

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, are among those reported in this regular section of the Bulletin. We hope to publish the complete proceedings of important conferences when other facilities for timely publication are lacking. In most cases, brief accounts should be expected.

Conference Title

FIRST ANNUAL MEETING OF THE BIOELECTRICAL REPAIR AND GROWTH SOCIETY

Philadelphia, Pennsylvania. Local arrangements by Dr. Z. B. Friedenburg and Nancy Thiede.

November 1981

The first meeting of the newly formed Bioelectrical Repair and Growth Society (BRAGS) brought together about 225 clinicians and basic scientists to share their latest efforts in electrically induced osteogenesis, chondrogenesis, peripheral nerve repair, regeneration and other soft tissue effects of bioelectricity on both the cellular and clinical level. Elected president was Dr. Carl T. Brighton, chairman of the Department of Orthopedic Surgery at the University of Pennsylvania. Dr. Joseph Watson, Department of Electrical Engineering, University of Wales, Swansea, U.K., was named president-elect.

Most of the papers presented were on bioelectrically stimulated osteogenesis. Progress of *in vitro* experiments on musculoskeletal cells and tissue was reported. Using both pulsed magnetic fields and capacitively coupled (electric) fields, groups from France, Israel, England, and the United States reported biochemical changes in cultured chondrocytes, chondroblasts, osteoblasts, and bone and cartilage fetal explants. These changes included an increase in DNA synthesis, c-AMP, glycosaminoglycans, and a decrease in alkaline phosphatase in several cases, and decrease in c-AMP, proline production and chondrogenesis in another. Some additional evidence for frequency (pulse rate) dependence as well as amplitude dependence was reported. While not all groups agree on mechanisms, most are firmly convinced that induced electric currents can markedly affect biochemical cellular processes. Inconsistency between groups, in the precise nature of the applied field, makes precise comparisons difficult thus far.

A number of basic studies relating to bone formation at electrode implants were also presented. A study in rabbits (Janssen et al, Utrecht) demonstrated bone growth at an intramedullary anode (most reports have favored the cathode) and this was also observed using bimetallic implants at much lower currents (Spadaro, Syracuse). Two reports were made of osteogenesis stimulated at 100 nanoamperes and below using DC cathodes, extending the lower limit of this phenomenon. Increased blood flow around titanium cathodes was demonstrated using the hydrogen washout technique in cat femora (Collins, Patterson et al) while the same group reported no significant change in electrode impedance during the course of cathode-stimu-

lated bone formation. Groups from Berlin and Utrecht showed electrochemical evidence that electrochemical reactions at DC electrodes are significant and could explain the success of such electrodes in stimulating osteogenesis *in vivo*. At moderate potentials (depending on the electrode material), pH shifts do not appear to be involved, but such shifts at higher potentials may be the cause of necrosis in tissue. Studying the cellular changes around the 20 microampere stainless steel cathode, Brighton and Hunt observed the appearance of polymorphic cells clustered about blood vessels in the medullary canal, which, in turn, seem to give rise to osteoblasts which lay down new bone tissue. Another report from the Philadelphia group gave evidence that the healing of segmental gap osteotomies in rabbit tibiae was **not** enhanced by the stainless steel cathode implant, agreeing with earlier reports that accelerated fresh fracture healing may not be stimulated by such an electrode.

On the clinical application of electrical stimuli in the healing of nonunited fractures, several updates were presented. The Philadelphia group (Brighton et al) reported results on 324 patients over the last 10 years using the semi-invasive, 20-microampere, stainless-steel cathode method. Results showed variable successes: Humeral nonunions, 54%; Tibial nonunions, 86% healed; overall, 83% success. Pin tract irritation was a complication (11%) while deep infection was not. Dr. Fritz Lechner (Garmische-P., FRG) reported on 325 nonunions treated with the Kraus/Lechner technique (low-frequency induced currents in special electrode implants). On average, the patients had 3.3 prior operations, and 105 were infected. With hospitalization usually less than 4 weeks, 93% achieved healing of their fractures. Mulier and colleagues (Belgium) reported 86% success rate in a small series of tibial nonunions treated with the Bassett/Pilla noninvasive pulsed magnetic field (PMF) method. Watson (Swansea) reported (with Downes) results on 40 patients using his PMF method based on an iron-core magnet operated at 1 Hz applied over the fracture site (non invasively). Results showed 70% of the patients achieved sound bone union in this series.

Other papers on clinical applications of electrical stimuli to the skeleton included one by Bassett et al. on PMF treatment of 20 patients with avascular necrosis of various causes. Radiographic improvement of the bone density as early as 2 months into the treatment was noted, with some reduction in pain and disability. Inoue et al. (Gifu, Japan) presented results on nine aged patients with intracapsular fractures of the femoral neck, treated with multiple pin-

ning and DC current through the pins for 5–7 weeks. All cases healed within 6 months, according to the authors. In addition to 53 cases of un-united fractures treated with the Bassett/Pilla PMF technique (71% healed), W.J.W. Sharrard (Sheffield, U.K.) treated 11 children with congenital pseudarthrosis of the tibia, with union achieved in 6.

The old controversy over the source of stress-generated electric potentials in bone was still being discussed, with the weight of evidence, especially from Pienkowski and Pollack (Philadelphia), pointing to streaming potentials as the most likely source in potentials measured in wet bone. The same was true for cartilage (Grodzinsky, MIT). It is felt that such potentials could be involved in the remodeling and maintenance of bone tissue.

New techniques being applied to bone healing were reported as well. Brighton applied radiofrequency current via "capacitive coupling" to fresh fibula osteotomies in rabbits and obtained improved healing progress versus controls at 10 days after injury. One of the pair of plate electrodes was insulated, the other made contact with the skin. The technique is surgically noninvasive. A group from Muenster (FRG) used two frequencies of alternating current to treat osteotomies in the right foreleg of sheep. The currents, they claim, produce a "beat" frequency (called "dynamic interferential current") of about 100 Hz at the fracture site. The authors report 3–10 times higher alkaline phosphatase levels in treated tissue.

Various experiments were described by groups from Belgium, New Jersey, Chicago, and London on attempts to enhance the healing and growth of skin, using direct current electrodes, and radiofrequency energy. Preliminary results were positive in 3 of 4 experiments. Wound healing with electricity may be considered a possibility, if future work confirms these results.

Frank and co-authors (Calgary, Alberta), assessed the effects of a 1-Hz pulsed magnetic field of the iron core (Watson) type on the healing of medial collateral ligaments in rabbits. Twenty-one and 42 days after division, suturing and daily PMF treatment in special slings, microscopic sections showed an increase in the vascularity and organization in the treated vs control tissue. Biochemically, hydroxyproline was significantly increased and hydroxyline significantly depressed in treated ligaments. The elastic modulus of the ligament was also twice as high in treated vs control groups.

Several interesting papers on healing and growth in nervous tissue were presented. D. H. Wilson (Leeds) reported acceleration of recovery in cut peripheral nerves treated with 27 MHz RF energy in both animal trials and human injuries. He also reported some measure of spinal cord repair using this modality in hemichordectomy in the cast. A group from Israel reported that the growth of neurites in regenerating goldfish retinas can be affected in magnitude and pattern by the application of a pulsed magnetic field. Siskin (Lexington, Ky) improved the limb regenerative activity in 4-day chick embryos with a combination of neural tube transfer and bimetallic current sources implanted to the site of the developing humerus.

An attempt to assess the effects of pulsed magnetic fields (PMF) of the Bassett/Pilla type on tumor cells in vivo was reported by Smith (Lexington, Ky). LSA lymphoma/as-

cites tumors in C57NA mice were treated by exposing the animals to the PMF or to an antitumor drug (BNCU) or both. The PMF alone or in combination with the drug did not significantly enhance survival of the infected animals, but the PMF treatment markedly decreased the spleen weights of the animals which were exposed. Furthermore, there seemed to be a pulse rate effect in that some frequencies of PMF seemed to reduce the activity of the BNCU agent. The prospect of modifying the action of systemic antitumor agents, especially at the tumor site, with electromagnetic stimuli seems worthy of further attention.

The next meeting will be held Sept. 20–22, 1982, in Oxford, U.K. For further information on the BRAGS society and copies of the transactions contact:

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Conference Title:

RESPIRATORY REHABILITATION AND POST-POLIO AGING PROBLEMS

Co-sponsored by Rehabilitation Gazette and Rehabilitation Institute of Chicago, Illinois

October 14-16, 1981

The catalyst for this unique conference was a special feature on respiratory rehabilitation and post-polio aging problems in the 1980 issue of the international journal, *Rehabilitation Gazette*. That issue highlighted the growing awareness of those problems and featured both medical and subjective experiences with post-polio motorneuron disease, which may accelerate the aging process and cause increased weakness of previously weakened muscles. It emphasized the lack of present medical experience with post polio-problems, and the lack of knowledge of the cost-effective home care experiences of post polio respirator-users—which are also relevant to many other disabilities.

Since budget-cutting times precluded federal funding, the conference was funded by the participants, who paid their own expenses, and by readers of the *Rehabilitation Gazette* and several other organizations that contributed to a fund which supplemented travel, hotel and equipment rental expenses for those who otherwise could not have attended. The contributing organizations included: Care for Life, Children's Memorial Hospital, Class of 1956 of Indiana School of Medicine, Lifecare Services, Inc., National Easter Seal, National Foundation, Northwestern University Medical School, and the President's Committee on Employment of the Handicapped.

The participants were polio survivors of the epidemics of the 1950's and physicians and therapists of those days, as well as pulmonary specialists and other physicians and medical personnel of the present day. There were nearly 200 participants—about 70 of them quadriplegic or paraplegic because of polio. These disabled individuals had a tremendous impact on the conference, demonstrating that very severely disabled persons can live productively at

home with appropriate services. About 30 of the quadriplegic participants have been using respirators, either full-time or nighttime, for more than 25 years. They live at home, have successful careers or manage households, raise children, and manage their physical needs with the assistance of their families and attendants.

Because so few contemporary physicians have experienced treating polio survivors, many participants were relieved to learn of a one-day evaluation program by an expert on their respiratory management, Augusta Alba, M.D., Goldwater Memorial Hospital, N.Y. The participants shared information and experiences with oral positive volume ventilators and oral positive pressure respirators that will make traveling more feasible for many who have been using iron lungs and that give more adequate ventilation to those who have been using less efficient respirators.

The conference called attention to the need for a network of information on the specialized needs of aging polio survivors and other respirator users. Until a more structured network is created, an informal network will continue to be available from the editors and readers of the *Rehabilitation Gazette*, which has been functioning as the international hub of specialized information for polio survivors since 1958.

The conference underscored the need for regional centers and for transferring the knowledge and experience gained by physicians who specialized in the management of respiratory polio quadriplegics to those now coping with respiratory management of other disabilities. One of the suggestions made was a training period with Dr. Alba for a pulmonary or related specialist from each of the regional spinal-cord-injury centers.

Many practical suggestions evolved during the conference. For instance, those who used a respirator initially and then were weaned should now have an evaluation by a pulmonary specialist to establish a base line and to determine if night respiratory assistance might be indicated. Others, without respiratory involvement, who are experiencing increasing weakness, should have an evaluation by a physiatrist. Some may have to change from crutches to a manual wheelchair or from a manual to a motorized wheelchair and make other adjustments to age.

The Planning Committee consisted of Eveline A.M. Faure, M.D.; Allen I. Goldberg, M.D., Medical Director, Division of Respiratory Care, The Children's Memorial Hospital; Gini and Joe Laurie, editors, *Rehabilitation Gazette*; Don A. Olson, Ph.D. and Elly Henig, Rehabilitation Institute of Chicago; and Margaret Pfrommer, Northwestern University Rehabilitation Engineering Program.

The participants came from Sweden, France, England, Germany, Canada, and the United States. Among the speakers were the following nondisabled medical personnel: Augusta Alba, M.D., Goldwater Memorial Hospital; Ann A. Bailey, M.D., Roosevelt Warm Springs Institute for Rehabilitation; Henry B. Betts, M.D., Rehabilitation Institute of Chicago; Mary Jay Bullock, O.T.R., Johns Hopkins Hospital; David Dickinson, M.D., University of Michigan Hospital; D. Armin Fischer, M.D., Rancho Los Amigos Hospital; Ernest Johnson, M.D., Ohio State University Hospitals; Joseph Kaufert, Ph.D., University of Manitoba Faculty of Medicine; Matthew Lee, M.D. Goldwater Memorial Hos-

pital; Frederick M. Maynard, M.D., University of Michigan Hospital and Geoffrey T. Spencer, FFARCS, St. Thomas' Hospital, London. The keynote address was made by Surgeon General C. Everett Koop, M.D.

Many of the following disabled speakers are respirator-dependent polio quadriplegics: Andre Dessertine, lawyer, France; Ronald H. Doneff, M.D., dermatologist, Indiana; Jack R. Genskow, Ph.D., Sangamon State University, Illinois; Judy Heumann, Center for Independent Living, California; Audrey J. King, Ontario Crippled Children's Centre, Canada; Rev. Patrick Lewis, Archdiocese of San Francisco, California; Robert B. McCown, Ph. D., physicist, New York; Eugene F. Murphy, Ph. D., Veterans Administration Rehabilitative Engineering Research and Development Service, New York, and Adolf Ratzka, Ph. D. candidate, Sweden.

Proceedings will be available in early 1982. For information, write to the *Rehabilitation Gazette*, 4502 Maryland Avenue, St. Louis, Missouri 63108.