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## Clinical Relevance for the Veteran

### SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

#### **A Method of Residual Limb Stiffness Distribution Measurement.**

William M. Vannah, PhD; David M. Drvaric, MD;  
Jeffrey A. Hastings; Joseph A. Stand, III;  
David M. Harning, CPO. (*p. 1*)

**Purpose of the Work.** A method of recording tissue stiffness maps was developed, with the intent of using these stiffness maps to shape sockets. In this report, the performance of the recording method was tested. **Subjects/Procedures.** The method used an air-driven, piston-like, indenter. The indenter pushed against the skin ten times per second. The indenter excursion was a function of the tissue's stiffness; softer areas indented more. Tissue stiffness maps were recorded four times, for each of six subjects. **Results.** The variability in the results was low (average standard deviation of 0.67 mm). However, isolated larger errors did occur with the system described. **Relevance to the Veteran Population.** Current socket CAD/CAM systems record only the outside shape of the limb. Use of tissue stiffness information, as an additional input to the CAD/CAM process, should result in improved socket fit.

*William M. Vannah, PhD*

#### **Step Activity Monitor: Long-term, Continuous Recording of Ambulatory Function.**

Kim L. Coleman, MS; Douglas G. Smith, MD;  
David A. Boone, CP, MPH; Aaron W. Joseph, MS;  
Michael A. del Aguila, MS. (*p. 7*).

**Purpose of the Work.** The objective was to develop a user-friendly instrument to monitor step activity for long periods of time in normal environments. **Procedures.** The electronics, sensor, and packaging for the Step Activity Monitor (SAM) were designed and extensively tested. A docking module that attaches to a computer and uses infrared light to program and read the monitor was also designed. **Results.** The

SAM is about the size of a pager and is worn on the ankle. It can record the number of steps a person takes each minute for over three weeks. The SAM was found to be more than 99% accurate and very durable in field use. **Relevance to the Veteran Population.** The SAM allows researchers to measure whether medical and rehabilitation treatments that aim to increase mobility and activity are actually achieving their goals. This kind of quantitative information is valuable in evaluating new treatments and measuring the effectiveness of existing treatments.

*Kim L. Coleman, MS*

#### **New Horizons in Stroke Rehabilitation Research.**

Helen Hoenig, MD; Ronnie D. Horner, PhD;  
Pamela W. Duncan, PhD; Elizabeth Clipp, PhD,  
RN; Byron Hamilton, MD, PhD. (*p. 18*).

**Purpose of the Work.** To promote health services research in stroke rehabilitation. **Procedures.** Information about stroke rehabilitation structures, processes, and outcomes was identified using extant databases (e.g., MedLine) and the Donabedian theoretical model of health services evaluation. **Results.** There are few studies identifying cost-effective stroke rehabilitation practices. Existing studies indicate that the organizational structure of rehabilitation influences stroke outcomes. While there are a number of valid and reliable outcome measures pertinent to stroke rehabilitation health services research, data about specific, beneficial rehabilitation processes and organizational structure are scanty for stroke. **Relevance to the Veteran Population.** Use of the structure, process, outcome model for rehabilitation research would help research be more informative and thereby help research be of more help in enabling the VHA to meet the needs of veterans with disabilities in a cost-effective fashion.

*Helen Hoenig, MD*

#### **Testing and Evaluation of Wheelchair Caster Assemblies Subjected to Dynamic Crash Loading.**

Gina E. Bertocci, PhD; Joseph Esteireiro; Rory A. Cooper, PhD; Therese M. Young, MS; Cherian Thomas, BS. (p. 30).

**Purpose of the Work.** Because many wheelchair users are unable to transfer to a motor vehicle seat during transportation, their wheelchairs must act as a motor vehicle seat and provide occupant protection. As most wheelchairs were not designed to function this way, they often fail under crash conditions, particularly at the casters. This study proposes a test method for evaluating caster performance under simulated crash conditions, and uses this test method to evaluate the common wheelchair casters. **Procedures.** We designed a dynamic drop (DD) testing device, with adjustable loading levels and rates that permitted us to match those of more costly sled impact testing and computer crash simulations while focusing specifically on the caster assembly. We evaluated seven such assemblies. **Results.** Five of the seven assemblies failed at loads experienced in crash situations. **Relevance to the Veteran Population.** In a crash situation, veterans undergoing vehicle transport in their wheelchairs are at greater risk than those seated in motor vehicle seats. Our method furnishes a cost-effective test for analyzing the crashworthiness of casters.

*Gina E. Bertocci, PhD*

#### **A Steering Linkage for Short Wheelbase Vehicles: Design and Evaluation in a Wheelchair Power Base® – A Technical Note.**

David M. Brienza, PhD and Clifford E. Brubaker, PhD. (p. 39).

**Purpose of the Work.** Our goals were to design a steering linkage for a powered wheelchair capable of steering all four wheels. The most important design considerations were to minimize cost and complexity while providing maximum maneuverability with a zero turning radius. **Procedures.** The traditional method for implementing such a steering linkage is to use individual steering motors for each wheel. We used a single linear actuator to control the steering angles of all four wheels for a lower cost alternative to such systems. **Results.** Our design goals were met using a linkage with just one motor to control all four wheels. Using a two-bar linkage and cam arrangement, we were able to design a linkage that permits each wheel to rotate through 180° with very little misalignment. **Relevance to the Veteran**

**Population.** When our linkage is incorporated into a compact wheelchair power base, the vehicle is able to turn about its center, thereby minimizing the space necessary to maneuver the chair. The distinction between an actively steered wheelchair and one that is driven using differential control of the drive wheels is significant. Steered vehicles provide more precise control and improved performance in adverse conditions. Wheelchairs incorporating this new linkage can improve mobility of powered wheelchair users.

*David M. Brienza, PhD*

#### **Augmentation of the 100 kg ISO Wheelchair Test Dummy to Accommodate Higher Mass.**

Rory A. Cooper, PhD; Thomas J. O'Connor, MS; Jess P. Gonzalez, BS; Michael L. Boninger, MD; Andrew Rentschler, BS. (p. 45).

**Purpose of the Work.** The purpose of this work was to describe modifications to the design of the 100-kg International Organization for Standardization (ISO) wheelchair test dummy. For several years, there has been a need for a test dummy suitable for testing wheelchairs designed for occupants with a mass in excess of 100 kg. Wheelchairs for larger people are a growing sector of the wheelchair market. The design modifications will provide larger consumers with the same quality of assurance previously only afforded to people weighing less than 100 kg. **Procedures.** The design changes are based upon published data for obese individuals. With these data, we derived equations for determining the distribution of the additional mass among the test dummy components and the locations of the centers of mass. The results of this study provide guidelines for adding mass to the 100-kg wheelchair test dummy to accommodate testing of wheelchairs designed for obese individuals. **Results.** The results of this study are the design changes and equations necessary to modify the 100-kg ISO test dummy to accommodate testing of wheelchairs for larger individuals. The design of the dummy was constructed and tested wheelchair standards procedures. **Relevance to the Veteran Population.** This study provides a proven design for testing wheelchair for larger individuals. Veterans with mass of greater than 100 kg will be able to use wheelchairs tested to standards designed for them.

*Rory A. Cooper, PhD*

### **Diabetic Amputations in the VA: Are There Opportunities for Interventions?**

Gregory G. Fotieo, MD;

Gayle E. Reiber, MPH, PhD; Janette S. Carter, MD;

Douglas G. Smith, MD. (p. 52).

**Purpose of the Work.** This study describes the sources of outpatient care and the pivotal events that led to lower limb amputation in a population of veterans with diabetes. **Subjects/Procedures.** Seventy-nine patients from three VA hospitals were interviewed about health care utilization, pivotal events, and footwear and prior amputation history. **Results.** The VA was the primary source of outpatient health care. Over one-half of the patients had a history

of a prior amputation. The most frequently cited pivotal events were shoe-related and blood vessel problems. The use of protective footwear was associated with a trend toward less shoe-related events. **Relevance to the Veteran Population.** Improvements in VA foot care has the potential to decrease amputations since the VA is the primary source of outpatient care for these people. Veterans with diabetes and particularly those with a prior amputation should be targeted for foot care programs. Finally, the prescription of protective footwear could reduce the incidence of shoe-related ulcers and potentially amputations.

*Gregory G. Fotieo, MD*