INNOVATIONS

Future Solutions Now An NCMRR Update

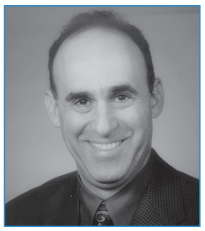
Spring–Summer 2008

Inside This Issue

Director's Message

Neural repair and regeneration are among the hottest topics in neuroscience research right now. Nearly every week, articles in leading scientific journals trumpet significant advances in our understanding of the control of synaptic plasticity, axonal sprouting, neural progenitor cells, etc. Why then, is translation into advances in clinical rehabilitation so difficult? I believe that there are many contributing factors.

First, our scientific base of understanding on neural repair is still limited, and most of the knowledge is very recent. Until the 1980s, the nearly universally held dogma was that plasticity in the adult mammalian central nervous system was extremely limited and that no new neurons were created after development was completed. This view slowly began to change, and with it, the attitudes of clinicians who are for individuals with neurological illness and injury. Curiosity and scientific inquiry began to replace nihilistic fatalism, albeit slowly.



Michael Weinrich, M.D., Director, NCMRR

Demonstrations of cortical plasticity induced by repetitive experience provided powerful evidence that engaging patients in specific activities could induce beneficial, plastic changes in their brains. However, there remain vast gaps in our understanding of how to manipulate and potentiate plasticity in human brains, of how to enhance and augment the functions of neural progenitor cells, and of how to induce axons to cross damaged areas and re-establish synaptic connections with appropriate targets. These are profoundly difficult problems. Their solutions will require much basic investigation as well as extensive safety testing.

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Greetings!

The National Center for Medical Rehabilitation Research (NCMRR) continues to expand its portfolio of projects and resources, many of which are described in this electronic update. New and innovative technologies are continually being developed, improved upon, and made ready for clinical trials and/or the marketplace, and much of this occurs with NCMRR support. In this issue of ***Innovations***, the NCMRR's director, Dr. Michael Weinrich, poses some interesting questions and far-reaching challenges to the medical rehabilitation research community (see above).

This particular edition of ***Innovations*** calls attention to the topic of rehabilitation engineering and technology--specifically technology that is being developed as a result of NICHD funding. This update also reviews some completed projects and current resources available for investigators in the field of medical rehabilitation, specifically those related to the development of rehabilitation engineering and technological advances for people with disabilities. This issue also highlights institutional training grants and programs that focus on supporting the development of researchers in rehabilitation technology. We are pleased to be able to bring these resources, technologies, and challenges to your attention. We hope that you will find this information interesting, informative, and helpful.

—Carol A. Sheredos, P.T., M.A., NCMRR

Do you have any questions for NCMRR staff?

For example, do you need help identifying an appropriate funding mechanism for your application? Is there a topic you would like to see in a future *Innovations*?

If so, please e-mail us at sheredoc@mail.nih.gov.

Thank you!

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Director's Message

Perhaps most difficult is what I would call the problem of multiple "length" scales. Here I am generalizing the notion of "length" beyond simple distance. The central concept of a length scale is that different phenomena come into view at different orders of magnitude length--our concepts must change in a qualitative way as the length scale changes. Former Senator Thomas "Tip" O'Neal famously said that "all politics is local." In the current context, we might translate that to say that all biology happens at the nanoscale. Biological structures interact at the levels of molecules and membranes where quantum mechanical effects are important. At a larger level, however, we can view subcellular plasticity changes in synapses and axons that are visible with the electron microscope. At this level, quantum effects have faded into the background. At a still larger level, we can consider changes at the level of an entire cell, as when a neural progenitor cell differentiates into a mature neuron. Long ago, we learned that neurons function in ensembles for information processing, such as cortical columns or barrel fields. As clinicians, we examine patients as we seek to determine the function of whole systems, e.g., visual processing or "motor systems." Finally, we have to deal with the "emergent properties" of the nervous system so characteristic of us humans--beliefs, goals, moods, motivations, etc. Let me hasten to add that we have not even begun in this simple scheme to address problems at the level of participation in the community or effectiveness of health interventions, additional "length" scales. The International Classification of Functioning, Disability, and Health (ICF) serves as a useful classification system and will hopefully serve to motivate investigators to develop measurement tools useful across multiple length scales. However, a notable void in the ICF is any conceptual framework linking deficits at different domains or length scales.

As I consider the recent history of therapeutics for neurological disorders, for example, dopaminergic agents for Parkinson disease, anticonvulsants for epilepsy, cholinesterase inhibitors for myasthenia, etc., I am struck by the possibility that most of the clinical trials to establish efficacy have had to consider at most two length scales. In contrast, when we consider the clinical trials in rehabilitation, i.e., plasticity in context, we are forced to confront problems of learning, memory, and response to injury--problems at the molecular, cellular, systems, and behavioral levels. I submit that a fundamental problem for rehabilitation research is that we are dealing with more than two length scales simultaneously. For example, consider the problem of amphetamines and stroke recovery. More than 30 years after the observation that amphetamine potentiates the recovery of experimental stroke in rodents, we still do not have a preparation, schedule of administration, or program of activities that will reliably enhance recovery in humans with stroke.

What are the implications for advances in neural repair and rehabilitation? Clearly, there are major advances occurring in our understanding of synaptic physiology and plasticity, of cellular physiology, and of differentiation and cortical organization and plasticity, as well as substantial advances in our understanding of materials and their interactions with living tissue at the nanoscale. We will need to capitalize on these advances to develop new interventions for rehabilitation. However, our problem will remain neural repair in context. The context includes the history, the activities, and the "emergent properties" of the individual, as well as his or her environment and social context. The implication for research is that we need hypotheses spanning these different length scales and measurements to confirm or refute the hypotheses. Clearly, it is not feasible to test hypotheses encompassing all possible length scales, and it is much easier to propose and test hypotheses at the smallest scales. Nonetheless, our particular challenge in rehabilitation research is to develop and test interventions that will improve function and quality of life.

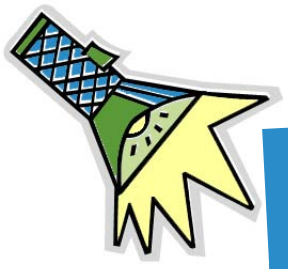
I believe that progress in this area will require research partnerships across traditional boundaries. NCMRR has funded the *Medical Rehabilitation Research Infrastructure Network* to promote research training in specifically targeted areas. We hope that interested clinicians and investigators will avail themselves of these opportunities and that this effort would facilitate the development of innovative research partnerships. We are currently considering the re-issue of this program and would welcome your comments on its priorities and effectiveness. We also expect to re-issue *Research Partnerships to Improve Functional Outcomes (PAR-04-077)* to provide investigators with resources to develop new research partnerships--stay tuned.

—Michael Weinrich, M.D., Director, NCMRR

Check Out the NCMRR's Previous E-Updates!

If you have missed any previous ***Innovations*** updates, they are available at:

- *Innovations: Future Solutions Now--An NCMRR E-Update (Spring-Summer 2007)*
- *Innovations: Future Solutions Now--An NCMRR E-Update (Summer-Fall 2006)*
- *Innovations: Future Solutions Now--An NCMRR E-Update (Fall-Winter 2005)*



E-Update Spotlight: Rehabilitation Engineering & Rehabilitation Technology

The term *rehabilitation engineering* was first officially used in the Rehabilitation Act of 1973 (Public Law 93-112), which was enacted to "extend and revise the authorization of grants to States for vocational rehabilitation services, with special emphasis on services to those with the most severe handicaps, (and) to expand special Federal responsibilities and research and training programs with respect to handicapped individuals…" The term is specifically used in Sec. 202, (b) (2): "The Secretary [of Department of Health, Education, and Welfare] is authorized to make grants [for the]…establishment and support of Rehabilitation Engineering Research Centers to (A) develop innovative methods of applying advanced medical technology, scientific achievement, and psychological and social knowledge to solve rehabilitation problems through planning and conducting research, including cooperative research with public or private agencies and organizations, designed to produce new scientific knowledge, equipment, and devices suitable for solving problems in the rehabilitation of handicapped individuals and for reducing environmental barriers…"

According to the *Rehabilitation Engineering Network*, "Rehabilitation engineering involves using advanced technology and innovation to help meet the needs of individuals with disabilities. A rehabilitation engineer knows the basic disability areas, resources, current laws, and existing technology. Through the application of the engineering disciplines, mathematics, physical sciences, life sciences, analysis, and logical problem solving, the rehabilitation engineer strives to maximize a client's abilities and independence. Design and application of enabling technology are major skills of the rehabilitation engineer. Rehabilitation engineers also team with other rehabilitation professionals to restore an individual's ability to work and live as normally as possible."

Rehabilitation technology involves the actual intervention, equipment, or other technology that permits the end user to perform an activity or perform the activity better. Rehabilitation technology is the outgrowth and application of rehabilitation engineering and includes the systematic application of technologies, engineering methodologies, or scientific principles to meet the needs of, and address the barriers confronted by, individuals with disabilities in areas that include education, rehabilitation, employment, transportation, independent living, and recreation. The term includes rehabilitation engineering, assistive technology devices, and assistive technology services (from *http://www.rehabengineer.com/*).

According to the official organization of the rehabilitation engineering profession, *RESNA (formerly known as the Rehabilitation and Assistive Technology Society of North America)*, "rehabilitation engineering" is a broad term involving engineers, equipment vendors, therapists, and other professionals, all of whom engage their specific disciplines in the supply and/or application of assistive (rehabilitative) technology for persons with disabilities.

A portion of the *Behavioral Sciences and Rehabilitation Engineering Technologies (BSRT) Program* at the NCMRR develops and supports the application of engineering and bioengineering principles to study the habilitation of individuals with disabilities. A major focus of the Center's mission is to support research for developing technologies aimed at helping individuals with disabilities perform daily activities; the rehabilitation engineering technologies portion of this Program is the lead on such projects. For more information on the Program, see the interview with the Program director, Louis A. Quatrano, Ph.D., in *NCMRR Staff in the Limelight*. The NCMRR is funding several programs in the Medical Rehabilitation Research Infrastructure Network that have expertise in rehabilitation engineering. Please visit *http://www.ncmrr.org/Expertise/RehabilitationEngineering/tabid/221/Default.aspx* for more information.

In addition, research in a closely related field, that of assistive technologies, is a focus for the *NCMRR Spinal Cord and Musculoskeletal Disorders and Assistive Devices (SMAD) Program*. Nancy Shinowara, Ph.D., is the director of the SMAD Program, which will be featured in an upcoming ***Innovations*** e-update.

NCMRR Staff in the Limelight

Louis Quatrano, Ph.D.

Director, Behavioral Sciences and Rehabilitation Technologies (BSRT) Program

Each ***Innovations*** focuses on one of the NCMRR's staff and his or her program(s) in hopes of giving the Center's constituents more knowledge about the NCMRR's staff and programs. Because this ***Innovations*** focuses on rehabilitation engineering and technology, the Center is highlighting its BSRT Program and its Program director, **Louis Quatrano, Ph.D.**

Innovations: Where did you receive your education? In what subjects/fields are your degrees and what were your areas of concentration?

Dr. Quatrano: I received my B.S. degree from the State University of New York (SUNY) at Geneseo (education and mathematics). I received an M.S. degree from Ohio University in student personnel and counseling, and a Ph.D. from Northwestern University in counselor education (research design and statistical analysis).

Innovations: What factors influenced your decision to focus on these areas?

Dr. Quatrano: I was interested in people and their development and mathematics seemed like a good tool that could be utilized to predict different aspects of development.

Innovations: When did you first come to NCMRR?

Dr. Quatrano: I started at the NCMRR in 1991.

Innovations: What did you do before coming to NCMRR?

Dr. Quatrano: Before coming to NCMRR, I was a referral officer and a scientific administrator for an aging study section in the Division of Research Grants, which is now the Center for Scientific Review, at NIH.

Innovations: What influenced your decision to go into research, particularly rehabilitation research?

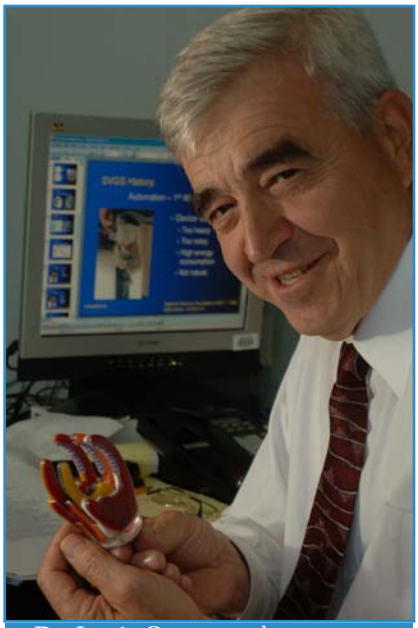
Dr. Quatrano: Two factors: An early medical experience and a research experience examining return on investment in the education of persons with disabilities. As a teenager, I was injured and underwent a corneal transplant procedure. The operation was a success--the graft was successful, but my vision was limited. Recovery was interesting because they did not offer "rehabilitation." You had the procedure, and they sent you home. What happened after that was up to you and your family.

Later, after graduate school, there was an ongoing debate about why individuals with disabilities should be supported in attaining higher education levels. So, several researchers (i.e., two economists and a rehabilitation counselor) were interested in pursuing a study to examine the cost benefit and psychosocial impact of higher education on individuals with disabilities. I joined the team and, together, we obtained a grant to pursue the study.

Innovations: The BSRT Program involves funding for projects in behavioral sciences in addition to those in rehabilitation technologies. Please tell us about that Program and how it fits into the world of rehabilitation.

Dr. Quatrano: The behavioral sciences are an important part of rehabilitation and, in some instances, technology can be part of a facilitating environment for learning or relearning to take place. How the interaction promotes the health of an individual with a chronic condition continues to be an important question. The brain-computer interface (BCI) is an area of interest stimulated by the NCMRR that is a good example of how technology for severely impaired individuals can be used to restore communication.

In 1999, the NCMRR, together with the Wadsworth Center, New York State Department of Health, initiated an International BCI Conference Series in Rensselaerville, New York. The NCMRR recognized that this fledgling, interdisciplinary field could, with adequate support, develop the technology to offer people with severe motor disabilities (e.g., amyotrophic lateral sclerosis, brainstem stroke, cerebral palsy, and spinal cord injury [SCI]) communication venues and control technology that did not depend on neuromuscular output. That first conference, *BCI Technology: Prospects and Problems*, brought together 40 researchers from the fields of neuroscience, psychology, engineering, mathematics, computer science, business, and clinical rehabilitation to discuss the state of the field and its future directions.



Dr. Louis Quatrano shown with the LN-4 Prosthetic Hand (Grant Number R44HD036921). Visit *http://www.LN-4.org* for details on this item.

Subsequent meetings in 2002 and 2005 doubled the meeting size

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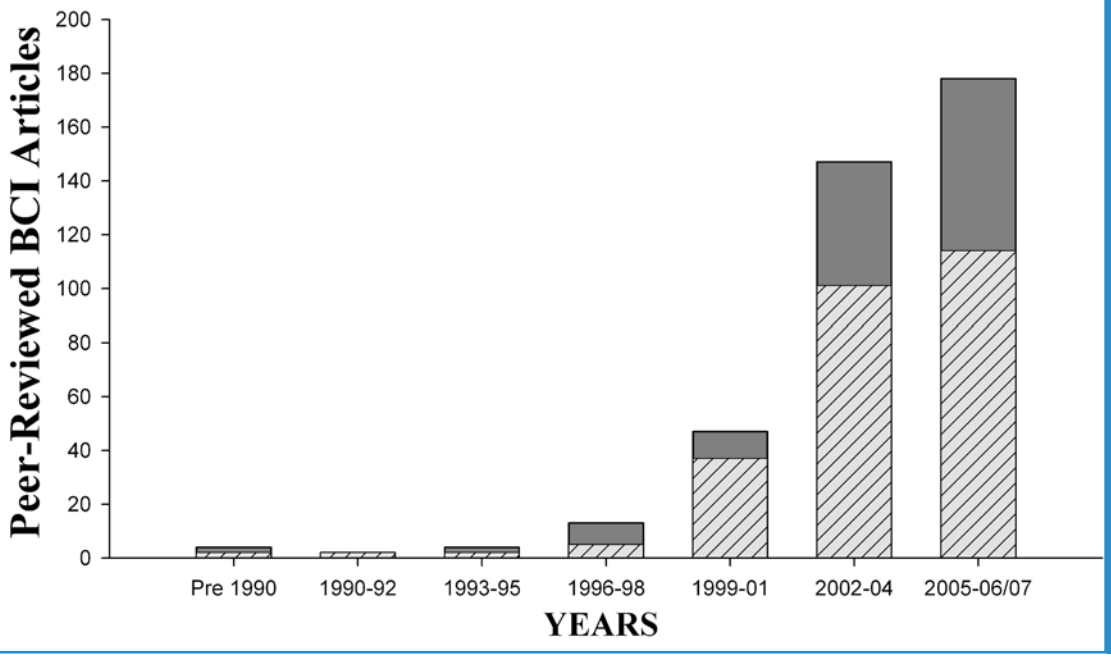

Figure 1.

The growth of peer-reviewed articles on BCI research has been very impressive

(Source: T. Vaughan; Wadsworth Center).

(first 80 and then 160 attendees, respectively, from all over the world); enlarged the scope of the meeting by integrating new topics (e.g., invasive BCIs and augmentative communication software applications); incorporated an Internet-based data competition that preceded the meeting and aroused great interest in the signal-processing community; and greatly emphasized student and postdoctoral fellow participation to support continued development of the field. Each conference published its substance as a comprehensive state-of-the-art collection of peer-reviewed articles in dedicated issues of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) journal *Transactions on Neural Systems and Rehabilitation Engineering* (Volumes 8, 11, and 14; more than 70 articles).

The enormous impact of these meetings is demonstrated by the fact that more than three-fourths of all the BCI articles published before 2005 include one or more authors who participated in one or both of these meetings (see **Figure 1** above). The next International BCI Conference is being planned for June 2009 and will be held in Sturbridge, Massachusetts, in conjunction with the New York Academy of Sciences and the Wadsworth Center. One of the goals of this meeting will be to establish a BCI society and journal. Perhaps more importantly, this meeting will highlight data from the first independent home use of electroencephalogram-based BCI systems. The NCMRR's investment in the field is clearly beginning to pay off for the individuals that it serves. (See also *Introducing Gerwin Schalk: Volition, not Science Fiction* for more information.)

Innovations: You are responsible for overseeing several small business grants, particularly the Small Business Innovative Research (SBIR) grant (R43) and the Small Business technology Transfer (STTR) grant (R44) mechanisms.

Because this ***Innovations*** focuses on rehabilitation engineering (the application of engineering and bioengineering principles in the rehabilitative process), can you please describe that portion of your Program?

Dr. Quatrano: Most applications in response to the omnibus solicitation (*http://grants.nih.gov/grants/funding/sbir.htm*) involve translating innovations into program delivery or creating devices that can be commercialized or further tested in research settings before they are commercialized or widely used in clinical rehabilitation. With advances in scientific areas such as nanotechnology, biomedical imaging, genetics, biomedical computing, etc., there are numerous opportunities to incorporate scientific advances into different phases of research in the rehabilitation process. In the past, the Program has supported research on:

- Mobility devices, including improvements in wheeled mobility (e.g., *http://www.magicwheels.com/*);
- Low-tech and high-tech advances in prosthetics and orthotics (e.g., *http://orthocareinnovations.com/AboutUs.html*);
- Software development, specifically resource information for families supporting individuals who have physical disabilities (e.g., *http://www.idrama.com/Media/InMotionAmputee020100.htm*); and
- Technology to improve therapy, such as improving clinical assessment and improving outcome measurement (e.g., *http://www.qualitymetric.com/proveit/grants/Ph-II-Pediatric-Health.pdf*).

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Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR) Corner

In keeping with the theme of this special issue of ***Innovations***, below are some current or recent SBIR/STTR projects, attributed to the field of rehabilitation engineering and technology, whose projects are already in or nearly in the commercial market.

- Kaufman, Kenton – R01HD030150 – Logic-Controlled Electromechanical Free Knee Orthosis, Mayo Clinic College of Medicine, Rochester, Minnesota
  Program: BSRT

  The goal of this project was to design, develop, and test a small, lightweight, electronically controlled knee joint that could be installed on a conventional knee-ankle-foot orthosis (KAFO). The knee joint unlocks during the swing phase of gait and locks during the stance phase of gait. The orthosis, termed a "stance-control orthosis," was released to the market at the International Society of Orthotics and Prosthetics meeting, which was held in Vancouver, Canada, in August 2007. The company marketing the product is Otto Bock, the same company that manufactures the C-Leg. The news release is available at *http://www.ottobockus.com/ABOUT/PRESS-RELEASES/sensorwalk_press.asp*.

- Krebs, Hermano I. – R01HD045343 – The Effect of Proximal and Distal Training on Stroke Recovery, Massachusetts Institute of Technology, Boston, Massachusetts
  Program: BSRT

  Myomo™, Inc., a developer of non-invasive medical device technology, announced that the editors of *Popular Science* have chosen the Myomo e100 NeuroRobotic™ System as the recipient of the 2007 Best of What's New Award in the personal health category. According to the magazine, these awards have honored innovations that can make a "positive impact on life today and change our views of the future." The editors evaluate thousands of products each year to develop the awardee list, and the award is the highest accolade *Popular Science* gives.

  The Myomo e100 NeuroRobotic™ System is a user-controlled, wearable, portable, robotic brace designed to non-invasively treat arm dysfunction caused by stroke, the leading cause of long-term disability in the United States. Clinically shown to improve mobility in patients from 4 weeks to 21 years after stroke onset, the Myomo device helps patients relearn how to move by allowing them to self-initiate and control movement of hemiparetic (partially paralyzed) arms using their biological signals. No electrical stimulation or invasive procedures are employed.

  The device is built on NeuroRobotics™, a platform technology that merges advances in neuroscience and robotics with scientific research showing the brain's capacity to remap following an injury. NeuroRobotics™ is designed to promote motor recovery by non-invasively targeting the neurological and muscular systems that affect motor control. Initially for upper-extremity stroke motor recovery, NeuroRobotics™ has the potential to treat many conditions that result in loss of neurological function or atrophy.

- Boninger, Ronald – R44HD039535 – Development of the GAMECycle® Exercise System, Three Rivers Holdings, LLC, Pittsburgh, Pennsylvania
  Program: BSRT

  The objective of this project was to develop a new upper-extremity exercise device integrated with a video game (GAMECycle®) that would require sufficient metabolic demand and effort to induce an aerobic training effect. The GAMECycle® is used by children, adults, and seniors. In the clinic, the GAMECycle® is used by people who have or have experienced stroke, TBI, SCI, spina bifida, and other neurological disorders or diseases of the spine. For additional descriptions and a video demonstration, see *http://www.3rivers.com/gamecycle.php*.

- Sears, Harold – R44HD36119 – Electric Heavy-Duty Work Hand, Motion Control, Inc., Salt Lake City, Utah
  Program: BSRT

  This project was funded to develop two new rugged, electric terminal devices (TDs) for heavy-duty work activities, both based upon the same rugged drive and motor. These TDs include the Work Hand and the Work Hook. These newly developed TDs are lighter, can be used in more extreme environments, and offer more versatile gripping shapes than other electric TDs. This new technology was built upon the Motion Control Hand and the Electric Terminal Device, which both utilize a two-speed drive and are capable of 10 kg or 22 lbs of pinch force (as measured with 7.2 volts). The project came about as an answer to the limitations of existing electrical TDs, which are generally not durable enough for many work environments because of susceptibility to water and dirt. Existing TDs were therefore not designed for truly rugged work. This now-commercially available system will give upper-limb deficient individuals the benefits of a highly functional, externally powered work hand suitable for a wide variety of work, home, and recreational environments. (For additional information, visit *http://www.utaharm.com/etd.php*.)

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NCMRR Staff in the Limelight: Lou Quatrano, Ph.D.

Experience suggests some advances may take time, usually 10 to 20 years, with no guarantee of widespread use clinically or commercially. For example, NCMRR has supported a researcher who is building a mechanical two-gear wheel for wheelchairs (*http://www.magicwheels.com*). This relatively simple-sounding project involved a mechanism with more than 250 precision parts and technology from several companies. After 10 years of research, development, and structural/clinical/consumer testing, a product has evolved. In other situations projects provide results shortly after the Phase II application. For example, HipGrip is a dynamic spring-loaded pelvic support device for persons having difficulty maintaining pelvic positioning in a wheelchair. The device allows the user to lean forward and provides variable resistance to assist the user back into an upright position. Beneficial Designs, Inc., (*http://www.beneficialdesigns.com/*) successfully completed the project (NIH/NICHD Phase II Grant number R44 HD36156), and the HipGrip is currently being manufactured by Bodypoint, Inc. (*http://bodypoint.com/*). Entrepreneurs are encouraged to collaborate with rehabilitation clinicians to broaden the areas of science pursued to advance future rehabilitation practice and to improve the health of persons with physical disabilities.

Innovations: Please tell us something about the behavioral sciences portion of your Program.

Dr. Quatrano: First, the Program follows the general definition of behavioral research that is described by the Office of Behavioral and Social Sciences Research at NIH, found at *http://obssr.od.nih.gov/Content/About_OBSSR/BSSR_Definition/*, as applied to individuals with physical disabilities. Behavioral and social sciences research is a large, multifaceted field, encompassing a wide array of disciplines. The field employs a variety of methodological approaches including: surveys and questionnaires, interviews, randomized clinical trials, direct observation, physiological manipulations and recording, descriptive methods, laboratory and field experiments, standardized tests, economic analyses, statistical modeling, ethnography, and evaluation. Yet, behavioral and social sciences research is not restricted to a set of disciplines or methodological approaches. Instead, the field is defined by substantive areas of research that transcend disciplinary and methodological boundaries.

The Program attempts to attract researchers who are interested in examining the interrelationships among the individual, technology, and the environment. With improved patient outcome measures and increased interest in the effect of rehabilitation interventions on the individual's health by public and private organizations, opportunities for behavioral scientists to participate in rehabilitation research should increase. Study sections, such as Behavioral Medicine Intervention and Outcome, Bio-behavioral and Behavioral Processes, Health Services Organization and Delivery, and the Musculoskeletal Oral and Skin Sciences, review applications.

Innovations: What training grant mechanisms are the most popular in the BSRT Program? In what topics/areas are projects funded by new investigators in your Program?

Dr. Quatrano: The career development path for new investigators in the BSRT Program usually begins with a "K" mechanism, followed by a small grant (R03 or R21), and then possibly an R01. Career development grants selected by new investigators are usually the ones for which they meet the eligibility criteria.

Innovations: Have you seen any changes in the field of medical rehabilitation research since you started at NCMRR?

Dr. Quatrano: My joining the NCMRR coincided with the 1991 Institute of Medicine (IOM) publication *Disability in America: Toward a National Agenda for Prevention*, a publication that identified disability as a significant national problem. In general, 16 years later, my observation is that I would agree with the most recent IOM volume of *The Future of Disability in America*, that we have made some progress in understanding disability, its causes, and potential prevention strategies. Nonetheless, much remains to be done at all levels from pathophysiology to societal integration. Interestingly enough, the impairment conditions such as SCI, traumatic brain injury (TBI), amputation, etc., remain, albeit with some improvements in acute treatments. However, there is increased attention by the states and the federal government on systems-level concerns, such as the costs of disability and the effectiveness of interventions, both for the aging baby-boom generation as well as for children.

Innovations: On a more personal note, what do you do in your spare time (if you have any)?

Dr. Quatrano: I like to tinker with machinery.

Innovations: Thank you so much for taking the time to share these thoughts with us. Is there anything else you would like to share with our constituents?

Dr. Quatrano: If anyone has a research concept that he/she feels would be appropriate for the BSRT Program, I would encourage him/her to discuss the concept with me before investing the time and energy in developing a full proposal.

Dr. Quatrano's Contact Information

Biosketch of Lou Quatrano

Phone: (301) 402-4221

E-mail: quatranl@mail.nih.gov

NOW RECRUITING!

NCMRR-Supported Clinical Trials

SIRROWS: Stroke Inpatient Rehabilitation Reinforcement of Walking Speed

- Principal Investigator (PI): Bruce Dobkin, M.D., University of California, Los Angeles (Grant number R01HD046740)
- Contacts: Study Coordinator, Prudence Plummer-D'Amato (pdamato@ucla.edu), or Dr. Dobkin (bdobkin@mednet.ucla.edu)
- Program: BSRT

BrainGate

- PI: John P. Donoghue (Grant number R01EB007401) (See related item in *What's Hot in Medical Rehabilitation Engineering and Technology Research?*)
- For a list of clinical sites, visit *http://www.cyberkineticsinc.com/content/clinicaltrials/braingate_trials.jsp*
- Program: SMAD

Respiratory Muscle Training in Ventilator-Dependent Patients

- PI: Anatole D. Martin, P.T., Ph.D., University of Florida (Grant number R01HD042705)
- Contact: Anatole D. Martin, P.T., Ph.D. (dmartin@phhp.ufl.edu)
- Program: TSR

Study of Citicoline for the Treatment of Traumatic Brain Injury (COBRIT)

- Visit *http://tbi-ct.org/* for a complete listing of sites, PIs, and contacts (cooperative agreement)
- Program: TSR

Therapy for Reading Problems in Adults After Brain Injury

- PI: Rhonda B. Friedman, Ph.D., Georgetown University (Grant number R01HD036019)
- Contacts: Sarah F. Snider, M.A., S.L.P. (sfs24@georgetown.edu), or Nora L. Watson (nlw9@georgetown.edu)
- Program: BSRT

Electrical Stimulation After Total Knee Arthroplasty

- PI: Lynn Snyder-Mackler, P.T., Sc.D., University of Delaware (Grant number R01HD041055)
- Contact: Lynn Snyder-Mackler, P.T., Sc.D. (smack@udel.edu)
- Program: SMAD

Effects of Spinal Cord Injury on Female Sexual Response

- PI: Marca L. Sipski, M.D., University of Alabama, Birmingham (Grant number R01HD03014)
- Contact: Paula Spath (pspath@uab.edu)
- Program: SMAD

Exercise Study for People with Parkinson Disease

- PI: Margaret L. Schenkman, P.T., Ph.D., University of Colorado at Denver and Health Sciences Center, Aurora (Grant number R01HD043770)
- Contact: Jaime C. Salay (jaime.salay@uchsc.edu)
- Program: BSCD

Relaxation Training to Decrease Pain and Improve Function in Adolescents with Cerebral Palsy

- PI: Joyce M. Engel, O.T., Ph.D., University of Washington (Grant number P01HD033988)
- Contacts: Joyce M. Engel, O.T., Ph.D. (knowles@u.washington.edu), or Amy J. Hoffman (ajulian@u.washington.edu)
- Program: BSRT

Constraint-Based Therapy to Improve Motor Function in Children with Cerebral Palsy

- PI: Edward Taub, Ph.D., University of Alabama, Birmingham (Grant number R01HD040692)
- Contact: Edward Taub, Ph.D. (etaub@uab.edu)
- Program: PCCR

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Now Recruiting: NCMRR-Supported Clinical Trials

Functional Electrical Stimulation (FES) for Footdrop in Hemiparesis

- PI: John M. Chae, M.D., Case Western Reserve University (Grant number R01HD044816)
- Contacts: Cathy Corrigan, R.N. (ccorrigan@metrohealth.org), or Peggy Maloney, R.N. (mmaloney@metrohealth.org)
- Program: TSR

Strength Training Using Neuromuscular Electrical Stimulation for Children with Cerebral Palsy

- PI: Samuel C.K. Lee, P.T., Ph.D., Shriners Hospital for Children, Philadelphia (Grant number R01HD043859)
- Contacts: Samuel C.K. Lee, P.T., Ph.D. (sclee@shrinenet.org), or Ann M. Tokay, D.P.T. (atokay@shrinenet.org)
- Program: PCCR

Shoulder, or Elbow, or Wrist: What Should We Train First After a Stroke?

- PIs: Bruce T. Volpe, M.D., Burke Medical Research Institute, New York, & Hermano I. Krebs, Ph.D., Massachusetts Institute of Technology (Grant number R01HD045343)
- Contacts: Avrielle Rykman, O.T.R. (arykman@burke.org), or Bruce T. Volpe, M.D. (BVOLPE@burke.org)
- Program: BSRT

Stress Management for Patients with Multiple Sclerosis

- PI: David C. Mohr, Ph.D., University of California, San Francisco (Grant number R01HD043323)
- Contacts: Claudine Catledge (claudine.catledge@va.gov), or Yuriko Courtney (nycourt@u.washington.edu)
- Program: BSRT

Treatments for Recovery of Hand Function in Acute Stroke Survivors

- PI: Jayme S Knutson, Ph.D., Case Western Reserve University (Grant number R21HD054749)
- Contacts: Peggy Maloney, R.N. (mmaloney@metrohealth.org), or Catherine Corrigan, R.N. (ccorrigan@metrohealth.org)
- Program: SMAD

Subacromial Corticosteroid Injection for Hemiplegic Shoulder Pain

- PI: John Chae, M.D., MetroHealth Medical Center, Case Western Reserve University (Grant number K24HD054600)
- Contacts: Peggy Maloney, R.N. (mmaloney@metrohealth.org), or Catherine Corrigan, R.N. (ccorrigan@metrohealth.org)
- Program: TSR

Improving Memory in Patients with Multiple Sclerosis

- PI: Lauren B. Krupp, M.D., State University New York, Stony Brook (Grant number R01HD38107)
- Contact: Patricia Melville, R.N. (Pmelvill@neuro.som.sunysb.edu)
- Program: TSR

FES for Upper Extremity Recovery in Stroke

- PI: John Chae, M.D., MetroHealth Medical Center; Case Western Reserve University (Grant number R01HD049777)
- Contacts: Peggy Maloney, R.N. (mmaloney@metrohealth.org), or Catherine Corrigan, R.N. (ccorrigan@metrohealth.org)
- Program: TSR

Treadmill Training with Body-Weight Support in Patients with Spinal Cord Injury

- PI: Blair M. Calancie, Ph.D., University of Miami Project to Cure Paralysis (Grant number U01HD37460)
- Contact: Blair M. Calancie, Ph.D. (bcalancie@miamiproj.med.miami.edu)
- Program: SMAD

Treatment for Movement Problems in Elderly Stroke Patients

- PI: Edward Taub, Ph.D., University of Alabama, Birmingham (Grant number R01HD34273)
- Contact: Edward Taub, Ph.D. (etaub@uab.edu)
- Program: TSR

A Randomized Controlled Trial on Preventing Pressure Ulcers with Wheelchair Seat Cushions

- PI: David M. Brienza, Ph.D., University of Pittsburgh (Grant number R01HD04109)
- Contact: Margo B. Holm, Ph.D. (mholm@pitt.edu)

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The remaining projects listed below include some of the grants funded by the NICHD under NCMRR.

- Atkinson, Stewart – R43HD057715 – Electronic Control of Combination Knee/Ankle Prosthetic, Seattle Prosthetic Design, LLC, Seattle, Washington
  Program: BSRT

  The technology developed in this project will provide amputees with the "best possible limb system by making use of recent innovations in accelerometer technology and wireless electronic design, thereby enhancing a (knee-ankle) system that has proven to provide the best biomechanics of any system currently on the market." The purpose of the Phase I grant is to provide the above-knee (AK) amputee with a limb system that increases comfort and functionality by combining the best features of prosthetic limbs developed over the last 30 years.

- Bachrach, Benjamin – R43HD055697 – Multi-Axis Cartesian-Based Arm Rehabilitation Machine (MACARM): A Novel Cable Robot for Upper-Limb Neurorehabilitation in Stroke Survivors, Intelligent Automation, Inc., Chicago, Illinois
  Program: SMAD

  This project seeks to develop a robot-based three-dimensional rehabilitation environment for training upper-limb movements following stroke. The proposed work builds on the previous development and preliminary research using the MACARM. The MACARM is a unique cable robot with a large work volume, high stiffness and force capacity, high positional and force-measurement accuracy, and the potential to provide six degrees of freedom of motion.

- Dobbs, James Ross – R43HD057745 – Development of a Totally Modular Prosthetic Arm with High Workability (ToMPAW), Benedict Engineering Company (BEC), Tallahassee, Florida
  Program: BSRT

  ToMPAW was a research project originally organized under the European Commission's Fourth Framework Programme and led by Stellan Brimalm of Brimalm Engineering. The result of the original research effort was ToMPAW Version 1.0, a concept for a cost-effective, modular, flexible arm system that addresses the needs of both prosthesis users and the prosthetists fitting them. The proposed effort for this Phase I project is to continue the design and development of the ToMPAW Version 1.0 system and to demonstrate the advantages of the system over other upper-extremity prosthetic devices. The Phase I scope will include development of Version 2.0, which will incorporate the modular functionality concept into the actual design and will advance the design for ease of manufacture and commercialization.

- Fago, John – R43HD055708 – ActiveImplant Prosthesis for Lower Limb Amputees, Simbex, LLC, Lebanon, New Hampshire
  Program: BSRT

  This goal of this SBIR project is to quantify the feasibility and potential for an implantable prosthetic device at the distal end of the cut bone for AK amputees. It is hypothesized that such a device can significantly improve residual limb tissue health and load distribution within the prosthetic socket, which would lead to a dramatic improvement in the functional rehabilitation, resultant productivity and overall quality of life of AK amputees.

- Jakobs, Thomas – R43HD054025 – Laser Pointing in a Safe Context for People with Disabilities, InvoTek, Inc., Alma, Arkansas
  Program: BSRT

  The proposed system offers people with severe disabilities an important new method for communicating when speaking is not possible. Presently, all augmentative communication systems require a person to interact directly with that device in order to generate messages, requiring a person to have significant training in operating the device. For many people with disabilities, frequent and precise setup is needed before they can use the device. The proposed system, named LaserCam, offers assistive-device users the ability to use their environments-comprising three-dimensional objects, photographs, and communication symbols, to communicate. The user selects objects in this predefined "laser-safe" communication area by targeting the objects with a custom laser that is exceptionally eye safe. The envisioned system permits a facilitator to design an access scheme that enables the user to progress seamlessly from low-tech partner-interpreted pointing to high-tech independent computer access.

- Lopresti, Edmund F. – R44HD040023 – Smart Wheelchair Component System (SWCS), AT Sciences, Pittsburgh, Pennsylvania
  Program: BSRT

  The goal of this project is to develop a set of components that can be added to standard power wheelchairs to convert them into "smart" wheelchairs, which can assist the user in navigation and obstacle avoidance. During Phase I, a prototype of the SWCS was developed from a laptop computer and a collection of sonar, infrared, and bump sensors. The evaluation activities performed during Phase I demonstrated that the system is compatible with multiple brands of wheelchairs, can accept both continuous and switch-based input, and can support front-, mid-, and rear-wheel drive wheelchairs. During Phase II, the researchers will refine the system hardware and software, replace the laptop computer with an embedded microprocessor, fabricate enclosures for the system components, and develop tools to support clinicians in installing and configuring the system.

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Now Recruiting: NCMRR-Supported Clinical Trials

Study of Hand Therapy 3 to 24 Months After Stroke

- PI: James B. Koeneman, Ph.D., Kinetic Muscles, Inc. (Grant number R44HD041805)
- Contacts: *(Phoenix, Arizona)* Lisa Orozco (lisa.orozco@bannerhealth.com), or Richard Herman, M.D. (richard.herman@bannerhealth.com); *(Atlanta, Georgia)* Veronica Rowe, M,S., O.T.R./L. (vrowe@emory.edu), or Steven L. Wolf, P.T., Ph.D. (swolf@emory.edu)
- Program: SMAD

Transfer of Grasp Control Across Hands After Stroke

- PI: Preeti Raghavan, M.D., Mount Sinai School of Medicine (Grant number K23HD049472)
- Contacts: Eddie Li (212-241-7182), or Preeti Raghavan, M.D. (preeti.ragahavan@mountsinai.org)
- Program: TSR

For a full listing of all NICHD-sponsored clinical trials, visit *http://www.nichd.nih.gov/health/clinicalresearch/index.cfm*.

What's Hot in...

...Medical Rehabilitation Engineering & Technology Research?

The NCMRR, with the National Institute of Biomedical Imaging and Bioengineering (NIBIB), is co-funding an NIH grant for the development of implants that restore neurological function. Cyberkinetics Neurotechnology Systems, Inc. (OTCBB: CYKN; "Cyberkinetics"), Brown University, and the Cleveland FES (Functional Electrical Stimulation) Center at the Case Western Reserve University will do work under this five-year, $6.5 million grant. To learn more about this project, visit *http://phx.corporate-ir.net/phoenix.zhtml?c=182802&p=irol-newsArticle&ID=1035846&highlight=*.

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SBIR/STTR Corner

- Narendran, Kailas N. – R43HD056622 – Data Collection and Acquisition Capabilities for Wearable Robotic Rehabilitation, Myomo, Inc., Spaulding Rehabilitation Hospital, Boston, Massachusetts
  Program: BSRT
  See related project *Krebs, Hermano I (R01HD045343)*
- Pitkin, Mark – R43HD057492 – Manufacturing Technology for Skin-Integrated Composite Prosthetic Pylon, Poly-Orth International, Sharon, Massachusetts.
  Program: BSRT

  The proposed study is aimed at developing a new "Residuum-Integration Prosthetic Technology" to be used in limb prosthetics. The technology will include a Skin and Bone Integrated Pylon (SBIP), which will connect the residuum with an external limb prosthesis. The SBIP will not only be integrated with the residual bone, but also with the residuum's skin in order to minimize the risk of infection and secondary trauma.
- Veatch, Bradley D – R44HD047985 – A Child's Body-Powered Prehensor with Adaptive Grasp, ADA Technologies, Littleton, Colorado
  Program: BSRT

  The Low Energy Sequential Action Prehensor (LESA) is the only available body-powered TD with voluntary closing and opening capabilities in one unit. Body-powered TDs currently on the market (commonly known as "hooks") are either in an open or closed mode, making it necessary for most arm/hand amputees to have two different TDs, between which they change manually depending on specific activities. Many arm/hand amputees also find it difficult to pickup and hold onto objects with the currently available devices. LESA's patented design includes an extraordinary gripping and holding system that reduces accidental drops and enables users to pick up objects as small as a coin. The objective of this project is to develop and test a pediatric version of LESA.

For a complete listing of NCMRR-supported SBIR/STTR projects, visit:

- *NCMRR-supported projects for fiscal year 2007*
- *NCMRR-supported projects for fiscal year 2008*

NIH NEWS

The National Institute of Biomedical Imaging and Bioengineering (NIBIB) sets up U54 Point of Care (POC) Technology Centers

As the result of a *workshop* and a Request for Applications (RFA) (*http://grants.nih.gov/grants/guide/rfa-files/RFA-EB-06-002.html*), the NIBIB is setting up several Point-of-Care Centers for Emerging Neurotechnologies (POC-CENT) utilizing the U54 funding mechanism. According to the RFA, outside researchers may submit collaborative exploratory projects to the Centers for funding (about three to four per year).

Several POC-CENTs are already being funded.

One such example is the POC-CENT at the University of Cincinnati, led by PI Fred Beyette (Grant number U54EB007954). This Center is focused on developing diagnostic technologies for neurologic emergencies where information is needed by the physician quickly. The remit for the technologies to be developed is to advance point-of-care (POC) information and information flow for the neurologic patient in the emergency room, neurosurgery suite, neuroradiology, and the neurosurgical intensive care unit. Indeed, any time the physician requires rapid information from the neurologic patient, it will be considered as having potential need for POC diagnostic information. These diagnostics will include but will not be limited to: blood tests, urinalysis, imaging, non-invasive sensors, spinal fluid, and biopsy/tissue samples.

The POC-CENT program has five cores, which represent numerous disciplines to foster and facilitate the application of ideas to clinical applications. These cores include clinical testing, exploratory projects, clinical needs assessment, training, and administration. Representatives from the neurology, neurosurgery, engineering, and entrepreneurial development departments, the business community, the medical device industry, and university administration all support these cores.

According to its application, the goal of the University of Cincinnati project is to improve the care and health of neurologic patients by providing fast and reliable information about the biological event the patient is experiencing by developing a pipeline of technologies and a establishing a pathway toward the development of emerging neurotechnologies focused on POC diagnostics. The Cincinnati group will work closely in the region, with the POC Technology (POCT) Research Network, and with the engineering, medical, scientific, and commercial communities at the University.

Other active POC-CENTs include:

- Gerald J. Kost – U54EB007959 – Project: Rapid multipathogen detection for POCT and national disaster readiness
- Charlotte A. Gaydos – U54EB007958 – Project: Center for POCT research for sexually transmitted diseases
- Bernhard H. Weigl – U54EB007949 – Project: Center to advance POC diagnostics for global health

Resources for Rehabilitation Researchers

- *BECON: The Bioengineering Consortium*

  BECON is the focus of bioengineering activities at the NIH. The Consortium consists of senior-level representatives from all of the NIH Institutes, Centers, and Divisions, plus representatives from other federal agencies concerned with biomedical research and development.

- *Bioengineering and Information Science Technology Initiative (BISTI)*

  The focus of biomedical computing activities at the NIH is the BISTI Consortium (BISTIC), which consists of senior-level representatives from each NIH Institute and Center, plus representatives from other federal agencies concerned with biocomputing. The BISTI site includes information about BISTI symposia and funding opportunities in bioinformatics.

- *National Institute of Biomedical Imaging and Bioengineering (NIBIB)*

  The NIBIB is an Institute within the NIH devoted to merging the physical and biological sciences to develop new technologies that improve health. NIBIB's goal is to accelerate the pace of discovery and speed the development of biomedical technologies that prevent illnesses or treat them when they do strike.

IN THE NEWS

Long-term Benefit of Stroke Treatment

A recent article published in *The Lancet* demonstrates that the benefit of constrained-use therapy for stroke patients is long lasting. This study was funded by the NICHD (Grant number R01HD037606) with co-funding from the National Institute of Neurological Disorders and Stroke. For more information, visit:

- *Retention of upper limb function in stroke survivors who have received constraint-induced movement therapy: the EXCITE randomised trial.* *Lancet Neurol*. 2008 Jan;7(1):33-40.
- *Movement Therapy Helps Stroke Patients* (WebMD)

Strengthening Exercise for Persons with Cerebral Palsy

This NICHD-funded project (Grant number R21HD048742) at Middle Tennessee State University, Murfeesboro, Tennessee, is investigating the provision and effects of underwater treadmill training for persons with cerebral palsy. Visit *http://www.wsmv.com/video/14426614/index.html* for more information.

Zebrafish May Shed Light on Disease Control

Tiny, translucent zebrafish, spotted with fluorescent agents that glow brightly under a microscope, may help scientists discover treatments for diseases such as juvenile diabetes, Parkinson disease, and Alzheimer disease. At least that's the hope of Jeff Mumm (Grant number R44HD047089), a neurobiologist and founder of St. Louis-based Luminomics, Inc. Read about Jeff at *http://stlouis.bizjournals.com/stlouis/stories/2006/07/24/focus3.html?q=luminomics*.

A Powerful Mind

A Hollins professor and polio survivor leads a global organization to help others with the disease.

Dr. Lawrence Becker is a former member of the NCMRR Advisory Board.

NCMRR Conference Calendar

National Medical Rehabilitation Research Advisory Board--May 1-2, 2008, and December 1-2, 2008. The Board reviews and assesses federal research priorities, activities, and findings in rehabilitation research and makes recommendations to the NCMRR director and to the NICHD director. The Board has a unique role in working with NCMRR staff to evaluate the relevance and effectiveness of existing research programs and identifying opportunities for new directions. The Board is composed of clinicians, researchers, and consumer advocates with a broad range of expertise in medical rehabilitation and the promotion of opportunities for people with disabilities, as well as *ex-officio* members from relevant federal agencies.

Contact: Ralph Nitkin, Ph.D., at (301) 402-4206
For background on the Board, visit *http://www.nichd.nih.gov/about/overview/advisory/nmrrab/index.cfm*.

In the next *Innovations*