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Message from the Director

The Rehabilitation Research and Development Service (Rehab R&D) believes that the next century holds tremendous promise for clinical advances in rehabilitative care for veterans who suffer from disability or impairment. Progress made by clinician researchers makes it possible to anticipate great strides in functional recovery and thus optimal independence for patients. An increasing arsenal of rehabilitative therapies that focus not only on adaptation but restoration is now a reasonable expectation.

As a service, Rehab R&D is committed to improving the health of veterans with disabilities through six Rehabilitation R&D Centers of Excellence across the country, each specializing in a specific area of research. For example, The Center for Functional Electrical Stimulation focuses on a technology that uses a controlled electrical current to activate paralyzed muscles, playing a significant role in returning full or partial function to disabled patients. Rehab R&D's wide spectrum of research activities also include studies on amputation, spinal cord injury, vision impairment, hearing loss, and disabilities associated with aging. Rehab R&D plans to expand its service to include veterans affected by multiple sclerosis, Parkinson's disease, and traumatic brain injury. In addition, we conduct studies designed to validate rehabilitation therapies, and we are evaluating intrinsic mechanisms of healing. To further promote innovative work from the next generation of VA investigators, Rehab R&D has added four new Career Development Awardees.

We are very proud of all VA Rehab R&D investigators and are excited about the promise shown in all our funded studies. We believe you will share this enthusiasm as you read through our 1998 research accomplishments.

Mindy Aisen, M.D.
Director

■ Special Populations

Better understanding of muscle potentials will enhance nerve injury assessment.

A standard part of the clinical examination of patients with suspected nerve entrapment syndromes or demyelinating neuropathies involves stimulating a peripheral nerve and recording the electrical signal evoked in the innervated muscle. VA researchers at the Palo Alto Rehab R&D Center use cutting-edge computer simulations to gain new understanding of how these signals travel from nerves to muscles, and, consequently, spread throughout the limb. They recently demonstrated, for example, the pathway of electrical signals of hypothenar muscles in the hand from interosseous muscles several centimeters away. This discovery has important implications for the correct clinical interpretations of these signals – and for the diagnosis of patients with nerve entrapment syndromes and other nerve disorders.

McGill KC, Lateva ZC. The contribution of the interosseous muscles to the hypothenar compound muscle action potential. Muscle & Nerve 1998.
Kevin McGill
VA Medical Center Palo Alto, CA

Educational interventions may help reduce recurrence of surgically repaired pressure ulcers in SCI patients.

VA Rehab R&D researchers are testing an educational intervention to reduce the recurrence of pressure ulcers following a type of surgical repair in spinal cord injury (SCI) patients. This surgery, called a myocutaneous flap, is performed to remove severe pressure ulcers from bony protuberances; unfortunately, recurrence in SCI patients is common. Recurrence often results in multiple surgical procedures, hospitalizations, increased medical expenses, and time away from family, work, and recreational activities. VA researchers are evaluating the efficacy of individualized education and structured follow-up to reduce the recurrence of surgically repaired pressure ulcers in patients with SCI. In addition, the study will determine whether monitoring levels of urinary collagen metabolites, which reflect skin degradation, can improve early ulcer detection. When the study is completed, researchers hope to be able to reduce hospital time and medical costs and improve the quality of life for people with SCI.

Presentation and poster at the National Wound Symposium, Sept. 1998
Delivered presentation to the Baylor University of Texas, Dept. of Physical Medicine and Rehabilitation Alliance Research Conference, April 1998.
B2082RA

Researchers advance implant technology to restore elbow extension in SCI patients.

Research by VA is improving the ability of implanted neuroprosthesis systems to restore elbow extension in patients with spinal cord injury (SCI). The new technology uses electrodes implanted in the triceps to provide extension and a tilt sensor mounted on the arm to trigger supported stimulation when necessary. These improvements bring greater independence and better functional capability for patients by increasing their work space operation to shoulder level.

Memberg WD, Crago PE, Kilgore KL, Kirsch RF, Keith MW. Functional electrical stimulation to restore elbow extension in individuals with C5/C6 tetraplegia. Proceedings International Conference of the Surgical Rehabilitation of the Upper Limb in Tetraplegia 1998; (65).

Crago PE, Memberg WD, Usey M, Keith MW, Kirsch RF, Chapman GJ, Katorgi MA, Perreault EJ. An elbow extension neuroprosthesis for individuals with tetraplegia. IEEE Transactions on Rehabilitation Engineering 1998; 6; 1 (1-6). B835-3RA

New FES system provides paraplegics with local area mobility.

Advances by VA in the implantation and control of functional electrical stimulation (FES) walking systems hold great promise for paraplegics by increasing their mobility and improving their ability to work. The first research participant, a 39-year-old man with paraplegia, is now testing the new 16-channel system, which allows him to exercise and walk in a limited area around his wheelchair. Improvements in patient health and independence resulting from the use of the new FES can lead to significant reductions in the need for supportive assistance and specialized devices.

Sharma M, Marsolais EB, Polando G, Triolo RJ, Davis JA, Bhandra N, Uhlir JP. Implantation of a 16-channel functional electrical stimulation walking system. Clinical Orthopaedics and Related Research (1998) 347; (236-242). B0681-3RZ

SCI patients benefit from improved bowel and bladder control technology advances.

Bowel and bladder complications cause extensive morbidity and socio-economic cost in patients with spinal cord injury. Researchers in Cleveland, using Functional Electrical Stimulation (FES) techniques applied to bladder control, have been successful in enabling subjects to empty their bladder on demand. Consequently these subjects have shown significant reduction of urinary tract infection, urinary incontinence, and catheter usage. Further research in animal models promises to have similar successes in bowel control.

B804RA

Computer-aided wheelchair prescription system assures better fit for veterans.

A computer software program developed by VA is an effective, easy to use and affordable wheelchair prescription aid, ensuring that veterans receive vehicles that meet their needs the first time around. Properly fitted wheelchairs are critical for patients who need them. Wheelchair selection errors may lead to pressure sores, blood clots, spinal problems and unnecessary mobility or lifestyle limitations. The right wheelchair improves patients' mobility, provides them with a chance to participate in sports, expands their employment opportunities and enhances their health and quality of life.

Users and prescribers of wheelchairs enjoy a large and increasing selection of wheelchair models, each with a variety of customizable accessories. While users have the opportunity to select a wheelchair precisely meeting their needs, that doesn't always happen. One reason is information overload. With so many wheelchair models, information changes, options and manufacturers enter the scene and wheelchair standards change.

As the largest procurer of wheelchairs in the US, VA developed the Computer-Aided Wheelchair Prescription System (CAWPS) to streamline the wheelchair prescription and purchase process. CAWPS supplies easy access to accurate and comparable information on wheelchairs and tracks data on client parameters throughout the purchasing and prescription process. CAWPS also provides assistance with the preparation of written reports and justification necessary to obtain funding for wheelchairs.

Use of CAWPS helps reduce the number of wheelchair replacements because of improperly fitted chairs and lowers wheelchair maintenance costs. VA sees a substantial need among users for this program; some 20 organizations have requested that they be considered as beta test sites for CAWPS. VA currently is in negotiations with two companies to develop CAWPS as a product.

Shapcott N, Walker N. Incorporating digital video into a software based expert system. Proceedings, RESNA '96, June 7-12, 1996.

B6853DA

New tool provides more accurate bone loss information.

Research at the Palo Alto VA Rehabilitation Research and Development Center have produced new insights into the nature of bone loss in persons with spinal cord injuries and their consequent higher risk of fractures. Therapies for preventing and reversing bone loss can be evaluated with a standard clinical CT imaging system in combination with computer algorithms for bone registration and beam hardening corrections. This tool has given investigators the most accurate information to date on the loss of bone mass in the SCI patient population. In a parallel study, a method for increasing bone fracture resistance through the repeated application of low-magnitude trauma forces was developed and recently patented. More work needs to be done to prevent fractures; VA research has shown that although reduced bone mass is a significant risk factor for patients with spinal cord injury, it is not the only one.

A501-4R and A2014-R

■ Sensory Disorders & Loss

New outcome assessment tools for vision rehab are goal of major R&D study.

A major VA Rehabilitation R&D project is under way to develop new functional assessment tools that will be used to evaluate and improve the quality of a wide range of vision rehabilitation services. The multi-site initiative involves phone interviews with approximately 2,000 visually impaired veterans who receive Blind Rehabilitation Services from VA programs and another 2,000 non-veterans who receive similar services from non-VA programs. Data from these interviews will be used to evaluate and fine-tune the new functional assessment instruments and to develop risk adjustment models. Ultimately, these tools will be used to improve the efficacy and efficiency of vision rehabilitation services delivered by VA and other programs.

De l'Aune W, Blasch B, Williams M. Mobility training outcomes. Proceedings: The 9th International Mobility Conference, Atlanta: Department of Veterans Affairs Rehabilitation R&D Center 1998; 33-37.

De l'Aune W. Measurement of orientation and mobility outcomes of the rehabilitation of the visually impaired: An international perspective. Proceedings: The 9th International Mobility Conference, Atlanta: Department of Veterans Affairs Rehabilitation R&D Center 1998; 375-381.

C2179-4, C2241-R

New scanning laser ophthalmoscope promises breakthroughs in assessing visual impairment.

Researchers at the Kansas City VAMC and the Atlanta VAMC are conducting a series of studies to perfect a state-of-the-art scanning laser ophthalmoscope that will improve the assessment of visual function in people with visual impairments. Some assessments underway with the new ophthalmoscope include: the relationship between basic eye movements and the ability to carry out more complex tasks in activities of living, the ability to find visual information in a visual field, face recognition ability, and an outcomes assessment project. Ultimately, defining the relationships between visual function as assessed by the scanning laser ophthalmoscope and activities of daily living will help refine diagnosis and training methods used in vision rehabilitation services.

Schuchard RA. Fixation/macular binocular perception characteristics in low vision subjects with macular scotomas. Investigative Ophthalmology & Visual Science 1998; 39:S398.

Fletcher DC, Schuchard RA, Walker JP, Wing GL, Raskauskas PA. The effect of visual impairments on ADLs and well being as identified by the NEI-VFQ. Investigative Ophthalmology & Visual Science 1998; 39:S841. C838-2RA

Computer program quantifies language handicap in patients with aphasia.

A computer software assessment tool developed by VA researchers has far-reaching clinical applications for the assessment and treatment of language impairment in patients with aphasia. The new software program objectively assesses the amount of effort expended by listeners who are attempting to understand aphasic speakers. This information can be used to yield a measurement of spoken language handicap, encompassing both the impairment of the speaker and the effects of language im-

pairment on normal listeners. This new tool ultimately will allow clinicians to measure the severity of communication disorder in patients with aphasia, monitor their treatment outcomes, and devise training modules for primary partners.

Doyle PJ, McNeil MR, Goda AJ, Spencer KA, Cottrell K, Lustig A. The effects of concurrent picture presentation on retelling of orally-presented stories by adults with aphasia. Aphasiology 1998; 12, 561-574.

Doyle PJ, McNeil MR. Quantifying Spoken Language Handicap in Aphasia. Proceedings of the 1st Annual Meeting of VA Rehabilitation Research & Development Service 1998; 1, 51 C894-2RA

International Conference on Orientation and Mobility for the Visually Impaired hosted by VA.

Over 400 orientation and mobility clinicians and researchers from around the world gathered at the Atlanta VAMC in July 1998 exchanging new information and charting the direction of this vital field. It is particularly appropriate that the Atlanta Rehabilitation Research and Development Center hosted this prestigious event on the 50th anniversary of VA's unique blind rehabilitation program. Russell Williams, the first Chief of the first VA Blind Rehabilitation Center at Hines and a blinded veteran, presented an exhilarating overview of this field. Russell Williams developed the Rehabilitation curriculum for orientation and mobility instruction using a long white cane that is now taught world wide.

Originally published in 1980 by Dr. Bruce Blasch (Atlanta VAMC), the VA model for orientation and mobility was revised in 1998 as "The Foundations of Orientation and Mobility." Edited by Blasch, Wiener & Welsh and based on updated curriculums and research, it is recognized as the leading text in the field.

■ Acute & Traumatic Injury

VA's EPP position controller improves design and function of upper limb prostheses.

A VA research initiative using digital microcomputer technology will modernize the design of electric-powered upper limb prostheses. VA researchers are developing a position-sensitive controller that will improve functional performance, fitting flexibility, and ease in controller components. The new controller – called an EPP (electric physiologic proprioception) – provides sensory feedback from the prosthesis to the amputee, thus giving the amputee a better “feel” for the position of his prosthetic limb in space. Currently, the technology for upper extremity prostheses lags behind that for lower limb prostheses; this important VA research effort will assure better prostheses and better controllers for all upper-limb amputees.

A2087-RA

Enhanced optical scanner improves design and production of prosthetic sockets.

Computer aided design and manufacturing technologies have resulted in better, more comfortable prosthetic sockets. Even so, replicating the remaining limb shapes prior to socket design remains a problematic process fraught with flaws. These flaws compromise the fit of the prosthetic socket and limit the function of the prosthesis. To accurately duplicate residual limb shapes, the VA has designed and built an enhanced optical scanner, which is being tested at five VA prosthetic clinics for accuracy, speed and repeatability.

By eliminating the need for a plaster cast of the residual limb, VA's new optical scanner will cut in half the time required for limb characterization and measurement. Expedited design and manufacture of accurate prosthetic sockets using the new scanner will provide better, more comfortable prostheses improving the function and independence of veteran amputees.

Other applications for this device include: the compilation of a quantitative prosthetics and orthotics database for use in improving prosthetic socket and orthosis designs; the development of a database of patient limb seg-

ment contours, areas and volumes to determine the efficacy of medical treatments and rehabilitation regimens; and the use as an educational tool in the analysis of clinical practices. Precisely fitting prostheses allows individuals with amputations a better quality of life and the ability to engage in far more activities, including sports like running, skiing, and basketball.

Houston VL, Mason CP, Beattle AC, et al. The VA-Cyberware lower limb prosthetics-orthotics optical digitizer. Journal of Rehabilitation Research and Development, 32:55-73, 1995.

A2068RA

Electrical assistive device provides an attractive alternative for ventilator patients.

VA investigators are developing a fully implantable ventilatory assistive device that will greatly enhance the quality of life and independence of veterans on ventilators. Stimulating electrodes implanted through the abdomen activate the diaphragm muscle – freeing patients from the constraints of mechanical ventilators and reducing their risk for nerve damage and infection. Additionally, this approach is expected to be much less expensive than conventional methods.

Mortimer JT, Peterson DK, Nochomovitz ML, et al. Long-term intramuscular electrical activation of phrenic nerve: safety and reliability. IEEE Transactions on Biomedical Engineering, 41:1115-1126, 1994.

B6343RA

■ Aging

VA designs new system to diagnose and reduce risk of falls.

VA researchers are developing a state-of-the-art system to reduce the number and severity of fall-related injuries while increasing the mobility and independence of older veterans. This advanced accelerometric motion analysis system will assess balance and impairment in patients who are at risk for falls, help formulate individual therapies, and monitor patient progress. Currently, VA is enlisting the support of a commercial partner to develop this technology further. Potential commercial applications of this system include clinical diagnosis of nursing home and hospital patients' fall risk, as well as athletic and occupational injury prevention and rehabilitation.

E2182-DA

■ Chronic Diseases

New bonding agent makes orthopedic implants stronger.

The primary problem found in cemented hip implants is debonding at the implant-cement interface. This leads to cracks around the implant and subsequent cracking through the cement mantle to the bone. Researchers at the VA Palo Alto Rehab R&D Center and Stanford University have found a way to strengthen the bond using a unique silane coupling agent that chemically bonds bone cement to an orthopaedic implant alloy. Hip implants coated with the new coupling agent were up to 170 percent stronger than uncoated controls in laboratory testing. For hip replacement patients, this breakthrough promises implants with longer life spans and, therefore, less chance of future surgeries.

Paal AF, Yerby SA, Young PM, Beaupre GS, Goodman SB. The Effect of a Silane Bonding Agent at the Bone Cement-Implant Interface. Transactions of the 45th Orthopaedic Research Society 1999; p. 122.

Yerby SA, Young PM, Beaupre GS, Paal AF, Goodman SB. The Effect of a Silane Coupling Agent on the Bond Strength of Bone Cement and Cobalt-Chromium Alloy. 1st National VA Rehabilitation Research and Development Meeting, 1998; P111.

Scott Yerby, Gary Beaupre
VAMC Palo Alto, CA

Post-stroke patients with hemiplegia benefit from strenuous exercise.

A new study by researchers at the VA Palo Alto Rehab R&D Center challenges the conventional belief that patients with post-stroke hemiplegia should refrain from strength training exercise. Muscular weakness can be a serious problem for post-stroke patients with hemiplegia, or paralysis that affects only one side of the body. But few of these patients are prescribed a strength training regimen because of the widely held view that this type of exercise increases spasticity. In the VA study, 15 patients with post-stroke hemiplegia pedaled an exercise bicycle at different workloads. The researchers found that, at higher workloads, the patients were able to produce greater forces with their functional legs – without increases in movement dysfunction. These results suggest that strenuous exercise such as bicycle pedaling at higher workloads can have a positive effect on people with post-stroke hemiplegia.

Brown DA and Kautz SA. Increased workload enhances force output during pedaling exercise in persons with post-stroke hemiplegia. Stroke 1998; 29: 598-606.

Steve Kautz, Kevin McGill
VAMC Palo Alto, CA

Pedorthotics - a new computer technology advances orthopedic footwear design.

Proper custom orthopedic footwear for patients with foot deformities is essential to their physical independence and well-being. But the traditional manual method of designing and manufacturing this footwear is labor-intensive and demanding. New computer-assisted technology is revolutionizing the design and fabrication of orthopedic footwear at VA clinics. The Pedorthotic CAD/CAM System, developed by VA Rehab R&D researchers in New York, will expedite the delivery of custom orthopedic shoes for veterans with podiatric neuromusculoskeletal disabilities; degenerative disorders such as diabetes; arthritis; and peripheral vascular disease. Five VAMC Prosthetics-Orthotics clinics are currently participating in a study to test the use and effectiveness of this system.

In 1998, the Pedorthotics team won the health care division category in the prestigious Microsoft “Windows World Open,” the annual international competition which awards developers for innovative work in solving industry problems.

A674-3D

New 3-D computer model of the foot and ankle aids investigation of foot deformities.

Researchers in Seattle seek to improve preventive and corrective therapies used to address severe foot deformities through better understandings of underlying biomechanical phenomena. This group has validated a three-dimensional computational model that uses techniques of finite element analysis and multibody dynamics to examine the role of anatomical structures in the progression of deformities. With this information, investigators hope to better predict surgical outcomes and to optimize the design of corrective orthoses.

A2034 RA

Researchers identify pathways linked to motor recovery from stroke.

Research into the relationship between the central nervous system and motor function will have an important impact on the evaluation and treatment of stroke patients. This study has already supplied evidence that at least seven pathways in the brain play a major role in motor recovery following cortical stroke or damage. These findings will help clinicians make more accurate predictions about functional recovery following a stroke.

Strick PL, Hoffman DS. Effects of a primary motor cortex lesion on step-tracking movements of the wrist. Journal of Neurophysiology, 73:891-895, 1995.

B2013RA