

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Balance and Stabilization Capability of Paraplegic Wheelchair Athletes.

Pierre Louis Bernard, PhD; Edouard Peruchon, PhD;
Jean-Paul Micallef, PhD; Claude Hertogh, PhD;
Pierre Rabischong, MD (*p. 287*)

Purpose of the Work. In order to prevent wheelchair athletes from having painful accidents, an investigator would need to know what the individual plans to do and whether that individual is capable of doing it. Performance analysis of the body balance regulation system in the sitting position is a basic measurement for evaluating function. The aim of the present study was to define balance control capabilities of paraplegic wheelchair athletes with different levels of injuries to the spinal cord. **Subjects/Procedures.** Acceleration transmitted to the head was measured to determine the balance performances of the subjects. Moreover, to define the strategies of the wheelchair users, the relative contribution of cervical and thoracic spines to balance was evaluated by measuring acceleration at various sites along the spinal column. Two groups, each with six athletes with paraplegia, one composed of "high paraplegic athletes" (HPA), with a neurological level between T4 and T8, and one composed of "low paraplegic athletes" (LPA), with a neurological level between T11 and L5, were selected. A third group consisting of six "able-bodied healthy athletes," was also used to provide us with a functional reference. **Results.** There seems to be a relationship between the stabilization capability and the neurological level of the subject. On the whole, we observed that the damping factor values at the head decreased with the intensity of stress. The authors attempted to differentiate balance strategies in the LPA and HPA groups through analysis of the relative contributions to damping of the thoracic and cervical spinal segments. The first results show an increasing tendency of neck reflex stiffening according to the neurological level. **Relevance to Veteran Population.** This study reveals the balance capabilities of athletes with paraplegia and offers a means of analyzing their behavior under well-defined mechanical conditions. This method could be a relevant quantitative indicator for assessing the ability of the subject with paraplegia to obtain efficient body balance in the sitting position.

Pierre Louis Bernard, PhD

A Survey of Marginal Wheelchair Users.

Barnaby A. Perks, BSc, MSc;
Rosalind Mackintosh, Dip COT;
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Geoff I. Bardsley, B Eng, PhD, MBES (*p. 297*)

Purpose of the Work. As part of a project entitled "The Determination of Optimum Wheel Configurations for Wheelchair Users," this survey was carried out to identify and describe wheelchair users in Tayside, Scotland, who have limited self-propulsion. **Subjects/Procedures.** From a population of over 3,000 wheelchair users, 83 users were selected for interview. The interview was in the form of a questionnaire designed to highlight factors limiting successful wheelchair propulsion and daily use. **Results.** Survey results indicated that marginal users represent approximately 15 percent of the occupant-propelled wheelchair population. The average age was 48 years and the largest diagnostic category was Multiple Sclerosis. Fifty-nine percent of those questioned felt that their wheelchairs were not adequate for their requirements. **Relevance to Veteran Population.** The survey results suggest direct implications for the assessment, choice of wheelchair, and on-going review of users' needs.

Barnaby A. Perks, BSc, MSc

Distributed Random Electrical Neuromuscular Stimulation: Effects of the Inter-stimulus Interval Statistics on the EMG Spectrum and Frequency Parameters.

Yuan-Ting Zhang, PhD; Philip A. Parker, PhD;
W. Herzog, PhD; A. Guimaraes A, PhD (*p. 303*)

Purpose of the Work. One basic measurement technique that is commonly used for evaluating muscular fatigue is the median frequency of the power spectrum of the electromyographic (EMG) signal. The purpose of this study was to demonstrate how different electric neuromuscular stimulation (ENMS) techniques (periodic versus random) affect spectral measurements of the EMG signal, particularly the median frequency. **Procedures.** To mimic the nonperiodic firing of active motor units as observed during voluntary muscle contraction, a random inter-stimulus interval was introduced in the electric neuromuscular stimulation protocol. A mathematical model, similar to that of EMG signal generation, was used to illustrate the dependence of the median frequency on the stimulation rate and on the pulse nonperiodicity as measured by the coefficient

of the variation of the inter-stimulus intervals. Experiments using periodic and random stimulations were performed on the cat soleus muscle. **Results.** Periodic stimulations were found to be limited in reproducing EMG spectra similar to those obtained during voluntary muscle contractions. The dependence of the median frequency on the stimulation rate during periodic stimulations is much stronger than that during random stimulations which mimic the behavior of nonperiodic firing of active motor units. **Relevance to Veteran Population.** Knowledge of relationships between spectral and stimulation measurements may help in the understanding of the mechanism underlying muscle fatigue and may lead to improved designs of electrical neuromuscular stimulators. This applies to functional electrical stimulation of paralyzed muscle to enable a person to walk.

Yuan-Ting Zhang, PhD

Initial Clinical Evaluation of a Wheelchair Ergometer for Diagnostic Exercise Testing: A Technical Note.

W. Edwin Langbein, PhD; Kevin C. Maki, MS;
Ming H. Hwang, MD; Pat Sibley, RN; Linda Fehr, MS
(p. 317)

Purpose of the Work. Numerous patients receiving health care from the VA medical system have lower limb disabilities (LLD). Previous research has demonstrated that lower limb disabled possess greater than average risk of acquiring coronary artery disease (CAD). The purpose of this study was to evaluate a new wheelchair ergometer (WCE) and exercise test protocol for detection of CAD in men with LLD. **Subjects/Procedures.** Forty-nine patients (63 ± 9 yr) completed WCE tests. Testing was done in stages with increases in work every three minutes. Metabolic and electrocardiogram measurements were taken. **Results.** Fourteen tests were rated positive, 21 negative, and 14 nondiagnostic for exercise-induced ischemia. In 18 patients who underwent coronary angiography, the predictive value was 100 percent (10/10) for a positive, and 50 percent (2/4) for a negative WCE test result. These findings suggest that WCE is a viable initial diagnostic option for some persons who cannot adequately perform treadmill or cycle exercise. **Relevance to Veteran Population.** Wheelchair exercise testing of veterans with LLD can provide clinically useful information about the presence or absence of CAD and facilitate long-term tracking of their cardiovascular health status.

W. Edwin Langbein, PhD

The Southampton Hand: An Intelligent Myoelectric Prosthesis

Peter J. Kyberd, MSc, PhD and
Paul H. Chappell, BSc, PhD, CEng, MIEE (p. 326)

Purpose of the Work. To improve the functional range of hand prostheses while enhancing the cosmetic appearance of prosthetic hands. **Subjects/Procedures.** Two subjects have used different versions of the Southampton hand. One used the hand in the laboratory for a detailed assessment of the ease by which he could operate the hand. The second used a portable system at home and work. **Results.** A comparison of the Southampton Hand with conventional devices showed it was as good as the best elements of any current device, combining the best functional performance of one with the best cosmetic appearance of another. **Relevance to the Veteran Population.** These tests show that it is possible to construct a prosthetic hand which is both more functional and cosmetic than existing designs, while ensuring that it is easier to operate. This would make the technology accessible to a wider user population.

Peter J. Kyberd, MSc, PhD

Toward Classification of Dysphagic Patients Using Biomechanical Measurements.

Narender P. Reddy, PhD; Rony Thomas, MS;
Enrique P. Canilang, MD; Judy Casterline, MA, CCSP
(p. 335)

Purpose of the Work. Dysphagia is the impairment of the swallowing mechanism and presents a major problem in the rehabilitation of stroke patients and others with paralyzing diseases. Dysphagia often leads to aspiration, choking, and even death. Current techniques of the assessment are either qualitative and often based on feeling, or involve videofluorography examination which exposes the patient to radiation. The purpose of this investigation was to develop and evaluate techniques for noninvasive measurement of the swallowing, and to develop and evaluate an expert system to classify the risk for aspiration in the patient using these measurements. **Procedures.** Noninvasive measurement of various parameters such as the tongue thrust, swallow pressure, and throat acceleration were obtained and used to classify the patient. This classification was later compared with the classification made by the clinician. **Results.** The biomechanical measurements correlated with the clinical findings well, and the expert system based on biomechanical measurements classified the patient well. **Relevance to Veteran Population.** The noninvasive biomechanical measurements of the swallowing

can be used for continuing assessment on a daily basis so as to identify the patient at risk for aspiration and prescribe proper feeding protocols.

Narender P. Reddy, PhD

A Voice Output Reader for Displays on VCRs and Other Domestic Products.

D. Gareth Evans, BSc, and Paul Blenkhorn, BSc (*p. 345*)

Purpose of the Work. To investigate a non-intrusive method, using a hand-held video camera and image processing, to enable blind people to access the electronic displays on domestic products such as microwave ovens,

video recorders, hi-fi systems, etc. **Subjects.** None. **Procedures.** To demonstrate the feasibility of such a system, a prototype has been evaluated by using emulations of a complex Video Cassette Recorder interface with Gas Plasma and Liquid Crystal Displays. **Results.** The system was found to be robust and virtually error free when precise camera alignment was maintained, except for an occasional error in interpreting '0' as '8' on a seven segment display. **Relevance to Veteran Population.** This work can contribute to the production of a 'Display Reader' which would enable blind veterans to operate current and future domestic products more effectively.

D. Gareth Evans, BSc