Conference Reports

Conferences sponsored by the VA Rehabilitative Engineering Research and Development Service, or by individual VA Medical Centers in cooperation with VA RER&DS programs, will be reported in this new regular section of the Bulletin. In some cases we hope to publish the complete proceedings of important conferences, when other facilities for timely publication are lacking. In most cases, more brief accounts should be expected, with emphasis on subjects, contributors, and the availability of papers or a "Proceedings'

Conference Title:

NERVE-BUNDLE CONDUCTION VELOCITY DISTRIBUTION WORKSHOP

RER&D Center, VA Medical Center, Palo Alto, California

July 23–24, 1979

The Rehabilitative Engineering Research and Development (RERanD) Center of the Palo Alto VA Medical Center sponsored a workshop on a new class of methods for evaluating peripheral nerve function—nerve-fiber conduction velocity distributions (NCVDs).

Contemporary clinical methods for studying conduction in peripheral nerves characterize only a small subpopulation of the thousands of nerve fibers in a nerve bundle. The signals recorded routinely during conventional nerve-conduction studies contain information about nerve fibers with a wide range of velocities, but only the fastest fibers are currently analyzed.

The practice of studying only the fastest fibers has been accepted because of previous inability to extract quantitative information about the slower-conducting fibers. Over the past 5 years, however, several research groups have attempted to extract more information from the compound action potential (CAP) of a nerve bundle. The approach has been to estimate the distribution of conduction velocities in a nerve bundle using methods derived from analytic models of the CAP. The NCVD is similar in concept to the histologic fiber diameter distribution, but may be obtained using noninvasive electrophysiological methods. It is a measure of the contribution to the CAP made by nerve fibers in each conduction-velocity class.

The development of procedures for estimating NCVDs is the result of collaboration between clinical neurophysiologists and engineers working in the area of neurological signal processing. Although the necessary engineering tools and physiological models have been available for more than 40 years, it has required the catalyst of inexpensive but powerful laboratory computers to make such procedures practical. These methods offer a new way to evaluate nerve bundles that may be useful in the detection and diagnosis of peripheral neuropathy, as well as for studying the dynamics of nerve growth, development, degeneration and regeneration.

This workshop was a prototype for future meetings to be sponsored by this Center. Like others in various fields, it brought together principal investigators in a specific area of research to foster candid exchange of knowledge and ideas. Other specific goals were to compare the relative strengths and weaknesses of different methodologies, to propose standardization of certain quantitative aspects of the estimation procedures, to define assumptions and other areas requiring additional verification through basic research, and to promote a continuing dialog among geographically separate groups of investigators during the further development and application of these new analytical tools.

The workshop was open to the scientific community at large, but presentations and discussions were directed toward those with intimate knowledge of the subject. The 2-day format included detailed presentations by each investigator, followed on the second day by an open-ended roundtable discussion. Time was alloted for specific questions at the end of each presentation, but more global and philosophical questions were saved for the discussion. At the end of the second day, a joint laboratory experiment was designed and executed to compare experimental techniques and analysis methods.

In conversations before and during the workshop it became apparent that the conferees recognized a need to make the new methods under discussion more accessible to the biomedical community, free of the constraints imposed by the engineering and medical scientific journals. Each major group of participants was asked to submit its own material in the form of a chapter for publication, and these contributions constitute the central chapters of a monograph to be published early in 1981; the title is Conduction Velocity Distributions: A Population Approach to Electrophysiology of Nerve. Editors are L. J. Dorfman, K. L. Cummins, and L. J. Leifer. The publisher, Alan R. Liss, Inc., 150 Fifth Ave., New York, N.Y. 10011, expected to be off press by Jan. 29, 1981.

Selected segments of the discussion that took place during the presentations are appended to each of those chapters. It is our hope that the information in this monograph will be a starting point for investigators wishing to perform related research, and a reference guide for the clinical application of the methods.

The workshop's two days were divided into four segments. The first, moderated by L. Leifer, included these presentations: S. Bement, Single-Fiber Nerve

Conduction; S. Waxman, Pathological Conduction in Peripheral and Central Nerve Fibers; W. Olson, Fiber Diameter Distribution and Compound Action Potentials; and Z. Kovacs and T. Johnson, Nerve-Bundle Conduction Velocity Distributions—A Method Assuming Noisy Single-Fiber Action Potential (SFAP) Estimates.

Under the moderation of D. Perkel were these presentations: D. Sax and Z. Kovacs, Clinical Applications; A. Barker, Nerve-Bundle Distributions—An Iterative Method Using Two Recorded Compound Action Potentials (CAPs); K. Cummins, Nerve-Bundle CV Distributions—Closed-Form Estimate Based on Two CAPS; and L. Dorfman, Clinical Applications.

Under moderator K. Cummins: L. Leifer on CV Distributions in Motor Nerves, and S. Levine on Parameter Sensitivities in Muscle CAP Models. A discussion followed on model/distribution parameterizations, test procedures and controls. L. Dorfman then moderated discussions of major weak points and areas requiring further research, followed by discussion of chapter outlines and plans for the monograph.

Conference Title

1980 INTERNATIONAL CONFERENCE on REHABILITATION ENGINEERING

June 16–20, 1980, at The Sheraton Center, Toronto, Ontario, Canada. (Conference proceedings available.)

Following two major assemblies in North America, the 1978 and 1979 Interagency Conferences on Rehabilitation Engineering, the 1980 International Conference on Rehabilitation Engineering (ICRE), sponsored by eight international, Canadian, and American rehabilitation organizations and the firm of Everest & Jennings, Inc., was held June 16–20 at The Sheraton Center, Toronto, Ontario, Canada.

The Conference scheduled a stimulating diversity of events, including workshops on topics of current concern to the rehabilitation world, a plenary workshop session, and a summation of workshops held on the last day of the Conference; five scientific paper sessions, run in three parallel schedules and reflecting state-of-the-art activities in a wide range of highly relevant topics; and a coordinated set of instructional courses planned to provide specialists with the fundamental principles of areas outside their own specializations.

Each 2-hour instructional course was acceptable for 2 credit hours in Category I for the Physicians Recognition Award of the American Medical Association as well as for study credit by the College of Family Physicians of Canada.

In addition, the Conference program featured exhibits, audiovisual forums, a student Papers and Design Competition, ancillary meetings, tours of local rehabilitation institutions, and receptions. The keynote address, on the theme of "Integration Through Technology," was given by Dr. Paul Dollfus, Chairman, ICTA, Mulhouse, France, following the official Conference opening.

The 93 booths in the exhibits area displayed research and development advances and new products in such fields as robotics, pathokinesiology, non-vocal communications, microprocessors, pain control, noninvasive cutaneous blood flow monitoring and measuring techniques, shadow moiré, and implantable transducers.

On Wednesday, June 17 the first annual Everest & Jennings Distinguished Lecture took place in the Centre's Civic Ballroom, delivered by Colin A. McLaurin, D. Sc., P.E., Co-Director, Rehabilitation Engineering Center, Charlottesville, Virginia, following announcement of the new lecture series earlier in the day at an ancillary meeting of the Board of Directors of the Rehabilitation Engineering Society of North America (RESNA).

Another event of special note was the Student Awards Luncheon, on Thursday, June 19, in the Grand Ballroom. The finalists in the ICRE Student Papers and Design competition were presented with cash awards, funded by the Canadian Imperial Bank of Commerce, and The War Amputations of Canada. Mr. James Jenkinson, National President, The War Amputations of Canada, made the awards presentations.

Copies of the conference proceedings, entitled "Proceedings 1980: International Conference on Rehabilitation Engineering," which incorporates details of the scientific papers read at the conference, may be purchased, at $20.00 per copy prepaid, from:

Canadian Medical and Biological Engineering Society
c/o National Research Council of Canada
Room 183, Building M-50
Ottawa, Canada K1A OR8.

VA AMPUTEE WORKSHOP
(Summary and Recommendations)

March 29–30, 1979, at VA Hospital, Seattle, Washington. (The entire proceedings of the workshop were recorded and are available upon request.)

Participants included patients, basic and clinical research persons, prosthetists and prosthetic representatives, rehabilitation specialists, vascular and general surgeons, orthopaedic surgeons, and VA administrative personnel.

Analysis of inpatient and outpatient VA amputee population indicates that approximately 85 percent of major amputations now performed in VA hospitals are the result of vascular disease. Barring war or other national emergency, this amputee patient profile should remain relatively constant.

Amputees attending outpatient clinics and receiving VA services differ from hospital inpatient amputees: a much larger percentage of the outpatients are war and trauma related. Many are young males reflecting the war experience of Korea and Vietnam. Occasionally these younger war-related patients require revision surgery and in some instances come to primary amputation as a result of infection or deteriorating function. However, both revision and primary amputation under these circumstances are

becoming less frequent. The total caseload of major amputations can be expected to increase as more veterans reach the age at risk for degenerative vascular disease of the extremities.

The organization of clinical services, the quality of care, the level of rehabilitation and the per-patient cost to the Veterans Administration vary widely throughout the VA hospital system. This applies in particular to the ischemic amputee population. Without outlining specific circumstances or overall statistics, it is evident that not only is the quality of care erratic, it is in general inferior to that which can be attained on the basis of current, available, proven clinical experience. (This same situation exists among many civilian hospitals in the U.S., where amputee care may be far below the standard of quality appropriate.)

Deficiencies in present care are costly. Moore, et al., speaking at the workshop and based on their experience with vascular amputations at the San Francisco and Tuscon VA hospitals from December 1966 through August 1978, project a savings of approximately 80 million dollars to the VA over the next 5 years by upgrading the administration and care of inpatient amputations throughout the VA system. They note "this financial windfall is over and above the clear benefits to individual patients to whom lower mortality, and morbidity, and increased rehabilitation with return to productive life, cannot begin to be measured in economic terms". (Malone, Moore, Goldstone, and Malone)

There are, throughout the system, VA hospitals and outpatient services which now provide outstanding high-level clinical care and rehabilitation. These units provide a model from which deficiencies can be measured and statistical support obtained.

A reorganization and redirection of research, education, and clinical service is timely and is a high priority in VA health care.

Recommendations:

1. The Vascular Amputee

a. **Research**: The key to lowered morbidity in occlusive vascular disease is basic research. We must know more about etiology, evolution and possible prophylaxis. Surgery, whether vascular reconstruction or amputation, is palliative and does not basically alter the course of the disease.

There is inadequate objective information available to predict successfully the level of amputation expected to heal primarily in ischemic limbs. Amputee rehabilitation in the dysvascular patient is linked directly to level. In general, salvage of the knee means the difference between independent walking or not. This is usually true of the unilateral lower extremity amputee and almost completely true with bilateral amputees.

Sufficient clinical experience can make possible fairly astute judgement as to the appropriate level for amputation. There are, however, only a small number of experienced amputation surgeons, not only in VA hospitals but among all surgeons in America. Noninvasive, dependable, inexpensive laboratory tests are urgently needed. Laboratory studies directed towards evaluating extremity blood flow have been developed primarily to predict the site and success rate of vascular reconstruction. These tests are of limited value in determining the necessity or optimum level of amputation. Further data-gathering techniques are required. Under present study and clinical trial are such methods as thermography, the rate and degree of uptake of radio-active Xenon (Xenon 133), transcutaneous PO_2 ($TcPO_2$) determination, Doppler systolic shift of a monochromatic laser light recording red blood cell motion in skin capillaries, filter skin photography measuring hemoglobin content, segmental plethysmography, photo plethysmography, and skin perfusion. Active pursuit of this dynamic extremity blood flow research, both in man and animals, is required.

b. **Prosthetics**: Progress has been made recently in devising stable lightweight limbs for the geriatric patient. Ongoing research will be directed toward limb substitutes that minimize energy requirements that allow more adequately for associated disabilities and are easy to manipulate. Prosthetic innovations, a constructive departure from standarized fabrication and materials, can significantly improve quality of life for the dysvascular person. Cosmesis is far less important than stable, comfortable function. A new "family" of substitute limbs to meet special demands of these patients can be forthcoming with continued basic and applied research.

c. **Rehabilitation**: Available rehabilitation techniques have in many instances not been adequately tailored to the dysvascular amputee. Health care services are just now awakening to the special needs of, and opportunities for, accomplishment among the physically disabled elderly. Social attitudes toward this large segment of our population are changing; realistic, attainable rehabilitation goals can be individually established. Rehabilitation of the elderly dysvascular amputee, within the confines of the practical and possible, represents service of a high order. Small life-style gain is frequently of critical value to these citizens.

2. The Non-Vascular Amputee

War and non-combat trauma have left to VA responsibility several statistical peaks of amputees, the most recent being from Korea and Vietnam.

a. **Research**: Basic research relevant to these veterans, particularly the younger amputees, should include:

1. Fundamental studies in wound healing;
2. The response and adaption of skin and the deeper tissues to pressure and other force vectors such as shear, strain, stretch, etc.;
3. Detailed evaluation of the physical characteristics of residual limbs. Examples of such research are computerized X-ray photogrammetry of residual limbs using small metal implant markers; computerized volume displacement studies of residual limbs for gross volume, also contour mapping, displacement and pressure changes (with

and without weightbearing) in the absence and presence of muscle activity, etc.;

4. Improved understanding of amputee pain at the basic investigative level, which includes animal experimentation, electrical, histochemical, and morphological responses;

5. Muscle physiology as it relates to function in stabilized muscles in amputees;

6. Afferentation, i.e. sensory capabilities of residual limbs and the transfer of afferent tissue capability including secondary center augmentation;

7. Limb regeneration.

b. **Prosthetics**: The history of limb substitutes can be described as periods of rapid advancement of knowledge and plateaus of inactivity. The former have generally been associated with war. Since World War II however, there has been a modest but steady accrual of improved knowledge and technique, evaluation, and systematic dissemination of results. We could well be at the threshold of a significant spurt in prosthetics activity. Coupling of prosthetic design with patient function, particularly in the area of recreation, is needed. The more the amputee wishes to expand his or her physical capability, the greater the need for biomechanical analysis, gait studies, suspension systems including physiological suspension, and translation of new engineering and material research from other fields.

c. **Statistical**: Lack of accurate statistical information regarding the VA amputee population, and in fact amputees generally throughout the United States, is a roadblock to further improvement in amputee rehabilitation. The basic numbers are generally available. Facts such as the functional capability of various amputee profiles, information regarding vocational activity, intercurrent and possibly related illness and disease, and many other social, economic and medical facts can assist in establishing rehabilitation goals with prompt economic realization. An accurate knowledge of prosthetic utilization among older, non-institutionalized amputees is currently needed. Clinical, bio-statistical research support can provide additional guidelines and direction.

Summary

The workshop asked the Prosthetics Research Study to present an organization and management plan to implement recommendations. This plan has been completed.

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