From the Director's Desk

Where should we invest?

Now, more than ever, it is unclear where people should invest their money. The economic downturn has impacted stocks and the health care industry, and most investors just talk about weathering the storm. Unfortunately, I don’t have any sage advice related to personal investments. If you do, give me a call.

But with respect to PM&R, I do have investment advice: We need to continue to invest in our patients. Investing in their recovery is ethically, medically, and financially the right thing to do. I worry that the vulnerable patients we care for will be the first to be sacrificed in the current quest to cut costs. I believe that now, more than ever, we must act in a role that is uniquely important to rehabilitation — that of patient advocate as well as physician. We must work with patient-led groups and the health care colleagues we sit across from at meetings and conferences to form strong coalitions that are capable of being a loud voice in the sea of voices that will be calling for medical funding.

In this issue I am proud to report that UPMC has decided, once again, to invest in the rehabilitation of our patients. Using more than $20 million in funds, UPMC has built a brand-new rehabilitation facility within a state-of-the-art acute care hospital. This hospital, UPMC Mercy, is the new home of the UPMC Institute for Rehabilitation and Research (IRR). Being a dedicated rehabilitation hospital within an acute care hospital provides our patients with the best of both worlds — a new 77-bed facility with immediate access to the acute care teams that took care of the patients prior to rehabilitation. If you are in Pittsburgh, please stop by and see our new home.

Michael L. Boninger, MD
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University of Pittsburgh School of Medicine
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Institute for Rehabilitation and Research (IRR) at UPMC Mercy

The UPMC Institute for Rehabilitation and Research (IRR) attained a new milestone in rehabilitative care with the transition of the IRR from UPMC South Side to UPMC Mercy in July 2009. The new program creates a center of excellence for rehabilitation at which clinicians and researchers continue to improve the lives of patients with acquired brain injury, spinal cord injury, and other complex disabilities.

The IRR at UPMC Mercy is the result of a long evolutionary history spanning more than 150 years of providing medical services to the communities of Pittsburgh.

History

Mercy Hospital of Pittsburgh, 1847 to 2007

The Sisters of Mercy, a Roman Catholic order of nuns from Dublin, Ireland, were well-known across Britain and Ireland in the 1800s for the care they administered to the sick and poor. Answering an invitation to bring their ministry to the United States, a group of sisters arrived in Pittsburgh in 1843 and founded Mercy Hospital of Pittsburgh in 1847. Mercy’s list of firsts includes:

• the first hospital in the Pittsburgh region
• the first teaching hospital in the Pittsburgh region
• the first Mercy hospital established by the religious order
  (Mercy institutions now span the globe.)

The Memorial Home for Crippled Children, 1902 to 1998

Mary Irwin Laughlin, along with a group of philanthropic women, founded the Memorial Home for Crippled Children to improve the lives and health of children in the heavily industrial Pittsburgh of the early 1900s. The home quickly became one of the nation’s leading institutions for pediatric care and was soon a center of care for children and young adults with polio. In the 1970s, reflecting the growing need for adult rehabilitation care, the facility was changed to The Rehabilitation Institute of Pittsburgh and included inpatient and outpatient services for both children and adults.

In 1998, UPMC purchased the building and adult divisions to form the UPMC Rehabilitation Hospital. It was here that specialized treatment and clinical research programs in spinal cord injury (SCI) and traumatic brain injury (TBI) were centered. Physiatrists from the Division of Physical Medicine and Rehabilitation (of the UPMC Department of Orthopaedic Surgery) provided the hospital’s core attending physicians. In 2000, department status was granted to Physical Medicine and Rehabilitation (PM&R), reflecting its growing clinical and research prominence within the university and hospital system.

The changing face of physical medicine and rehabilitation, the use of nonsurgical interventions, the rise of bioengineering research, and SCI and TBI model system grants paved the way for the establishment of the Institute for Rehabilitation and Research (IRR) in 2004 at UPMC South Side. The UPMC Rehabilitation Hospital underwent a name and business structure change to become IRR. Services and research expanded to include other clinical and university health science departments.

IRR at UPMC Mercy, 2008 to present

Mercy Hospital joined UPMC in 2008. Now known as UPMC Mercy, the hospital continues as a Level I Regional Resource Trauma Center. It is the only local facility with a Level I trauma center and a burn center under one roof, and has been a leader in providing comprehensive care for victims of trauma and burn injuries for more than 40 years. UPMC Mercy has been a Commission on Accreditation of Rehabilitation Facilities (CARF) accredited institution in several key areas of rehabilitation medicine, making it a logical addition to the UPMC rehabilitation network. Relocating the IRR, UPMC’s hub of rehabilitation services, enables the rehabilitation team to take advantage of the established high level of care provided by the trauma center and continue that care from acute to outpatient stages at one location.

The new 77-bed rehabilitation facility includes:

• Spinal Cord Injury Unit (20 beds)
• Brain Injury Unit (19 beds)
• Stroke Unit (20 beds)
• General Rehab (18 beds)

Clinical research trials centered at the IRR at UPMC Mercy include the UPMC Spinal Cord Injury Model System (UPMC-SCI) and the Traumatic Brain Injury Clinical Trials Network (TBI-CT). Both are national, multicentered trials in which centers contribute demographic, injury, and treatment information to national databases, as well as developing and leading site-specific research protocols. For example, stroke patients may be eligible for an NIH-funded trial using donepezil to promote functional recovery, while TBI patients have an opportunity to join an NIH-funded drug trial using citicoline to aid in restoring cognitive function. As people transition from inpatient to outpatient at the IRR at UPMC Mercy, additional opportunities arise for participation in assistive device trials and mobility trials.
Innovations

Major renovations at the IRR were made to the spinal cord injury, brain injury, stroke, and general rehab units. Each self-contained unit offers a full array of medical and rehabilitation services.

- Patient walking tracks run 50 feet down a hallway on the SCI, TBI, and General Rehab units. The walking tracks enable patients to work on gait-training activities over ground.

- Select patient rooms also contain in-ceiling lifts, both regular and bariatric types. The patient lifts offer improved safety for patients and the staff assisting them.

- “Main Street,” one of the IRR’s specialty therapy gyms, simulates real-life obstacles to aid in the patient’s return to daily life. Here a patient can practice walking on cobblestones, asphalt, and flagstone, transitioning from surface to surface in one run.

- In 2005, the IRR obtained a Lokomat®, a state-of-the-art gait orthosis used in rehabilitation. At the time, IRR was one of a small number of rehabilitation facilities with this innovative equipment. The IRR’s Lokomat has been moved to UPMC Mercy, where it continues to enable patients to begin standing and gait training earlier in the recovery process, and at a more intense level. Physical therapists in the IRR Spinal Cord Injury Rehab Program also have noted improved ambulatory endurance and gait speed in some individuals who use the Lokomat.

To improve arm function after stroke, the IRR at UPMC Mercy has added the Armeo®, an arm rehabilitation device manufactured by the maker of the Lokomat. The Armeo enables patients to receive visual feedback while using the affected upper extremity to complete certain tasks or games. Rehab results are carried over into completion of daily self-care with increased use of the affected upper extremity.

The future

Physicians, neuropsychologists, nurses, therapists, and a large contingent of researchers are dedicated to ensuring that the UPMC IRR remains a leader in rehabilitation and research. Each person who comes to the IRR receives the very best of what we represent in our three core areas of focus: patient care, research, and education.

For more information about IRR, please visit http://www.upmc.com/Services/IRR

For more information about UPMC Mercy, please visit http://www.upmc.com/HospitalsFacilities/Hospitals/Mercy
Development of implantable brain-computer interface technology

Wei Wang, MD, PhD, is assistant professor in the Department of Physical Medicine and Rehabilitation of the University of Pittsburgh School of Medicine. Dr. Wang is the director of the department’s Human Rehab Neural Engineering Laboratory.

Many individuals with motor impairments have limited means to communicate and interact with their environment. Assistive technology can restore or augment function for these individuals and improve their quality of life. Unfortunately, the same motor impairments limit the user’s ability to operate devices using these assistive technologies. An emerging field called neuroprosthetics aims to directly interface with the nervous system in order to harness control signals for a wide variety of assistive devices. This new field has the potential to benefit individuals with severe motor disabilities secondary to spinal cord injury, amyotrophic lateral sclerosis (ALS), and stroke.

What is neuroprosthetics?

Neuroprosthetics encompasses a wide range of technologies that aim to replace a motor, sensory, or cognitive function by directly connecting to an intact part of the nervous system. The most successful and widely used neuroprosthesis is the cochlear implant, which provides a sense of sound to people who are hearing-impaired. Brain-computer interface (BCI) devices are a specific type of neuroprosthesis in which a direct communication pathway is established between the brain and an external device. BCI technology enables the user to control and communicate with external devices using only brain activity, without the need for overt movement.

Brief history of BCI research

Studies in nonhuman primates have used single-unit neural recording methods to derive movement direction, speed, and position information from neurons in the motor cortex. Animal studies, including the pioneering work completed at the University of Pittsburgh, led by Dr. Andrew Schwartz, have shown that nonhuman primates can learn to control an upper limb prosthesis in three-dimensional space to perform reaching and feeding tasks. Based on this strong foundation, Dr. Wang’s team is working to translate this basic research to clinical applications for humans. The challenge is to extract the same type of movement- or intention-related information with less invasive recording methods. Multiple neural recording modalities are being investigated for human BCI applications.

Because electroencephalography (EEG) measures electrical activity using noninvasive scalp electrodes, it is widely used in human BCI research. While moderate success for one- and two-dimensional computer cursors has been achieved using EEG, this neural recording modality is limited by its low spatial resolution, and user training is often very time-intensive.

The BrainGate™ system uses a 4 x 4 mm, 100-electrode microarray that penetrates two to three mm into the cortex — the same array used by Dr. Schwartz in his neuroprosthetic studies in nonhuman primates. Clinical trials of the BrainGate neural interface are being conducted, and subjects have learned to control a computer cursor using imagined arm and hand movements. The long-term stability of this recording method remains to be seen, because signal quality declines with time.

Electrocorticography (ECoG) recently has emerged as a promising neural recording modality for BCI applications.

The initial ECoG-BCI research has been performed exclusively in patients undergoing presurgical monitoring as part of their treatment for intractable epilepsy. ECoG electrode grids are implanted subdurally over the suspected epileptogenic foci for one to two weeks. During this time, neural recordings have been utilized by researchers for BCI development. Because the ECoG grids are placed directly on the brain, a higher spatial resolution than with EEG can be achieved, and movement-related information is preserved within a wide frequency range (0 to 200 Hz) of ECoG signals. Several studies, including work completed by Dr. Wang’s research team, have shown that human subjects can achieve effective control of cursor movement within a very short period of time with ECoG.

Developing an implantable human BCI device

Dr. Wang and his IRR colleagues, Douglas Weber, PhD, Jennifer Collinger, PhD, (Department of PM&R), and Elizabeth Tyler-Kabara, MD, PhD (Department of Neurosurgery) are leading the human neuroprosthetics effort at the University of Pittsburgh. Dr. Wang has received research support from the Clinical and Translational Science Institute Translational Tool Pilot Project program as well as a special fund from Arthur S. Levine, MD, senior vice chancellor for the Health Sciences, and dean, School of Medicine, to conduct translational research in human neuroprosthetics.

Figure 1: X-ray showing the placement of the standard clinical ECoG grid and the experimental micro-ECoG grid for a recent subject. The inset photograph compares the center-to-center electrode distance between the two electrode grids.
The human neuroprosthetics group, which includes other collaborators at the University of Pittsburgh and Carnegie Mellon University, is currently investigating micro-ECoG as a platform technology for an implantable BCI. Micro-ECoG electrode arrays have a much smaller footprint than traditional ECoG grids (see Figure 1), and can potentially be implanted through a small burr hole and placed above the dura mater, thus minimizing various clinical risks and the invasiveness of implantation surgery.

The team is testing custom-designed micro-ECoG arrays in patients undergoing subdural epilepsy monitoring. Micro-ECoG arrays are implanted next to the clinical ECoG grid without measurably increasing the risk to patients. Data from the last subject with a micro-ECoG array implanted above the motor cortical area showed that rich movement-related information could be decoded from micro-ECoG recording. It was possible to predict which finger was moving with 73 percent accuracy based on micro-ECoG signals (chance level: 20 percent). This subject was able to control the “jumping” action using neural signals related to finger movement while playing the Super Mario Brothers video game.

Results from the last subject suggest that micro-ECoG-based BCI devices hold great potential for high-resolution brain activity monitoring and the improvement of the quality of life for many individuals with motor impairments. The next step is to test this new technology in individuals who can benefit from an implantable BCI, such as those with a spinal cord injury.

A complementary line of research is developing magnetoencephalography (MEG) as a noninvasive tool for studying neural mechanisms and as a presurgical screening tool to determine micro-ECoG electrode placement. MEG can be used to identify cortical areas that contain information about intended actions. These areas would be targeted for micro-ECoG implantation. Dr. Wang has shown that MEG can be used to reliably detect the intended movement direction during motor imagery without overt movement from subjects. This is particularly important as we move toward an implantable BCI system for individuals with motor impairments. Through real-time feedback of cortical activity, a MEG-BCI system may be used to enhance cortical modulation by intended movement, which can improve the performance of BCI operation. Moreover, given the capability to promote neuroplasticity through BCI operation, MEG-BCI systems may hold great potential as a rehabilitation tool for patients with stroke and incomplete spinal cord injury.

**Clinical implications**

An implantable BCI would offer a new way for individuals with severe motor impairments to communicate and interact with the environment without requiring overt movement. Once reliable and independent control signals are derived, the possibility exists to operate any type of assistive technology, ranging from a computer to complex upper limb prosthesis. Given the possibility of micro-ECoG technology to bring significant functional gain with minimal clinical risk, it is expected that this new technology can potentially benefit not only those with severe motor disabilities, but also many individuals with various degrees of motor impairments caused by stroke and other neurological disorders.

For more information, contact Dr. Wei Wang at wangw4@upmc.edu.

**References**


Figures 1 and 2 reprinted from this article with permission from Wei Wang, MD, PhD.
Patient decision-making in motor neuron disease and PEG tube feeding

Paula Leslie, PhD, is associate professor in the University of Pittsburgh School of Health and Rehabilitation Sciences, Department of Communication and Speech Disorders. She completed her doctoral studies at the Newcastle University, Newcastle upon Tyne, United Kingdom.

The Phase 1 study discussed below was funded by Newcastle Healthcare Charity and Newcastle upon Tyne Hospitals NHS Charity and took place in Newcastle upon Tyne, United Kingdom.

Rehabilitation and decisions in progressive neurological disease may initially seem worlds apart, but recent evidence shows that using rehabilitation strategies maintains and improves function and quality of life longer into the disease process. The modern management of people with chronic degenerative diseases is increasingly surrounded by clinical and ethical challenges. A key area of health care is the provision of supplementary nutrition and hydration. Patients, caregivers, and professionals view the provision of nutrition as one of the most basic duties of care.

Unfortunately, there appears to be very little specific research on decision-making in motor neuron disease (MND), and almost none in terms of nutritional/feeding decision-making. Malnutrition is a common problem among patients with degenerative disease but the impact of nutrition on clinical outcome is only now being addressed. When the patient’s swallowing competence and eating capacity deteriorate such that adequate oral intake is no longer possible, consideration is given to artificial enteral nutrition, typically by percutaneous endoscopic gastrostomy (PEG).

Anecdotally, patients with chronic disease sometimes interpret the proposal of PEG insertion as an indication of imminent demise. One possible reason for this may lie in the evidence that PEG placement in MND may come too late for significant impact on the quality of life. Some clinicians now opt to discuss the possibility of the intervention earlier in the disease process; however, this choice is made in an evidence void. Other clinicians, aware of the hidden message of “PEG is a death sentence,” may, for the best of motives, opt to ignore the issue. The implications of leaving this decision until later are that patient input is much less and tolerance and nutritional benefits are less successful. Hence, a relatively costly intervention is being applied with good intent but at a time of least prospect for quality-of-life benefit.

The research

The research was a qualitative Phase 1 study involving six patients from one clinic, age 40 to 75, who have had to consider PEG insertion. Four participants (three female, one male) chose to have a PEG and two (female) opted against it; time from MND onset was four months to eight years. Semi-structured, private interviews were conducted with each individual concurrent with regular MND clinic appointments; relatives were allowed to be present if the patient wished, but were encouraged to allow the patient to speak for him- or herself. Because patients may be dysarthric, the researcher repeated unclear responses to clarify for transcription, with the repetition and interpretation checked with the patient to ensure the patient’s own words were used.

All patients reported that they had enough information to inform their decision and that access to the MND team was open. There was variation in how much information people wanted — the timing of this was important. Research showed that eating and drinking have many social aspects that are of equal or greater concern than just nutrition and hydration.

Clinical impact

Our data show that the decision to have or not have a PEG is a monumental step. Having the operation may signal a feared move in the disease progression. Patients want information at different rates. The health care team is perceived as most supportive when its members appreciate this. Communication between primary and tertiary care is important. Patient perception of professional care should be assessed to ensure both parties have the same perspective. Participating in the study allowed fresh discussion among family members about PEG-related issues not raised previously.
Future directions

The development of a decision-making framework to guide the application of such interventions is a very valuable long-term goal of this initial study. Our group carried out a similar study in patients who had a PEG sited more often as an emergency procedure. This is a different clinical and psychological situation and further exploration of these different scenarios merits study.

As the decision to offer PEG feeding moves away from reliance on only the clinical team to involve the family, it is vital that philosophical issues are weighed appropriately, but more pragmatic concerns also must be addressed: What information is or should be available, and how do or would patients and families use it? We already have a lot of “clinical information.” For example, patients who attend a multidisciplinary team meeting in the acute setting frequently will receive advice on the disease process and feeding options from overly technical sources. Patients and caregivers may not be ready to absorb this level of information and may struggle to reach a decision.

Finally, what can we learn in the United States from the U.K. experience? Would this knowledge allow us to fight for more appropriate services for our patients?

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References


IRRDay 2009

Each year the call for abstracts goes out across the University of Pittsburgh to students from the undergraduate to postdoctoral levels who are involved in rehabilitation research. Fifty-nine abstracts were received from departments, schools, and labs such as psychology, bioengineering, physical therapy, and orthopaedic surgery, and from the School of Nursing, Safar Center for Resuscitation Research, and Stem Cell Research Center.

IRRDay 2009 officially began with poster grand rounds, during which Honorable Mention winners presented their work to IRRDay faculty.

Honorable Mention poster winners

Undergraduates

- Katie Ehrenberg, Department of Psychology, mentored by PM&R associate professor Anthony Kline, PhD: A rehabilitation-relevant enrichment paradigm facilitates neurobehavioral recovery after experimental traumatic brain injury.

- David Grosco, Department of Biological Sciences, mentored by PM&R assistant professor Fabrisia Ambrosio, PhD, PT: Neuromuscular electrical stimulation improves muscle stem cell regenerative potential.

Postdoctoral students

- Giovanna Distefano, MS, PT*, under the direction of PM&R assistant professor Fabrisia Ambrosio, PhD, PT: Four weeks of neuromuscular electrical stimulation enhances the transplantation of muscle-derived stem cell into dystrophic skeletal muscle.

- Jim Hokanson, Department of Bioengineering, mentored by PM&R assistant professor Doug Weber, PhD: Using classifiers to evaluate cortical responses to primary afferent microstimulation.

PM&R residents

- Angela Garcia, MD, mentored by Brad Dicianno, MD: The occurrence of lymphedema in an adult spina bifida population.

- Manijeh Ryan, MD, mentored by Mary Ann Miknevich, MD: Retrospective cross-sectional study of the relationship between total functional independence measure (FIM) discharge score and discharge destination in acute in-patient rehabilitation unit.

continued
Postdoctoral/Fellows

- Chia-Lin Chang, PhD*, under the direction of PM&R assistant professor Wei Wang, MD, PhD, and Michael Munin, MD: The effect of reducing spasticity via Btx-A injection on cerebellar activity after chronic stroke.
- Nicole Hoh, PhD, RN, under the direction of School of Nursing associate professor Yvette P. Conley, PhD: BCL-2 genotypes and functional and cognitive-behavioral outcomes after severe traumatic brain injury.
- The researcher is funded in part through the NIH T32 grant, Training Rehabilitation Clinicians for Research Careers, at the Department of Physical Medicine and Rehabilitation, University of Pittsburgh School of Medicine. For more information about the training grant, please visit http://pmr.medicine.pitt.edu/content/Research/T32.pdf.

IRRDay also included presentations by guest faculty, John Whyte, MD, PhD, and Alan Jette, PhD, PT, followed by the Best Rehabilitation Award presentations.

IRRDay 2009 Best Rehabilitation Research presentations

- Steven Brose, DO
  Best Rehabilitation Research by a PM&R resident
  A sham manipulation tool for manual medicine research, and counterstrain manual medicine for the treatment of neck pain.
  S. Brose, D. Jennings, B. Liu
- Alexandra Gil, MS, PT
  Best Rehabilitation Research by a predoctoral student
  Stiffened pattern of movement is associated with worse physical function in people with knee osteoarthritis.
  A. Gil, P. Sparto, S. Piva, G. Fitzgerald
- Elke Husch Pereira Brown, MD
  Best Rehabilitation Research by a postdoctoral student
  The role of vascularity in skeletal muscle regeneration in adult mice.
  E. Brown, J. Lexell, R. Ferrari, B. Wang, M. Boninger, J. Huard, F. Ambrosio

Recently awarded

The Department of Veterans Affairs has selected the Human Engineering Research Laboratories (HERL) as the VA Center of Excellence for Wheelchairs and Associated Rehabilitation Engineering. As a Research Center of Excellence, HERL will receive $5 million during this five-year cycle of funding. This is the third time HERL has received this award. Drs. Michael Boninger and Rory Cooper are the principal investigators on this grant.

A center for wheelchair technology, HERL focuses on the design, development, and evaluation of new technologies to improve the mobility of physically impaired individuals. In its short history, HERL has become an important contributor to the fields of wheelchair design, seating systems, transportation systems, and novel approaches to the delivery of assistive technology.

For more information: www.herl.research.va.gov
www.herlpitt.org

UPMC

UPMC is an $8 billion integrated global health enterprise headquartered in Pittsburgh, Pennsylvania, and is one of the leading nonprofit health systems in the United States. As western Pennsylvania’s largest employer, with 50,000 employees, UPMC is transforming the economy of the region into one based on medicine, research, and technology. By integrating 20 hospitals, 400 doctors’ offices and outpatient sites, long-term care facilities, and a major health insurance services division, and in collaboration with its academic partner, the University of Pittsburgh Schools of the Health Sciences, UPMC has advanced the quality and efficiency of health care and developed internationally renowned programs in transplantation, cancer, neurosurgery, psychiatry, orthopaedics, and sports medicine, among others. UPMC is commercializing its medical and technological expertise by nurturing new companies, developing strategic business relationships with some of the world’s leading multinational corporations, and expanding into international markets, including Italy, Ireland, the United Kingdom, Cyprus, and Qatar. For more information about UPMC, visit our website at www.upmc.com.

For more information about our clinical services or for assistance with patient referrals, please call UPMC MedCall at 412-647-7000 or 1-800-544-2500.