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XIV. Head Trauma and Stroke

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Efficacy of Multiple Input Phoneme Therapy in the Treatment of Severe Expressive Aphasia

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—Stroke patients who display severe to profound expressive aphasia frequently fail with traditional treatment approaches. A new treatment technique, Multiple Input Phoneme Therapy (MIPT), has shown initial promise as an effective treatment technique for such patients. The purposes of this project are to: 1) demonstrate that patients classified as severely expressive aphasic will develop single word and phrase level communication as a result of MIPT; 2) demonstrate that concomitant changes in other modalities will occur as a result of MIPT; 3) develop a specific word list based on the MIPT hierarchy that can be used by other speech and language pathologists; and 4) study the length of time necessary for pa-

tients to complete the 22 steps in this therapy program.

Progress—Subjects diagnosed as having severe to profound expressive aphasia were randomly assigned to either a traditional or experimental treatment group. Each subject was seen two to three times per week for a 9-month period. Performance levels were carefully documented prior to treatment and at specific intervals.

Preliminary Results—Work completed to date indicates that subjects receiving Multiple Input Phoneme Therapy reached higher communicative performance levels than did those subjects receiving traditional therapy.

An Evaluation of a Microcomputer-Based Cognitive Rehabilitation Program for the Severely Head-Injured

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Sponsor: The Frances and Augustus Newman Foundation and the Head Injury Recovery Trust (H.I.R.T.)

Purpose—A microcomputer-based cognitive rehabilitation program has been developed to assist the severely head-injured patient to make as full and—if intervention begins shortly after trauma—as rapid a cognitive recovery as possible. Patients enter the program either as soon as possible after the trauma (usually upon emergence from a post-traumatic amnesia of at least a week) or after several years of recovery. The basic idea of the cognitive rehabilitation is the provision of a structured and progressive set of stimulating and intellectually challenging material designed to exercise the more general areas of cognitive impairment subsequent

to cerebral trauma (i.e., attention span, attention control, impoverished memory, slowness, logical problem solving).

Progress—Because of a large number of factors—both theoretical and economic—it was decided that the material should be presented by a small, relatively inexpensive microcomputer. One of the primary factors influencing this decision was the desire to design a rehabilitation program that could be primarily home-based. In this program the patients have, purchase, or are loaned a relatively inexpensive microcomputer (Acorn BBC Models Master B or its re-

placement, the Master) and the necessary peripheral equipment (a high resolution color monitor and a Modem). A network system has been developed that allows each of the remote machines in a patient's home to be linked to a central computer at the Institute, using modems over the standard telephone lines. The network system provides both continuous control over the patient's rehabilitation program and complete monitoring of the patient's performance. The system is designed so that the telephone link is connected only for the transmission of programs and the receipt of results. This ensures that telephone charges do not become unreasonable, even for quite remote users.

As the rehabilitation program has been developing over the past 3 years, the pressures of development have allowed only cursory objective evaluation of the therapeutic efficacy of this particular approach. However, the system now appears to be practical, efficient, and technically robust. It now appears possible and necessary to evaluate whether this approach pro-

vides tangible benefits to either recent or long-standing head-injury patients.

This evaluation is presently in a pilot phase and there are as yet no results to describe. However, it may be of interest to briefly describe some aspects of the design of the study. To evaluate the effectiveness of rehabilitation on recent head-injury patients—those who enter the rehabilitation project shortly after trauma—it is necessary to use a matched untreated patient group to control for the natural recovery that occurs after cerebral trauma. In contrast the long-standing head-injury patients—those who enter the project more than 2 years after trauma—can serve as their own controls if a substantial pretreatment baseline is obtained. The serial assessments each consist of extensive neuropsychological, neurological, neuropsychiatric, and electrophysiological examinations. The electrophysiological examination includes the recording of both sensory and cognitive event-related potentials (ERPs). The work is continuing and future progress will be reported in this publication.

Establishment of a Central Nervous System Trauma Center

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Sponsor: National Institutes of Health

Purpose—The goals of this project are to determine the cause of the decline in mortality from head injury observed during the last 2 years in San Diego County and to develop a comprehensive program for spinal cord injury patients to include acute care and rehabilitation. We also will continue to develop a head injury remedi-

ation center for San Diego County, participate in the multicenter collaborative trial of high dose barbiturate therapy for uncontrolled intracranial pressure, and continue our clinical research on evoked responses and catecholamines in severely head-injured patients.

Establishment of a Central Nervous System Trauma Center

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Sponsor: National Institutes of Health

Progress—Data collection for a multicenter randomized controlled double blind clinical trial of barbiturate coma in intractable hypertension began in October, 1982. A study de-

signed to derive a profile of the traumatic spinal cord injured patient began in January, 1983. Neuropsychological and psychosocial data is being collected on mildly head-injured pa-

tients to study the cognitive impact and subsequent natural history of mild head injury in different populations. Studies being continued or completed include: an analysis of cognitive

outcome of severe and moderate head injury; analysis to characterize demographic and clinical features; and studies of the features influencing outcome.

Aphasia Rehabilitation Program

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Purpose—A software program for the rehabilitation of a person with aphasia has been developed by the Volunteers for Medical Engineering, Inc. (VME), working with the Speech Pathology Department of the Johns Hopkins Good Samaritan Hospital. This program is designed to reinforce the memory of the client by giving, first, a question requiring a designated answer by filling in the blanks. If the person knows the answer, this is typed into the blanks and the maximum value is scored for that question. If one cannot recognize the needed word, then help can be had by pressing designated help keys whereupon the requested prompts (such as a high resolution graphic picture, or the beginning letter, are given on the screen or spoken by a speech synthesizer.) The system uses an Apple computer and Lis'ner 1000 speech synthesizer.

Progress—The software program has been written and is now being evaluated at the Johns Hopkins Good Samaritan Hospital and at the National Rehabilitation Hospital to determine: 1) how well it works for the clients; and 2) what improvements might be made to make it more effective.

Future Plans—We are starting to receive requests for the software from around the country and are preparing the documentation necessary for the users. The software developed to date has been done with spare-time volunteer effort. Proposals are being prepared requesting funding for this new effort and for the time to make requested improvements, so that timely releases can be made for the clients benefit.

Computer Acceptance of Maladaptive and Adaptive Aphasic Behaviors

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Purpose—This project will investigate computer strategies for recognizing perseveration and self-correction attempts by aphasic individuals, and will develop software routines both to interrupt perseveration and to facilitate self-correction. The behavioral tool for this project is

the Revised Token Test (McNeil and Prescott, 1978), a standard test in aphasia batteries, on which aphasic subjects are likely to display perseveration or self-correction tendencies. The programming for this project will be completed in 1986.

The Microcomputer as a Cognition Orthosis

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Sponsor: *Kenny Michigan Rehabilitation Foundation*

Purpose—The microcomputer has been used extensively as a tool for cognitive rehabilitation. Many microcomputer-based software packages for cognitive retraining of brain-injured individuals have been introduced. These programs attempt to remediate lost function.

Progress—Over the past 3 years we have developed a microcomputer-based system for compensatory intervention programs. This system is used to develop computerized "cognition orthoses" which are defined as "compensatory interventions stressing environmental modification and cuing for the completion of functional tasks."

A programming language called COGORTH (from COGnition ORTHosis) has been developed to program instructional modules (IM's) which serve as task-guidance systems for cognitively impaired individuals. These IMs are intended to allow individuals with cognitive deficits to complete, independently, tasks they could not otherwise perform without assistance. An IM has been developed for training individuals to consistently respond to computer instructions and queries. The IM is for an artificial task (building a pyramid from colored blocks). The task has many levels ranging from building the pyramid with all blocks directly in front of the patient to requiring the patient to search for the various blocks in different rooms while encountering interruptions.

Preliminary Results—A clinical trial of a cognition orthosis has also been completed. The patient was a 28-year-old woman with a wide range of neurocognitive deficits, including severe memory impairments associated with an episode of herpes encephalitis. She required 24-hour supervision and guidance. A simple ABA design was used to assess whether or not the patient could benefit from a computerized cognition orthoses (i.e., an IM written in COGORTH). During the first phase of trials the patient made many errors while attempting to perform a simple cooking task using only written directions. During the second phase of trials the patient was able to perform error-free using computer-assisted guidance. Finally, during the third set of trials, the patient once again made many errors using only written directions.

Future Plans—Studies now in progress are investigating the efficacy of an IM written in COGORTH as an aid for the completion of vocational tasks. Future studies will also explore the utility of COGORTH as a tool for enhancing the acquisition (as opposed to merely the guided performance) of functional activities. Work also is progressing to install COGORTH on an intelligent mobile base. If successful, such robotic applications may permit the use of COGORTH as an interface for patients in environments such as nursing facilities, who might otherwise require continuous supervision.

COGORTH: Cognition Orthosis Programming Language

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Purpose—Patients who acquire diffuse and/or focal lesions of the brain often sustain dramatic and potentially debilitating changes

of cognitive functioning. These changes may be characterized by limitations of attention, orientation, memory functioning, reasoning, social

skills, and higher-order integrative functions. These may lead to severe disruptions of behavioral style, level of independence, interpersonal relationships, and vocational capabilities. A technique for assisting such patients to function independently, using a computerized cognition orthosis, has been developed. In demonstrations, this "orthosis" has been successful in guiding brain-injured patients through tasks they could not otherwise perform unaided. (See preceding report)

Progress—COGORTH, a specialized computer language, provides a highly structured environment for programming sequential messages. These messages can be used to assist patients who need guidance for the completion of complex activities. They can be in the form of text presented on a video display, or they can be in the form of an audio signal or a visual cue such as a flashing light. A COGORTH program (Instructional Module) can display directions to a patient at any level of specificity for any task which can be represented as a sequence of steps. It can present sequences of messages at any time of day specified by the programmer, and can repeat that sequence of messages at any interval.

COGORTH provides programming capabilities for Instructional Modules which can: 1) check a patient's performance for errors; 2) branch to error correction or "help" procedures when difficulties are encountered; 3) manage interruptions of a task when a higher-priority task must be complete; and 4) manage electri-

cal devices in a patient's environment. Instructional Modules (COGORTH programs) are written in standard text files. Although COGORTH is an interpreter, it permits the use of library files for the inclusion of user-defined functions and routines. It is envisioned that COGORTH will be used by health professionals having a wide range of programming skills. Careful consideration is, therefore, being given to balancing the power and complexity of the language against the need for simplicity.

The first versions of COGORTH were developed in the C programming language on the Apple II microcomputer. During the past year we have ported it to the IBM-PC, which has allowed significant enhancement of the language. The size limit of Instructional Modules has been greatly increased; execution speed also has improved.

Future Plans—A number of enhancements for the COGORTH programming language are planned: increased environmental-control capabilities (especially control of a telephone); increased graphics capabilities for displaying pictures and drawings within an Instructional Module; and the development of Instructional Module libraries for various tasks. These libraries are intended to provide basic Instructional Modules for a variety of tasks which can be modified to fit an individual user's needs. Long-range plans include the development of built-in COGORTH functions for control of a robotic base.

Pharmacological Therapies in Central Nervous System Injury

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—The major focus of this research is the development of novel pharmacological therapies for central nervous system (CNS) injury including stroke, brain trauma, and spinal cord injury. It is hypothesized that common pathophysiological mechanisms that underlie these various insults to the CNS in-

volve the release of endogenous factors (including endogenous opioids) leading to secondary changes in microcirculatory flow.

Progress—A number of new CNS injury models have been developed during the past year including: 1) a stroke model in rats produced by

occlusion of the middle cerebral artery; 2) a stroke-ischemia model in rabbits produced by reversible occlusion of the middle cerebral artery (MCA), using a specially-designed clip; 3) compressive brain injury in rats produced through an extradural balloon catheter; 4) ischemic lumbar spinal cord injury in rabbits, using an intra-arterial balloon catheter; and 5) traumatic lumbar spinal cord injury in rabbits, using a weight-drop method.

Progress—Much of the work during this first year has been devoted to setting up the models and laboratories, and in developing a number of important new outcome measures: somatosensory and spinal evoked responses; compressed spectral array analysis of the EEG; and magnetic resonance spectroscopy (proton and phosphorous). Our initial pharmacological studies have been devoted to an evaluation of opiate antagonists in the new models, including naloxone, TRH, and the kappa-selective antagonist WIN44,441-3. In these studies animals are randomly assigned to a treatment group. At present, data from the various models remains preliminary: the kappa-selective opiate antagonist WIN44,441-3 stereospecifically improved the computerized EEG after MCA occlusion in

rats and protected against the loss of high-energy phosphates after occlusion. In addition, opiate antagonists improved both survival and neurological recovery after traumatic spinal injury in rabbits.

Future Plans—We also plan to evaluate the effects of endogenous opioids on injury, in order to test the hypothesis that endogenous opioids are pathophysiological factors in CNS injury. Outcome measures, in addition to those listed above, will include neurological score, histopathology, changes in tissue levels of endogenous opioids, and potentially autoradiographic blood flow and metabolism. Since evaluation of each of these parameters in each of the models will take approximately 5 years, our initial focus will be devoted to ischemic and compressive brain injury and ischemic spinal injury. The early stress on brain injury models over spinal trauma models is due to the more advanced development of magnetic resonance spectroscopy, computerized electrophysiological measures, blood flow, and metabolism techniques in these models. However, development of magnetic resonance spectroscopy in spinal cord trauma will be an aim of later studies.

Comparing Rat Brain Pathways from Normal and Transplanted Motor Cortex _____

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—One of the brain areas commonly injured after stroke or trauma is the motor cortex. Motor cortex injury frequently results in lasting hemiparesis and/or expressive aphasia. Our long-term goal is to determine if motor cortex transplants could partially or wholly restore motor function lost due to motor cortex injury in experimental animals.

Future Plans—First, motor-sensory pathways to and from normal rat motor cortex will be mapped. Regions of increased ^{14}C -2DG uptake will be mapped during stimulation of hindlimb and rostral forelimb motor cortex. Afferents

and efferents of rat motor cortex will be described with wheatgerm agglutinin-horseradish peroxidase (WGA-HRP) and ^3H amino acids. Second, the motor-sensory pathways to and from rat fetal motor cortex transplants will be mapped. The patterns of 2DG uptake produced by electrically stimulating fetal transplants 1 to 16 weeks after transplantation will be compared to the 2DG uptake patterns during normal motor cortex stimulation. The afferents and efferents of the fetal motor cortex transplants will be mapped 1 to 16 weeks after transplantation with WGA-HRP and ^3H amino acids. Third, we will train rats to barpress with one

forelimb, and determine whether motor cortex injury affects the rats' ability to barpress acutely and chronically. If so, we will determine whether transplants reverse the motor deficits.

We have previously shown that fetal transplants survive in cavities in host brain motor cortex and have a nearly normal glucose meta-

bolic rate. The present experiments will determine whether the transplants form connections with host brain, whether transplant stimulation activates host brain and produces movements, and whether transplants improve behavioral motor deficits in lesioned adult rats.

Socio-Cultural Mechanisms of Rehabilitation in Old Age

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Sponsor: *National Institutes of Health*

Purpose—Our objectives are: 1) to investigate the problematic issues suggested by the stroke rehabilitation literature—the influence of age on decisions about rehabilitation, practitioner/patient communication difficulties, lack of continuity in rehabilitation measures, minimal support to families, and health professionals' insufficient awareness of the influence of lifestyles on methods of coping with illness; 2) to address the major limitation of that literature—the lack of appropriate attention paid to process-in-stroke rehabilitation.

Future Plans—We will continue collecting data to test our specific research hypotheses. Patterns of intervention in the rehabilitation of stroke patients will be determined by three factors: 1) age of the patient; 2) physician attitudes toward rehabilitation that affect decision making; and 3) family members' perceived role

in the patient's rehabilitation and the nature and extent of their supportive efforts.

We plan to follow the rehabilitation process for 125 Mount Zion Hospital stroke patients and their significant family members for one year. To date, 48 patients are in the study. We plan to select the remaining 77 patients, conduct initial interviews, 3-month followup and 12-month followup interviews.

Qualitative analysis of first and 3-month followup interviews will continue: description of the range, content, and relationships among socio-cultural factors that influence the rehabilitation process. Quantitative analysis of first and 3-month followup interviews will begin and common descriptive statistics will be employed to explore a) means and medians for measures of central tendency; b) standard deviations for measures of dispersion; and c) relationships found among variables.

Remediation of Left-Sided Neglect and Interpersonal Communication Following Hemispheric Strokes

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Sponsor: *National Institutes of Health*

Purpose—This Stroke Clinical Center Grant is a new application representing a continuation and extension of investigations initiated by a Comprehensive Stroke Center Contract, NINCDS. The major thrust of this contract is to assess the community (the State of Oregon in our case) profile of strokes, primarily demo-

graphic in nature; this contract mobilized a broad interest in our stroke patient, who represent the centerpiece of this grant application. Our investigations emphasize therapies focused upon stroke patients in three broad areas of importance in the continuum of the problem: 1) preventive therapy; 2) acute medical treat-

ments; and 3) rehabilitation intervention for higher cortical impairment.

Preventive therapies are designed to assess various risk and prognostic factors in stroke patients to develop better molecular handles on both acute therapy and prevention. Factors which may yield to better identification and therapy of risks are: mononuclear cell cholesterol ester hydrolase activity; glycosylated hemoglobin; cholesterol turnover in atheromatous plaques; and physicochemical bases for platelet

behavior in stroke. Acute medical treatments focus initially upon the potentially beneficial assessment of prostacyclin infusion. In addition, staged, sequential evaluation of aminophylline/barbiturate and vasopressors will be continued in a prospective, randomized fashion. Rehabilitative intervention for higher cortical impairment deals with neuropsychological and language impairments with compensatory learning strategies.

Precursors of Stroke Incidence and Prognosis

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Sponsor: *National Institutes of Health*

Purpose—It is proposed to extend the prospective findings of the Framingham Study on stroke to 30 years of followup, including the age groups 75-84 years, and to examine a number of possible precursors for which there has been too little followup. These include the role of: arrhythmias as determined by 1-hour ECG monitoring; echocardiographic findings of valvular and myocardial dysfunction; lipid profiles including LDL and HDL cholesterol; physical activity status; menopausal status; psychosocial factors including Type A personality; carotid bruit, Ecolyzer confirmed smoking histories, and glucose tolerance based on a glucose load, among others. Further studies of asymptomatic carotid bruits will be carried out by analyzing the continuous-wave Doppler signal for its direction, mean frequency, and frequency content, as they are found at selected moments in the cardiac cycle over the carotid arteries in the neck, and by analyzing phonoangiography of carotid bruits in an attempt to identify those bruits which are true precursors of stroke. A more accurate delineation of the type of stroke will be accomplished using CT scan information in addition to clinical findings. This should

permit better definition of the frequency of different types of stroke, and a more accurate determination of the epidemiologic features of each type.

The stroke, its precursors and disability will be pursued, focusing particularly on the elderly. Functional assessment of the patients' activities of daily living will be made at the time of stroke, and 3, 6, and 12 months later. Scores on recently standardized test scales of activities of daily living—feeding, dressing, grooming, bathing, etc; assessments of function in the home and in society; and the use of aids and appliances following stroke will be obtained by a rehabilitation nurse. These data will permit detailed evaluation of disability following stroke in a general population sample. An attempt will be made to devise a more powerful predictive stroke risk profile using those ingredients identified above as independent contributors to stroke incidence. The decline in mortality rates from stroke has accelerated in recent years. Secular trends in incidence by stroke type will require more cases occurring over time, and should be available as a by-product of this proposal.

Recovery from Aphasia in Stroke

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Sponsor: *National Institutes of Health*

Purpose—This project, by obtaining systematic evaluation of the course of recovery from aphasia in a population of stroke patients, has three specific goals. First, this project will seek extensive information on the demographic, neuroanatomical, medical, and neurolinguistic correlates of the recovery of specific language functions in aphasia. This information about prognostic factors can be used as a database for the development of on-line computer-assisted decision aids that would be of use to the neurologist in deciding questions of patient management.

Second, the study will evaluate the hypothesis that some language functions recover better than others. Experimental tests that allow relatively selective evaluation of distinct aspects of language comprehension (such as phoneme discrimination) and of speech production (such as syntactic complexity) will be administered. Scores obtained on these measures will be used to evaluate the possibility that there are different recovery rates for particular

aspects of gross language functions such as comprehension and production. In addition to their considerable theoretical importance, the results of such an evaluation would have significant implications for the design of therapies and development of communication aids for the aphasic patient.

Third, the study will furnish data for testing hypotheses concerning the functional components that underlie the major aphasic syndromes. Specific issues to be addressed include the incidence of linguistically-defined symptoms (e.g., agrammatism) within the classical syndromes (e.g., Broca's aphasia), and the extent to which the phenomenon of evolution of syndromes during recovery reflects substantive changes in language capacities. This third goal reflects an attempt to join the theories and methods developed in recent neurolinguistic studies of language impairment with the more traditional approach to the study of recovery from aphasia.

Rehabilitative Software for Head Trauma Victims

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Sponsor *National Institutes of Health*

Purpose—Each year there are 70,000 new head trauma victims whose primary medical and long-term rehabilitation costs place tremendous financial burdens on their families. The need is great for low-cost rehabilitation tools that can be used in the home to supplement and reinforce therapy programs provided by rehabilitation professionals. Phase I of this effort will explore the viability of computer software implemented on inexpensive computers as an adjunct to professional therapy. Existing software will be altered to meet specifications prepared by the American Head Trauma Alliance (AHTA). Software will be provided both on cassette tape

and on cartridge to test ease of use of both forms. Alternate technologies for reprogramming cartridges will be evaluated.

A key element of the software design is the provision for modification by parents and therapists untrained in computing to tailor the programs to the needs and environments of individual head trauma victims. The resulting software and storage media will be tested by teams composed of head trauma victims, parents, and rehabilitation professionals. Guidelines for the development and use of such software will be prepared for dissemination by the AHTA.

Treatment of Affective Deficits in Stroke Rehabilitation

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Sponsor: *National Institutes of Health*

Purpose—Post-stroke affective disturbances are pervasive—i.e., they affect anywhere from 40 to 65 percent of stroke patients. The diagnosis and treatment of these disturbances in stroke patients is a major untreated problem facing the medical rehabilitation community. Traditional approaches to diagnosis which have relied exclusively on verbal self-report or nonverbal expressions of depression have not adequately addressed either the communication difficulties of aphasics or some of the other cognitive disturbances, such as aprosodia, minimization, and concrete thinking, which limit the cognitive capacities of stroke patients. Furthermore, the ef-

fectiveness of various approaches to treatment has not been systematically studied in this population at the present time.

The aims of this study are twofold: first, to validate a comprehensive diagnostic battery which permits an accurate examination of the affective disorders following stroke; and second, to evaluate the effectiveness of two approaches to treatment, anti-depressants and cognitive therapy, when administered singly or in combination. It is expected that greater accuracy in diagnosis and more aggressive treatment will significantly improve the quality of life of this subgroup of older Americans.

Community Study: Stroke Rehabilitation Using Volunteer Help

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Sponsor: *VA Rehabilitation Research and Development Service*

Purpose—This study is designed as a 3-year randomized clinical trial to determine whether aphasic stroke patients who receive volunteer visits three times per week for 1 year show any greater improvement in functional outcomes than those who do not receive such treatments. We oversampled, entering 95 patients into the study. The mean age of the test group was 75 versus 72 years in the comparison group. A two-tailed *t*-test indicates that these differences are not statistically significant.

Preliminary Results—More than 100 unpaid volunteers have been recruited to work with patients in the test group, and these volunteer visits have been enthusiastically received by patients, family members, and other caregivers both in private homes and nursing homes.

A statistical significance level of .05 was adopted for all analyses and groups were stratified by location. The means of the five major study variables for each group on entry into the

study indicate comparability of test and control group scores by home or nursing home. Scores on the Communicative Abilities in Daily Living for the test and control groups were 123 and 104 for patients at home and 51 and 36 for test and control group patients living in nursing homes.

Institutionalized patients in this study scored lower than institutionalized aphasic patients on whom this test was normed, which indicates greater impairment in this age group than might be expected. On PULSES Profile and Barthel's Index, there was greater functional impairment in the patients in nursing homes. Both the physical and psychosocial subscores of the Sickness Impact Profile also revealed greater impairment in nursing home patients. Thus, it was important to have stratified our randomization by location. The mortality rate in this study was higher than anticipated and further analyses are under way to examine this finding as it relates to treatment outcome.

Community Model: Rehabilitation of Older Adults with Brain Injuries

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—This randomized clinical trial will determine whether patients with acquired brain injuries due to stroke or trauma show any improvement in function as a result of receiving rehabilitation assistance provided by volunteers. Fifty-six patients have been entered into the study to date.

The performance of 100 patients will be assessed using multiple tools to measure functional outcome. The battery at 0, 6, and 12 months will consist of a neurological assessment, PULSES Profile, and Barthel's Index, field observations, and interviews by staff members

during which they will conduct the Rand Corporation's battery of physical, mental, and social health status measures, as well as their measures of general health perception. In addition, the Rosenberg Self-Esteem Scale will be used in conjunction with videotaped testing of the patient's performance in his own environment. This research is aimed at meeting the challenge of developing low-cost, quality rehabilitation services for an expanding elderly population in a manner which allows them to remain active participants in the communities where they live.

Efficacy of Computer-Assisted Rehabilitation

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—The objective of the present study is to demonstrate in an experimentally controlled manner the efficacy of a computer-assisted rehabilitation program (in addition to traditional rehabilitation) in improving the cognitive deficits secondary to stroke. Subjects will consist of 60 inpatients referred from an intermediate medicine ward who are active rehabilitation candidates. Thirty patients with right hemisphere strokes and 30 with left hemisphere strokes will be randomly assigned to either an experimental or a control group. Thus there will be four groups of 15 patients each. All patients will receive extensive pre- and post-treatment assessment from neuropsychology, audiology and speech pathology, occupational therapy, and psychology. Patients in the experimental group will begin an 8-week computer retraining program (1 hour per day, 5 days per week), in addition to traditional rehabilitation therapies. Control subjects will receive tradi-

tional rehabilitation only, plus an attention and time control. All patients will receive post-treatment reassessment, and followup adaptive functioning assessment at 3 months.

Future Plans—Project beginning date was April 1, 1985. The study was originally designed to be completed within 2 years or by March 31, 1987. However, there has been an unavoidable delay in obtaining ADP equipment (i.e., the required computers and software rehabilitation programs necessary to begin the running of subjects and data collection). These ADP funds were released on January 15, 1986, computer and software orders were immediately placed, and the equipment was received on April 10, 1986. The initial subjects are now being recruited and run. However, the study will have to be extended, at least through Fiscal Year 1987, to meet the study objectives and answer the research questions.

The Impact of NMR on the Management of Brain Lesions

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—The purpose of this study is to examine the effect of nuclear magnetic resonance (NMR) on the length of stay, hospital course, and diagnostic and therapeutic outcome of patients admitted for evaluation of possible intracerebral neoplasm or cerebrovascular abnormality. The design of this study involves a retrospective medical chart review covering two time periods. These periods will produce three comparison groups: 1) patients undergoing evaluation when only CT is available (the CT 1983 group); 2) patients evaluated when NMR is available and who undergo NMR imaging; and 3) patients evaluated when NMR is available but receive no NMR imaging. Analysis of variance and cost-benefit analysis will be performed to evaluate the comparison groups.

Progress—To date, approximately 75 percent of all potentially eligible charts have been located and abstracted. Half of these have been recoded

and the data entered onto magnetic tape. By July 31, 1986, the remaining available charts will have been abstracted, recoded, and entered onto tape. Following this task, data analysis will begin and will continue through September 1986. This is in accordance with the original project management plan. No major deviations from the original proposal have occurred or are expected with respect to workscope, budget, or schedule. Results are not yet available.

Future Plans—The results of this study are expected to provide empirical evidence of the impact, if any, of NMR on the clinical course of patients undergoing evaluation for suspected brain lesions. These data may be utilized by decision makers within the VA system and elsewhere in determining the efficacy and cost benefits of NMRs and may provide additional input into future NMR implementation decisions.

Evaluation of Family Stroke Education

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Sponsor: VA Rehabilitation Research and Development Service

Purpose—Failure in rehabilitation after stroke is often caused by lack of family education, but what educational content is essential to include in routine treatment for families of stroke patients has been difficult to determine. The effects of a structured education protocol is being measured with a Stroke Care Information Test, Family Assessment Device, and ratings of treatment adherence and family resources. About 160 hospitalized stroke patients will be selected for inclusion of a family member in scheduled stroke care instruction versus placement in a control group receiving no formal involvement with health care staff. It may be possible to improve adherence to a rehabilitation program by working with the family in areas found to be

related to informational needs.

Experimental subjects are expected to make significant increases in knowledge about the implications of stroke. Provision of reliable information about stroke may increase the effectiveness of rehabilitation efforts, reduce rehospitalization rates, allow persons to avoid extended convalescence, or improve compliance with rehabilitation principles.

Results—The pilot study findings are promising and were presented at the 1986 Dinsdale International Conference on Rehabilitation in Ottawa. Caregivers of 60 stroke patients were assessed 4 months after patient discharge from a stroke care unit. Areas of family interaction

which were significantly correlated with ratings of treatment compliance included: problem solving, communication, and affective involvement. Significant correlations were not observed for emotional response of the family, social role assignments, or behavior control. Better functioning families were consistently rated high on treatment compliance. Findings suggest that families with specific dysfunctional interactions may not comply with treatment

recommendations for home care after stroke.

Using a process of minimization to control for intervening variables, stroke patients are continuing to be selected and assigned to treatment or control groups to evaluate the effects of family education on stroke outcome. A paradigm to predict stroke outcome based on family instruction is being developed and two treatments, counseling and classroom instruction, are being compared.

Microwave Hyperthermia

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Progress—This study is being carried out under the direction of Dr. Michael Saloman, director of the neurosurgery department of the University of Maryland Hospital. A major part of the study is being done by the Volunteers for Medical Engineering, Inc. (VME) The engineers and technicians in this organization are presently donating their time and talents to the effort and are working in their basements or during their lunchtimes at Westinghouse Aerospace to accomplish their goals. Dan Buck, a Senior Advisory Engineer, has taken a network analyzer and ancillary equipment donated by Westinghouse to the VME, and has set up a lab so that he and his colleagues can carry out their investigations. Herman Rossman, another engineer specializing in thermal analysis, is designing a tissue simulator which includes an aqueous medium in an enclosure, and is formulating the contained interstitial material of the enclosure so that the microwave radiators can be used in the container to irradiate the simulated brain tissue with a dielectric constant of 50. The premise is that most of the work done to develop the microwave radiating element and the radiometer can be done on the simulated brain tissue and that the need for experimentation with animals can be reduced or eliminated. This is especially important regarding brain tumors because canine and feline brains are too small to properly simulate human brain. The model will also simulate the blood flow of

healthy tissue as well as that of the tumor. Analysis of the conditions at the interface of the tumor and the healthy brain tissue show good correlation with data from several other sources, giving credibility to the analytical approach and the assumptions that the blood flow in the tumor is poor compared to that of healthy tissue.

Preliminary Results—Preliminary tests on a novel "twin lead" antenna concept show microwave "end fire" penetration into phantom tissue greater than 1 cm for frequencies between 9.5 MHz and 1.8 GHz. Tests show bandwidths up to 200 MHz, which enables one to use radiometry for temperature measurements. This requires no extra invasive probes.

Three electronics technicians have been working to fabricate the microwave radiometers needed to test the various configurations. Several of these have been tested and the test results show that the radiation pattern can be controlled and the size of the invasive probe elements can be minaturized to be accommodated by the tubes inserted in the site of the tumor. A meeting with Dr. Saloman in June, 1986 revealed that radiometry capabilities to start temperature measurements were urgently needed. We also received dielectric constant 50 tubes from Trans-Tech, Adamstown, MD, (a gift to VME) to start work on a better impedance match to the brain tissue.

Future Plans—Several proposals are being prepared to seek funding for these study efforts in order to arrive more quickly at a radiating element that will deliver a controlled radiation

pattern while monitoring the temperature of the irradiated tumor so that only the tumor is elevated to the destruction temperature.

A Prosthesis for Writing in Aphasia

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Purpose—A case of severe nonfluent aphasia is described in which therapy with a writing prosthesis over a 6-month period resulted in a dramatic improvement in writing ability with the hemiplegic right limb in spite of minimal improvement in oral production. Convention and prosthesis therapy for writing with the left hand resulted in only marginal change. Hemiplegic writing with the aid of a prosthesis may be the most effective means of communication in severe aphasia.

Severe aphasics with right hemiplegia are often, with the aid of a prosthesis, able to write words to dictation with their hemiplegic limb though agraphic with the intact left hand. In global aphasics, hemiplegic writing is often the best linguistic performance and is superior to writing ability in many less severe aphasics without hemiparesis. This finding suggests that the retraining of writing in hemiplegic aphasics should be directed to the use of a right arm prosthesis rather than practice with the left hand. This paper reports the results of prosthesis training with a severe nonfluent aphasic.

Progress—A 58 year-old right-handed man developed a left CVA and right hemiparesis in December 1981. There was excellent recovery of speech and movement. A later CT scan demonstrated dilation of the left post-central sulcus consistent with infarct. One month later he developed another left CVA with persistent severe aphasia and denser right hemiplegia. On neurological examination he was alert and well-oriented, with spastic right hemiplegia, probable right visual field defect, and intact sensation. He walked with a cane. Mild bilateral conductive hearing loss was present. An EEG

showed left temporoparietal slowing.

Repeat CT scan demonstrated an extensive infarct involving frontal and parietal opercula and insula, sparing basal ganglia and thalamus. The infarct extended posteriorly to a supramarginal and angular gyri. Testing revealed marked nonfluent aphasia with moderate comprehension impairment. Spontaneous speech consisted of stereotyped perseverative single words and vowel sounds with severe oral apraxia. Answers to yes/no questions were unreliable; some monosyllabic words were repeated. On the Boston Diagnostic Aphasia Examination, auditory comprehension was spared for body parts and commands, and was poor for picture identification of auditory stimuli. Severe deficits were present on naming, oral reading, and repetition. Reading comprehension was poor for symbol discrimination, word recognition, and word-to-picture matching, but comprehension of sentences and paragraphs was rated as fair on testing.

Reevaluation 9 months post-onset showed improvement in comprehension and writing and little change in verbal skills. The patient was considered to have stabilized in therapy and a modified course of Melodic Intonation Therapy (M.I.T.) was initiated. With M.I.T., the patient experienced success only in the therapy setting and then only with cues (usually phonemic). There was no carryover to spontaneous use in therapy or at home. The patient began using the writing prosthesis 2 years post-onset. Initially, motor training involved tracing geometric shapes and a specially designed block letter alphabet in which each letter could be formed using one continuous stroke. For the first 2 months, the patient received two half-

hour sessions per week, which were later extended to 1 hour twice a week. To aid in the legibility of the letters and to constrain arm movements, the patient was required to insert individual letters within the squares of a grid. Fine motor control was not always possible, and the patient often strayed beyond the bounds of the outline.

Once the alphabet was mastered and the patient was comfortable using the device, a systematic approach to writing was initiated. Targets in writing progressed from single nouns and verbs to two-word productions (adjective + noun; noun + verb; verb + object) to phrase-length strings incorporating varied syntactic structures. A picture was shown, and the patient was asked to respond to various questions, such as: "Who is this?" or "What is going on?" The sentence length was increased to noun + verb + object, and then nouns were expanded to noun phrases (article + noun, adjective + noun).

Spontaneous writing (picture description) with the prosthesis tended to be agrammatic. In order to elicit correct spelling and syntax, dashed lines representing letters in the words of a simple descriptive sentence were entered into the grid for each picture stimulus. The patient was informed that he was to write a description of the picture using the dashes as cues, and to respond to questions as above. He was never specifically told to use any functors. He seemed to realize when functors were required, and either filled them in spontaneously or self-corrected after inserting content words. With this approach, he was able to produce sentences of astonishing complexity and good syntax given the severe nonfluency of speech and the relative agraphia with the intact left hand.

The training procedure for the right arm with the prosthesis was duplicated for the left arm, which was trained and tested under similar conditions using the same stimuli on different days. This permitted a direct comparison of left- and right-handed writing. Writing was analyzed as to orthography (legibility), spelling, relevance to stimuli, total word count, and types of grammatical forms. A consistent and

profound right arm superiority was present on all parameters including constrained versus unconstrained conditions. Left-hand writing, even with maximum structure, consisted of noun listings, odd letter strings, and unidentifiable sequences.

Preliminary Results—A patient with severe nonfluent aphasia received therapy with a writing prosthesis 2 years post-onset, and showed dramatic improvement in oral production. Conventional and prosthesis therapy for writing with the left hand resulted in only marginal improvement. These findings indicate that, in contrast to the usual approach, the treatment of writing impairment in hemiplegic aphasics should, in many cases, be directed at the hemiplegic limb rather than the "intact" left hand.

The use of a grid and dash format to constrain limb movement and direct attention to syntax made it possible to elicit sentences on picture description which were impressive in their syntactic structure given the degree of nonfluency, the extensive left frontoparietal CT lesion, and the dense left hand agraphia. This contrasts with agrammatic written productions to questions and picture descriptions without the constraints of the "dash" format, and supports the view of retained competence in agrammatism.

Studies of agrammatism show parallel syntactic deficits in comprehension and production, though few studies have tested subjects in multiple performance modalities, especially in writing. The results with our patient show that, with the appropriate method, considerable syntactic knowledge can be accessed in a severe motor aphasic.

The ability of this patient to write sentences with the hemiplegic limb, and previous demonstrations of writing to dictation in global aphasics, indicate that mental language is available to an extent not predicted by the production pattern. Studies of inner speech in aphasia, from early work on the Proust-Lichtheim maneuver (counting syllables in words) to the "tip-of-the-tongue" phenomenon, have not documented a dissociation between inner speech and speech production. Our cases are of

both practical and theoretical interest in demonstrating that it is possible to tap the inner mental life of the severe aphasic.

In our initial report we suggested that submerged levels in language representation might be accessed through the use of an older axial and proximal motor system. Specifically, the disruption of a "surface" level in language and motility permits access to earlier processing stages in both systems. This case extends the

findings of hemiplegic writing from global aphasia to severe anterior or "mixed anterior" aphasia and demonstrates that a program of therapy using the writing prosthesis can result in dramatic gains in writing out of proportion to other aspects of language production. This finding establishes training in hemiplegic writing as an adjunct to aphasia therapy, and provides a method for the exploration of language capacity in patients with severe aphasia.

Device Evaluation for Cognitively and Motor-Impaired People

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Purpose—The Tufts-MIT Prescription Guide, described in an accompanying report, has been developed to evaluate the suitability of alphabet-based devices for motor-disabled clients whose cognitive impairment is not severe. The purpose of this project is to develop additional client evaluations and devices evaluation items as needed in order to provide useful guidance in the selection of a most appropriate device for a client who may not, or not yet, be capable of functional spelling.

Progress—To date, work has focused on improving the existing system in order to make it

more easily used by and more informative to clinicians without requiring them to have specific knowledge of Lotus, programming, or the particular structure of the system. Part of our evaluation of client needs has been restructured using an expert system shell. Evaluation with clinicians is taking place to assess the usefulness of that structure as opposed to the existing structure, which is an adaptation of Lotus 1-2-3 software. Review of cognitive assessment materials for use with motor-disabled and cognitively-impaired individuals, or young people is now in progress.