computed tomography (SXCT) imaging and plantar pressure analysis to quantify internal foot structure and external pressure during plantar loading. **Subjects/Procedures.** Methods were tested using a diabetic subject with plantar ulcer and a healthy control. Spiral CT measurement data were compared to like caliper measures to assess accuracy. Plantar loads were applied during CT scanning. Plantar pressure data were recorded and compared to walking trials. **Results.** SXCT measurements were within 2mm of truth and SXCT plantar pressure recordings were within 6.5% of walking trials. Hammer toe deformity (2nd toe), severe atrophy of the intrinsic muscles, and less contact area during plantar loading, and a peak plantar pressure three times greater at the site of the ulcer were measured in the diabetic foot as compared to the healthy control. **Relevance to the Veteran Population.** Determining the differences between the diabetic and healthy foot, and how these differences relate to plantar pressures will help clinicians and researchers to understand and manage the structural factors that contribute to skin breakdown.

Kirk E. Smith, AAS

Altered Motor Control and Spasticity after Spinal Cord Injury: Subjective and Objective Assessment

Arthur M. Sherwood, PhD; Daniel E Graves, MEd;
Michael M. Priebe, MD (p. 41)

Purpose of the Work. This paper describes the comparative utility of surface electromyographic (sEMG) recordings in studying spasticity in individuals with spinal cord injury (SCI) versus clinical assessment with the Ashworth scale. **Subjects/Procedures.** Ninety-seven veterans with SCI were studied. Subjects underwent a physical examination by a SCI physician, followed immediately by a 45 min sEMG recording during defined maneuvers. sEMG data from the passive movement section were compared with the Ashworth scores for hip and knee movement. **Results.** The activity averaged from lower limbs was significantly less in individuals with little or no spasticity judged clinically

compared to those with spasticity. Clinical and sEMG scores do not agree perfectly, but arguments are presented that sEMG data are more representative of underlying spasticity. **Relevance to the Veteran Population.** This paper proposes an alternate to conventionally used measures of spasticity to be used when quantitative objective data are needed, for example, to judge responses to new treatments.

Arthur M. Sherwood, PhD

A Practical EMG-based Human-Computer Interface for Users with Motor Disabilities

Armando B. Barreto, PhD; Scott D. Scargle, MSEE;
Malek Adjouadi, PhD (p. 53)

Purpose of the Work. This research pursues the development of an alternative human-computer interface for individuals with motor disabilities. In this interface the computer cursor is not controlled by a hand-held mouse. Instead the Electromyogram signals from the user's facial muscles are used for cursor control. **Subjects/Procedures.** The interface has been tried with able-bodied volunteers who did not use their hands to operate the computer during the trials. Four electrodes were placed non-invasively on the subjects' heads for the trials. **Results.** The test subjects successfully drove the cursor from any corner of the screen to its center, performing mouse clicks at the beginning and end of these excursions, in an average time of 16 s. **Relevance to the Veterans Population.** The performance achieved by test subjects during evaluation of this interface indicates its potential towards facilitating access of veterans with motor disabilities to the use of computers and computer networks.

Armando B. Barreto, PhD

Compelled Weight Bearing in Persons with Hemiparesis following Stroke: The Effect of a Lift Insert and Goal-directed Balance Exercise

Alexander S. Aruin, PhD; Tim Hanke, MS, PT;
Gouri Chaudhuri, MD; Richard Harvey, MD;
Noel Rao, MD (p.65)

Purpose of the Work. The purpose of this work was to evaluate the effects of a lift to the shoe on the non-paretic lower limb and targeted exercise in overcoming the learned disuse of the paretic limb. **Subjects/Procedures.** Weight bearing on the paretic side was measured while standing at rests with lifts to the shoe on the non-paretic limb. Eight

individuals with hemiparesis due to stroke participated in the study. In addition, one of the patients was wearing a shoe lift insert on the non-paretic limb during a 6-week period. **Results.** Shoe lifts improved symmetry of weight bearing during standing. There was also significant improvement of walking speed, stride length, and weight bearing seen as a result of wearing a shoe lift insert. **Relevance to the Veteran Population.** Improved symmetry of bipedal standing obtained with the lift to shoe on the non-paretic limb may contribute to better postural control and mobility in patients with hemiparesis.

Alexander S. Aruin, PhD

Effects of Thoraco-lumbar Electric Sensory Stimulation on Knee Extensor Spasticity of Persons who Survived Cerebrovascular Accident (CVA)

Ray-Yau Wang, PhD; Rai-Chi Chan, MD;
Mei-Wun Tsai, MS (p. 73)

Purpose of the Work. This study investigates the effects of surface spinal para-vertebral stimulation on knee extensor spasticity in patients with stroke. This information is useful in treating spasticity in patients who survived from stroke. **Subjects/Procedures.** Ten stroke survivors with knee extensor spasticity received electric stimulation for 45 minutes through surface electrodes applied to the skin in the 12th thoracic and 1st lumbar areas for 5 times. **Results.** Nine of 10 patients demonstrated a decrease in the modified Ashworth scale post treatment. The EMG activity of the spastic quadriceps during active knee flexion was also decreased post treatment. The active torque value of knee flexion or extension at 30, 60, or 90°/s of angular velocity did not change significantly post treatment. **Relevance to the Veteran Population.** Spasticity is present in most patients with stroke, including veterans. Our findings support the beneficial effects of surface paraspinal thoraco-lumbar sensory stimulation in the treatment of knee extensor spasticity in stroke survivors.

Ray-Yau Wang, PhD

A technique for quantifying the response of seated individuals to dynamic perturbations

Derek G. Kamper, PhD; Thomas C. Adams, MA;
Steven I. Reger, PhD; Mohamad Parnianpour, PhD;
Kamran Barin, PhD; Maureen A. Linden, MS (p. 81)

Purpose of the Work. This work describes the development of a method for measuring the postural stability of a seated individual exposed to forces that may challenge his balance. **Subjects/Procedures.** Force and acceleration data were used to estimate the position of the subject's center of mass with respect to the seat of a wheelchair. Accuracy was tested during rotation of the subject and wheelchair with a tilt platform, creating the dynamic threat to balance. **Results.** A reasonable estimation, with specified limitations, of this center of mass location could be attained with the developed technique. The equipment and methodology proved to be transferable to a van as well. **Relevance to the Veteran Population.** This technique could help improve the assessment of seated stability in dynamic environments, such as those experienced by wheelchair users in motor vehicles, in order to guide selection of cushions and supports.

Derek G. Kamper, PhD

Wheelchair rider risk in motor vehicles: A technical note

Greg Shaw, PhD (p. 89)

Purpose of the Work. The purpose of this study was to gain a better understanding of the risk involved in riding different sizes and types of motor vehicles for wheelchair riders. **Subjects/Procedures.** Wheelchair user deaths and injuries from the National Injury Surveillance System data base was used to gain insight into and better categorize wheelchair rider risk. To provide added insight and to better categorize wheelchair rider risk the investigators pursued an alternative approach using fatality rates for all passengers to approximate the risk faced by wheelchair riders. **Results.** Because of the errors in accident data, the very limited data regarding incidents and unsubstantiated assumptions required to use the data to approximate wheelchair rider risk estimating a general risk level provides a basis for decision making regarding the requirements for safety interventions including the selection of wheelchair tiedowns and occupant restraint systems (WTORS). **Relevance to the Veteran Population.** It is of critical importance to have a more accurate understanding of current wheelchair tie downs (WTORS) to help determine if poor occupant restraint belts due to alternative sitting posture significantly affects the chance of injury and therefore justifies special accommodation.

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