

Clinical Relevance for the Veteran

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Assessment of Skin Blood Content and Oxygenation in Spinal Cord Injured Subjects During Reactive Hyperemia.

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Purpose of the Work. Pressure sores (decubitus ulcers) on the skin are one of the most serious complications of spinal cord injury and other conditions which directly affect veterans as a result of loss of mobility and sensation. Many days of hospitalization may be necessary to treat these pressure sores, and the residual scarring of tissues can leave them even more vulnerable. **Subjects.** Ten able-bodied and 10 spinal cord injured subjects. **Procedures.** In this study, an optical technique was developed to noninvasively detect the amount of blood in the small blood vessels of the skin and to determine how much oxygen the blood is carrying. For periods of 5, 10, and 15 minutes, pressure was applied to the hips of a group of 10 able-bodied and 10 spinal cord injured subjects in order to detect differences in the refilling of blood to the small blood vessels of the skin once the pressure was removed. This study sought to determine whether spinal cord injured subjects experience less effective blood refill than able bodied subjects, which would help to explain the spinal cord injured subjects' increased risk for pressure sores. **Results.** Although subtle differences were detected between the two groups of subjects, they were not large enough to be of clinical significance. However, this may be one small step toward early detection of an area on the skin vulnerable to a possible pressure sore. **Relevance to Veteran Population.** It is anticipated that based on this work an objective technique for differentiation of persistent redness of the skin of a spinal cord injured person will enable early identification of tissue distress, and thus help in the prevention of pressure sores.

Martin Ferguson-Pell, PhD

A Skin Indentation System Using A Pneumatic Bellows: A Technical Note.

Martin Ferguson-Pell, PhD; Satsue Hagsisawa, RN; Robert D. Masiello (*p. 15*)

Purpose of the Work. This technical note describes the development of a mechanical device "Skin Indentation System" for use in studies that seek improved understanding of how pressure sores develop in spinal cord injured and other groups of people with conditions that result in loss of sensation and/or mobility. Pressure sores can result in prolonged periods of hospitalization, can be life threatening, and often seriously disrupt the lives of disabled veterans and others at risk for developing them. The indenter permits controlled loading of the tissues in studies where physiological responses are monitored in response to simulated pressures on the bony areas of wheelchair users, when sitting, or patients who are in bed for prolonged periods of time. The attributes of the indenter design include its technical simplicity and flexibility, which facilitate its use in studies involving disabled subjects since they can remain in a comfortable position during the period of testing. This study provides details of the design, and describes its technical performance and accuracy. **Procedures.** A computer-controlled bellows-indentation system has been developed to monitor blood flow to denervated skin that has been under prolonged pressure. The bellows indenter is attached to a free-arm stand which provides sufficient flexibility to apply forces to selective areas of the body. **Results.** Performance tests using this system demonstrate that clinical use of the system provides a tool for force application in experimental protocols for pressure sore studies. A bellows-indentation system has been developed to monitor the return of blood to the skin having been under prolonged pressure. This is discussed in greater detail on pages 1-14. **Relevance to Veteran Population.** Pressure sores (decubitus ulcers) are a serious complication among people with spinal cord injury. Prolonged externally applied pressure to the skin is a primary causal factor in generating the development of pressure sores (i.e., sitting in a wheelchair without changing position at regular time

intervals). Clinically, this system could be used for studies where the physiological response of the tissues to pressure is to be monitored following a known history of pressure sores over a particular area of the body. In this way, one could foretell the possibility of a pressure sore developing long before one actually occurs.

Martin Ferguson-Pell, PhD

Automatic Speech Recognition to Aid the Hearing Impaired: Prospects for the Automatic Generation of Cued Speech.

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Purpose of the Work. Substantial progress has been made in recent years toward developing machines for automatic recognition of speech. The purpose of this study was to investigate a possible application of this new technology in which speech cues are derived from the acoustical speech signal and then used to provide supplemental visual cues for speechreading (lipreading). **Subjects/Procedures.** Four hearing-impaired subjects participated in an experiment evaluating the effectiveness of Cued Speech, a technique for providing supplemental cues in speechreading using hand gestures. The subjects were 18–27 years of age, had acquired hearing loss before 2 years of age and were highly experienced in the reception of Cued Speech. Four subjects with normal hearing and no previous training in Cued Speech also participated. The speechreading abilities of these subjects were measured both with and without the supplemental manual cues. A second experiment compared human ability to identify relevant speech cues for supplementing speechreading from speech spectrograms with that obtainable using automatic speech recognition technology. (The speech spectrogram is a visual representation of the frequency spectrum of speech measured over a sequence of short time intervals.) Three of the subjects were highly trained in reading speech spectrograms, the fourth was an expert spectrogram reader. A recently developed model of human audiovisual integration was used to evaluate the benefit to speechreading of the supplemental cues obtainable by human spectrogram reading and automatic speech recognition. **Results.** Persons expe-

rienced in the use of Cued Speech showed close to perfect reception of continuous speech at near normal speaking rates when these supplemental manual cues were used. Predictions based on the performance of spectrogram readers and automatic speech recognizers, as producers of supplemental visual cues for speechreading, indicate that skilled speechreaders could reach a segment identification accuracy of roughly 75–90% using these cues. This level of performance is roughly equivalent to the accuracy of segment identification required for the observed level of continuous speech reception using manual Cued Speech. **Relevance to Veteran Population.** Automatic speech recognition technology offers new possibilities for audiovisual speech communication with veterans who have severe hearing loss. In order to develop practical devices for this purpose, however, it is important to determine both the potential and inherent limitations of this application of automatic speech recognition technology.

Rosalie M. Uchanski, PhD

Automated Fabrication of Mobility Aids: Review of the AFMA Process and VA/Seattle Shapemaker Software Design.

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Purpose of the Work. Computer-aided design and manufacture (CAD/CAM) of prosthetic and orthotic devices has moved out of the laboratory into clinical use. The VA Rehabilitation Research and Development Service has directed projects concerning this emerging technology under the name: Automated Fabrication of Mobility Aids (AFMA). **Procedures.** Three research groups (Seattle, Chicago, New York) formed a collaborative team to evaluate CAD/CAM systems developed in England and Canada. **Results.** The collaboration resulted in a national database of the results of fitting below-knee amputees with CAD/CAM systems. From these findings was created new mobility aid design software (ShapeMaker™) concurrent with AFMA clinical testing of preexisting systems. **Conclusions.** In order to provide a foundation for future discussions regarding AFMA, this paper provides a descriptive review of AFMA and a review of the conceptual basis for the ShapeMaker software development. **Relevance to Veteran Population.** By providing

clinicians access to user-friendly computer-based tools, the clinicians will have more information available which, in turn, will benefit the veteran consumer who will receive a better-fitting mobility aid.

David A. Boone, CP

Tibial Bone Density Loss in Spinal Cord Injured

Patients: Effects of FES Exercise.

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Purpose of Work. Past studies of the effects of physical activity on bone in spinal cord injured (SCI) patients were inconclusive. The present study evaluates bone loss in the tibia subsequent to SCI and determines if bone loss can be reduced through lower limb exercise induced by functional electrical

stimulation (FES). **Subjects/Procedures.** A group of 37 SCI subjects, 0.1 to 22.4 y postinjury, underwent tibial bone density measurements by a special computed tomography scanner, the OsteoQuant®. Fifteen of these had follow-up measurements while undergoing lower limb FES exercise programs.

Results. The bone density loss calculated from the pre-exercise measurements was between 51.5% and 32.7% for trabecular, subcortical, and cortical bone during the first 2 years postinjury. No major loss was calculated after 7 years postinjury. For the exercise group, the bone loss was reduced by 0.2–3.3% per year relative to the expected loss.

Conclusion. It appears that FES-induced exercise of 1 to 3 hours per week reduces the expected bone loss. **Relevance to Veteran Population.** Bone loss subsequent to SCI may be prevented through lower limb exercise induced by FES; therefore reducing the risk of fractures of the lower limb.

Thomas N. Hangartner, PhD