

Clinical Relevance for the Veteran

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Plantar Pressures with Total Contact Casting.

Jacqueline J. Wertsch, MD;
Lawrence W. Frank, MD; Hongsheng Zhu, PhD;
Melvin B. Price, DPM, PT; Gerald F. Harris,
PhD, PE; Henry M. Alba, MD (*p. 205*)

Purpose of the Work. When a person does not have normal feeling on the bottom of the foot, he/she can develop sores and ulcerated areas on the foot. One of the treatments that has been used is total contact casting. The purpose of this study was to examine how much casting reduces the pressure on the bottom of the foot. **Subjects.** Plantar pressures were collected from six individuals during walking normally and with a total contact cast. **Procedures.** A portable microprocessor-based data-acquisition system was used to record the pressure under the foot with each step. **Results.** The study results showed that total contact casting does reduce high pressure areas on the sole of the foot. **Relevance to Veteran Population.** This study helps define how total contact casting can aid in the management of the individual who has ulcerations on the bottom of his/her foot.

Jacqueline J. Wertsch, MD

A Small and Lightweight Three-Channel Signal-Conditioning Unit for Strain-Gage Transducers: A Technical Note.

Joan E. Sanders, PhD; Lezley M Smith, MSE;
Francis A. Spelman, PhD (*p. 210*)

Purpose of the Work. In Rehabilitation Medicine, biomechanical force measurements on human subjects as they walk are important. For example, force measurements between a residual limb and prosthetic socket during walking potentially provide insight applicable to the design of better prosthetic limbs. Typically, so as not to interfere with a subject's normal motion, it is important that the instrumentation be small and lightweight. The pur-

pose of this work was to develop a small and lightweight amplifier for force transducers used in biomechanical assessment. **Procedures.** The dimensions of the unit are 4.5 cm × 3.0 cm × 2.5 cm and an approximate mass of 15 grams. In evaluation studies, it was shown to perform reliably with low noise. **Results.** The unit is being used with normal and shear interface stress transducers to measure interface stresses on persons with lower limb amputation as they walk. **Relevance to Veteran Population.** The device enhances researchers' capabilities to collect relevant biomechanical data, information that potentially can be used to enhance the quality of prosthetic componentry and treatment strategies for the veteran and general populations.

Joan E. Sanders, PhD

Skin Response to Mechanical Stress: Adaptation Rather Than Breakdown—A Review of Literature.

Joan E. Sanders, PhD and Barry S. Goldstein,
MD, PhD (*p. 214*)

Purpose of the Work. Oftentimes, understanding of medical problems in one discipline can be improved by understanding related issues in other disciplines. New ideas are generated which often lead to new perspectives and approaches to medical challenges. The purpose of this review paper is to assemble work in the literature on the adaptation of skin to repetitive mechanical stress. **Procedures.** Papers from disciplines such as Comparative Anatomy and Biomechanics are discussed and put in perspective of how the findings are of relevance to Rehabilitation Medicine. The work is particularly relevant for prosthesis-users and wheelchair-users because their skin must be encouraged to adapt to become load-tolerant before excessive or prolonged weight-bearing is initiated. **Relevance to Veteran Population.** This review provides numerous examples of skin adaptation and provides insight, at a micro-level, of the adaptation process. It sets new directions for scientific research toward a better understanding of skin adaptation and toward developing new therapies to encourage the adaptation processes so that skin breakdown is avoided.

Joan E. Sanders, PhD

Phase Plane Analysis of Stability in Quiet Standing.

Patrick O. Riley, PhD; Brian J. Benda, MS;
Kathy M. Gill-Body, MS, PT; David E. Krebs,
PhD, PT (*p. 227*)

Purpose of the Work. The Purpose of this work was to determine if center of gravity and center of pressure phase plane (velocity versus displacement) plots provide insight into the dynamic aspect of balance control. **Subjects/Procedures.** We analyzed the standing balance control of 11 healthy subjects and 15 subjects with bilateral vestibular hypofunction (BVH). We altered the base of support and visual information. AP, lateral, and combined stability parameters were calculated based on the root mean square variance of velocity and displacement. **Results.** The phase plane plots and parameters showed changes in stability as base of support was altered or visual input was removed, and revealed stability differences between the control and BVH groups. **Relevance to Veteran Population.** We conclude that phase plane plots are useful in characterizing balance control. Impairment of balance control adversely affects the safety and functional status of many elderly persons including veterans.

Patrick O. Riley, PhD

Asymmetry in Walking Performance and Postural Sway in Patients With Chronic Unilateral Cerebral Infarctions.

Ekaterina B. Titianova, MD, PhD and
Ina M. Tarkka, PhD (*p. 236*)

Purpose of the Work. Hemiparetic stroke patients show various degrees of impairments in posture, gait, and voluntary movements. This study was designed to analyze the relationship between gait asymmetry in stroke patients and the ability of the patients to walk with different speeds. **Subjects/Procedures.** Twenty ambulatory patients with chronic infarction in one side of the brain were studied. Gait with five different speeds and standing posture were studied. Results were compared to similar studies performed on age-matched healthy subjects. **Results.** All patients had more asymmetric gait than the normal subjects. Increased lateral sway during standing was indicative of a narrow range of walking velocities among the patients. Interestingly, the overall gait asymmetry did not predict the ability

of a patient to use a range of velocities. Patients with lesions in the right side of the brain seemed to have less walking abilities than patients with lesions in the left side of the brain. **Relevance to Veteran Population.** Gait studies using the methods described in this paper allow objective evaluation of endurance and its development during recovery. Also, subtle changes in the different phases of gait, swing, and stance can be recognized and analyzed. Results may help in adjusting assistive devices.

Ina M. Tarkka, PhD

Strain-Based Fatigue Analysis of Wheelchairs on a Double Roller Fatigue Machine.

J. David Baldwin, PhD and
John G. Thacker, PhD (*p. 245*)

Purpose of the Work. Like many other structures, wheelchairs are subjected to loads that vary in time. Such loading is known to cause failure by metal fatigue at intensities significantly lower than the static strength of the structure. The goal of this project was to record the stress variation in wheelchair frames as they were tested on a double roller fatigue machine. From these data, the stress histories could be analyzed and fatigue life estimates could be made. **Subjects/Procedures.** Two wheelchairs, one manual, the other power, were used in this study. Using strain gages, the stresses at three frame locations on each wheelchair were measured as the chairs were run on a double roller fatigue machine. Data were collected by a computer-controlled data acquisition system. The strain histories were used in two ways. First, the strains were converted to von Mises stresses, which were evaluated in terms of maximum and minimum values. Second, the strains were used directly in a strain-based fatigue analysis to compute an estimate of the life to failure for each strain gage location on the frame. **Results.** The stress histories indicated that the frame tubes near their crossing point were the most highly stressed points on the structure. Surprisingly low stresses were recorded in the frame behind the front casters. The fatigue life estimates also indicated the cross tubes as points of anticipated failure. There was a great deal of variability in the life estimates, however, for nominally identical strain histories, indicating the need for multiple replications of the load history record. **Relevance to Veteran Population.** The procedures described here

should guide manufacturers in preparing their wheelchairs for standard fatigue tests and evaluating the structural integrity of their wheelchairs in terms of fatigue life estimates.

J. David Baldwin, PhD

Power Wheelchair Range Testing and Energy Consumption During Fatigue Testing.

Rory A. Cooper, PhD; David P. VanSickle, MS; Steven J. Albright, BS; Ken J. Stewart, BS; Margaret Flannery, BS; Rick N. Robertson, PhD
(p. 255)

Purpose of the Work. The purpose of this study was to evaluate the feasibility of three methods of estimating power wheelchair range. Another significant purpose was to compare the current draw on pavement to current draw on an ISO Double Drum Tester at one meter per second. **Procedures.** Tests were performed on seven different unloaded power wheelchairs, and loaded with an ISO 100 kg test dummy. Each of the chairs was configured per the manufacturer's specifications, and tires were properly inflated. Experienced test technicians were used for the tennis court tests and treadmill tests. An ISO 100 kg test dummy was used for the ISO Double Drum Test. Energy consumption was measured over a distance of 1500 meters for each of the three test conditions. The rolling surface was level in all cases. **Results.** The range of a power wheelchair depends on many factors, including battery type, battery state, wheelchair/rider weight, terrain, the efficiency of the drive train, and driving behavior. The predicted range for the tennis court test at maximum speed ranges from a low of 23.6 to a high of 57.7 km. The range of the power wheelchair can be improved by the use of wet lead acid batteries in place of gel lead acid batteries. **Relevance to Veteran Population.** Power wheelchairs provide an important means of mobility for many physically impaired veterans. Wheelchair standards provide a means for clinicians and veterans to compare and contrast various products. The range that a power wheelchair can travel on a single charge is an important factor to consider when selecting a power wheelchair. This

study examined factors related to providing consistent and reliable test methods for estimating range. When manufacturers and test laboratories apply these methods, they will attain results suitable for comparison. This information will make it simpler for veterans and clinicians to select the appropriate power wheelchair for each veteran.

Rory A. Cooper, PhD

An Augmented Computer Vision Approach for Enhanced Image Understanding.

Malek Adjouadi, PhD; John Riley, ME; Frank Candocia, ME; Jean Andrian, PhD; Habibie Sumargo, ME (p. 264)

Purpose of the Work. The work presented here constitutes an approach in exploiting image information acquired by the camera(s) in order to yield useful three-dimensional (3-D) descriptions of the viewed environment. A primary objective sought is the development of algorithms that seek efficient and reliable guidance cues with the intent to improve the mobility needs of individuals who are blind. **Procedures.** A mathematical framework is provided pertaining to the development of suitable 3-D descriptions of the viewed real world. **Results.** The research efforts have thus far yielded imaging techniques which (a) provided guidance cues on simple indoor and outdoor scenes, (b) detect drop-offs or depressions, (c) discriminate upright objects from flat objects, and other debris, and (d) identify important objects such as stairs, crosswalks, and shadows (false alarms) under different situations. The concepts of spatially and spectrally augmented computer vision toward enhanced analysis and understanding refer, respectively, to 1) the inclusion of the stereo disparity measure (1/2-D) along with the (2-D) images, together yielding the augmented (2 1/2-D) representation, and 2) the implementation of the multiresolution concept of the wavelet theory to analyze and assess in detail the local properties of images. **Relevance to Veteran Population.** To yield purposeful 3-D views of the environment.

Malek Adjouadi, PhD