

Rehab *progress*

News from the University of Pittsburgh Medical Center Institute for Rehabilitation and Research

Summer 2010

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Rehab Progress — Summer 2010

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From the Director's Desk: Video gaming meets rehab



Dr. Boninger

My son asked me, “Dad, why do I have to stop playing Madden 09? I thought you said video gaming was great.” Now where did he get that idea?

As you’ll see in this issue of *Rehab Progress*, gaming has become a bigger part of my life — not just video gaming, but video gaming in the company of the Pittsburgh Steelers. Steelers team members were on hand recently to assist with the opening of our new Gaming and Robotics Center.

Why would a health system open a gaming center? Gaming brings to mind the proverbial couch potato with a bag of chips, a high calorie soda, and a game control he is unable to put down. But as we know, one key to effective rehabilitation is repetition, like the repetition involved in playing computer games over and over. All you need is movement. And with gaming it feels more like playing than “rehabbing.”

Enter the Wii® — a great tool for both movement and fundraising. At our recent

fundraising event to benefit community wellness initiatives, donors got to play Wii against their favorite Steelers team members. And in case you’re wondering if football talent relates to sports gaming talent, I can vouch that it does. Deshea Townsend crushed me.

Video gaming works as a rehab tool, but what if a patient is too weak to move? Here is where robotics comes in. As part of our partnership with the robotics technology company, Hocoma, our new Robotics and Gaming Center employs a device called the Armeo®Boom. This device supports the arm through all three planes of movement. At present, we are the only facility in the U.S. using the ArmeoBoom for gaming. In the future it may have application in the home setting as well.

A gaming robot at home? It’s one thing to tell the kids to limit their gaming time. But who’s going to tell a patient to stop playing a game that promotes healing? I think I’ll pass on that one.

Michael L. Boninger, MD

Director, UPMC Institute for Rehabilitation and Research
Associate Dean for Medical Student Research
University of Pittsburgh School of Medicine
Professor and Chairman
Department of Physical Medicine and Rehabilitation

UPMC opens new Gaming and Robotics Center

In November, UPMC celebrated the opening of its new Gaming and Robotics Center with a fundraiser called “Gridiron Gaming,” hosted by Pittsburgh Steelers starting left tackle Max Starks and his wife Tiffany Calloway-Starks, MD, attending

Guests used Wii® gaming equipment located on each floor of the hospital to challenge Steelers players to virtual games such as Wii bowling and tennis, while raising funds for wellness initiatives targeting people with disabilities.



Dr. Boninger addresses guests at the gaming fundraiser. Behind him are event co-hosts Max Starks of the Pittsburgh Steelers and Dr. Calloway-Starks.

physiologist at UPMC Institute for Rehabilitation and Research (IRR) and assistant professor in the Department of Physical Medicine and Rehabilitation. Dr. Calloway-Starks has been instrumental in incorporating gaming and virtual reality in rehabilitation.

The mission of UPMC IRR’s Gaming and Robotics Center is to promote optimal recovery for patients by providing them with the latest rehabilitation tools and techniques. The new center strives to improve the lives of patients with brain injury, spinal cord injury, and complex disabilities by continuing to develop rehabilitation programs that benefit and enhance independence and quality of life.

At the opening fundraiser, Michael Boninger, MD, director, UPMC IRR, spoke about repetitive movement in relearning arm movement after a stroke. “When you add games to the equation,” he said, “it adds the element of fun to rehabilitative movement repetition.”

Through its academic partnership with the University of Pittsburgh, IRR has long been a leader in advancing the field of rehabilitation through development and innovations in gaming and robotics technology. The institute’s current gaming and robotics equipment includes:



GameCycle®: A hand-operated exercise bike with a gaming twist

Invented at the University of Pittsburgh, the GameCycle combines a stationary hand cycle with a commercial video game, allowing patients to get exercise while playing any Nintendo GameCube® game.

- **How it works:** Using both hands, patients can cycle forward or backward in a rowing motion to move the game character on the GameCycle monitor. Speed and direction are controlled by how fast and in what direction patients “row.” Turns are made by tilting the hand cycle left and right. Adjustable resistance, hand grips, and height settings allow patients to customize their workouts according to their physical abilities.
- **How it helps:** The GameCycle provides cardiovascular and balance exercise, as well as flexibility and strength training for patients who’ve had a stroke, traumatic brain injury, or spinal cord injury. It is especially effective for those patients with limited use of one or both legs.

Lokomat®: A robotic treadmill for patients who can’t walk on their own

With the assistance of robotic leg supports, the Lokomat provides treadmill training to patients who are partially paralyzed or have limited use of one or both legs.

- **How it works:** Patients are placed into a harness and suspended over a treadmill where robotic sensors help their legs move in natural walking patterns.
- **How it helps:** Allowing patients to build muscle in their legs while triggering parts of the brain that control leg movement, the Lokomat benefits patients whose recovery depends on active walking exercise, including stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, and other patients with neurological diseases and injuries.

Nintendo Wii: Turning rehab into “Wii-hab”

In an inpatient therapy setting, the Wii is used both as a leisure-time activity and as part of patients’ individual rehab routines.

- **How it works:** While standing or sitting, patients can use the Wii to play various virtual sports and recreational games using one or both arms.
- **How it helps:** Therapists can adapt patients’ gaming experience to provide balance, endurance, flexibility, hand-eye coordination, and core stability exercises.

Regenerative Rehabilitation



Fabrisia Ambrosio, PhD, MPT

Director

Cellular Rehabilitation Laboratory
of the Stem Cell Research Center

Assistant Professor

Department of Physical Medicine
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Department of Physical Therapy,
Department of Orthopaedic Surgery

McGowan Institute
for Regenerative Medicine

In 2006 the National Institutes of Health (NIH) began funding Clinical & Translational Science Institutes (CTSI) at leading academic research centers across the country. The University of Pittsburgh is a member of the first round of academic centers funded. One of the main goals of the NIH initiative is to hasten the translation of basic science efforts into positive changes for clinical practice. The potential for the translation of biological regenerative and rehabilitative therapies over the next decade is substantial.

Until now, much of rehabilitation medicine and regenerative medicine have largely existed as independent silos. Treatments developed in regenerative medicine laboratories and applied to clinical trials in rehabilitation medicine are improving the connection between the two disciplines. Regenerative medicine, which involves the development of approaches to restore the regenerative capacity of aged, injured, or diseased tissue, has made considerable strides for the treatment of musculoskeletal disorders and injuries. Clinical trials using prolotherapy, cellular therapies, and platelet-rich plasma treatments as regenerative agents are ongoing, thanks to the translational efforts between laboratory and clinic.

In our laboratory, we have taken an innovative approach to addressing declines in skeletal muscle function that accompany the aging process. For example, stem cell transplantation has been widely investigated as a means to enhance skeletal muscle healing in cases of muscle pathology or aging. However, progress in the development of cellular therapies to improve muscle healing has been slow and limited by increased scar tissue formation¹ and massive cell death after transplantation². We are developing protocols that integrate rehabilitation approaches, such as exercise or electrical stimulation, early on in the development of biological therapies. Muscle-derived stem cells (MDSCs) demonstrate an increased myogenic regeneration in an injured or diseased muscle when transplantation is coupled with a muscle-loading protocol, such as treadmill running³, functional overloading⁴, or electrical stimulation. Interestingly, electrical stimulation, when administered alone, resulted in a decreased recovery of force five weeks after injury (Figure 1). Based on these results, we propose that there exists a synergistic relationship between muscle contractile activity and donor cell functionality

following transplantation into an injured or diseased muscle.

Translational studies, funded by the Pittsburgh Claude D. Pepper Older Americans Independence Center, are now investigating whether the application of rehabilitation approaches also may rejuvenate host stem cells in elderly individuals. Such studies may represent the first step in the development of targeted cellular rehabilitation approaches to counteract the effects of aging on skeletal muscle function and healing potential.

As the landscape of physical therapeutics evolves, rehabilitation specialists must continue to work closely with scientists in the field of regenerative medicine in order to hasten the translation of cutting-edge medical advances. Given the mutual goal of improved functional outcomes, it is clear that the future of regenerative medicine is tightly intertwined with that of rehabilitation.

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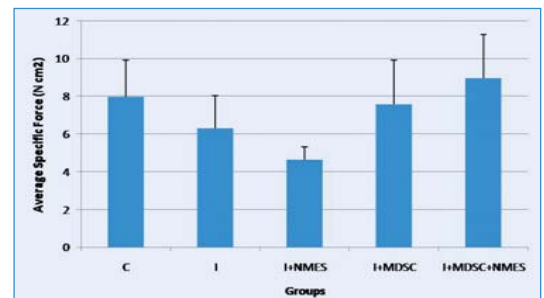


Figure 1. (unpublished results) Average specific force of wild-type mouse tibialis muscles as determined by in situ contractile testing. C = uninjured control; I = 5 weeks following contusion injury; I+NMES = 5-week neuromuscular electrical stimulation protocol initiated two days after injury; I+MDSC = muscle derived stem cell (MDSC) transplantation performed one day following contusion injury, muscles harvested five weeks following injury; and I+MDSC+NMES = combination therapy of MDSC transplantation and five-week NMES protocol following contusion injury (n=4-6 each group). C and I+MDSC+NMES significant $p < 0.05$ when compared to I+NMES

Platelet-rich plasma therapy: Regenerative injection therapy for the nonsurgical treatment of common musculoskeletal injuries



Megan Cortazzo, MD
Assistant Professor

Department of Physical Medicine
and Rehabilitation

Introduction

Platelet-rich plasma (PRP) has been used by maxillofacial surgeons and plastic surgeons since the 1990s to enhance healing in procedures such as mandibular bone grafts, sinus lifts, and skin grafts. PRP therapy is a relatively new technique being employed in the treatment of musculoskeletal conditions like osteoarthritis in joints and the spine, ligament and tendon injuries, tennis elbow, and ACL injuries. Clinical trials around the world are producing exciting outcomes in accelerated healing.

Traditionally, anti-inflammatory medications and cortisone injections have been used to treat arthritis, ligament tears, tendonitis, and other musculoskeletal injuries. However, positive outcomes after a soft tissue injury depend on the restoration of tissue, not necessarily the reduction of inflammation. Cortisone injections, while giving temporary pain relief, may lead to further injury by masking the pain¹. Research in recent years has concentrated on platelet-rich plasma therapy with growing evidence to the efficacy of this new treatment.

Platelet-rich plasma is an autologous concentration of growth factors contained in a small volume of plasma. This concentration of growth factors is prepared with a centrifuge and a sample of blood (Figure 1). Using the centrifuge to separate out the platelets, the sample is divided further into platelet-rich and platelet-poor plasma portions. The PRP is then injected into and around the site of injury for the purpose of enhancing the body's natural healing process. Because the blood used is a donor-recipient sample the risk of a transmissible infection is virtually non-existent².

Platelet rich plasma is a form of regenerative injection therapy in which biological concentrate of platelets stimulate the body's natural healing cascade.

Once thought to be responsible only for clotting, it has become evident that platelets are rich in growth factors that can act as scaffolding for tissue healing. Platelets contain multiple growth factors that are integral to wound healing. Transforming growth factor beta (TGF- β) is involved in mitogenesis of endothelial cells, fibroblasts, and osteoblasts. It regulates collagen synthesis and inhibits macrophage and lymphocyte proliferation. Platelet-derived

growth factor (PDGF) attracts macrophages and neutrophils and, like TGF- β , is involved in the regulation of epithelialization, granulation tissue formation, and stimulation of cell replication. Platelets also have granules that contain epidermal growth factor EGF (involved in cell differentiation, angiogenesis, and collagenase activity); vascular endothelial growth factor VEGF (used in angiogenesis); and fibroblast growth factor FGF (promotes proliferation of fibroblasts and stimulates angiogenesis)^{3,4}.

Platelet-rich plasma treatment

Blood is drawn from the patient and is placed into a centrifuge machine that concentrates the blood into platelet rich plasma. There are multiple PRP preparation centrifuges

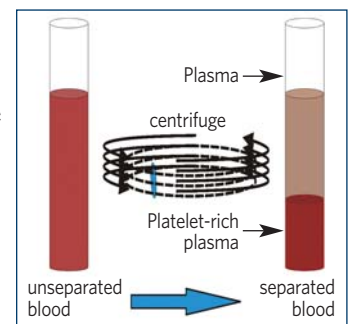


Figure 1

commercially available. Because of the multiple concentration systems available, it is difficult to generalize the effectiveness of PRP therapy⁵. Some systems claim that the PRP concentration contains at least six times the baseline of whole blood platelets and growth factors. Nevertheless, the tissue graft of platelets is rich in growth factors, and is injected to the affected area, often using ultrasound guidance for precision.

While clinical trials are ongoing, early results of PRP research are showing positive outcomes when the treatment is employed. A recent blinded study of chronic patella tendonosis included three injections at the site of injury administered 15 days apart. The participants were sent home with instructions on activity and pain relief, and final evaluation was at six months post-treatment. Short-term results show the PRP group experienced a reduction in pain, with the majority of these subjects able to return to full activity much more quickly than the control group⁶.

Surgical applications for PRP also are being studied. A clinical trial, conducted in Spain between 1997 and 2004, used PRP during surgical repair of the Achilles tendon. The PRP

was injected and used in a fibrin scaffold to cover the wound. The control group showed a markedly slower rate of healing and required longer recovery time before returning to physical activity than the PRP group⁷.

Who benefits from regenerative injection therapy with PRP?

After an injury, the human body responds in several phases in an attempt to repair itself. There is the immediate degenerative phase followed by the inflammatory phase, which in turn attracts growth factors and macrophages to form new tissue⁸. When tendons and ligaments are injured, the healing process can be slow and often incomplete⁹. Part of this is due to the limited vascular supply to the tissue and to scars that disrupt the healing architecture and thus the function of the tendon or ligament. Abnormal healing predisposes the tendon or ligament to further injury³.

Patients with chronic tendonopathy, rotator cuff tears, and muscle strains or tears are excellent candidates for platelet rich plasma therapy. In addition, there is emerging evidence that patients with osteoarthritis and decubitus ulcers may benefit from this treatment^{3, 10, 11, 12}.

PRP is an exciting non-surgical alternative treatment. The Department of Physical Medicine and Rehabilitation at the University of Pittsburgh will continue to be at the forefront of this exciting therapy, researching basic science and clinical applications.

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UPMC opens new Gaming and Robotics Center (continued from page 2)

Armeo: Task-oriented rehabilitation for weakened arms

The Armeo partially compensates for the weight of a patient's arm, allowing them to use their remaining strength to perform exercises while playing various computer games. The IRR uses Armeo's original device, the Armeo®Spring, and was the first facility in the U.S. to receive the new Armeo®Boom, a more cost-effective version being tested at the IRR.

- **How it works:** Patients insert their arms into the device to move in all directions while playing computer games, such as Solitaire, or completing simulated everyday tasks. The ArmeoSpring includes a grasping control to strengthen hand and wrist muscles.

- **How it helps:** Designed for stroke patients who have limited use of one arm, the Armeo also can help spinal cord and brain injury patients. Its purpose is to provide fun and motivating therapeutic exercise while "reminding" patients' brains how to control arm function.

UPMC IRR is committed to supporting and promoting the independence of our patients and people with disabilities in our community. We are excited to promote the use of robotics and gaming in rehabilitation. Plans are underway for the second "Gridiron Gaming" event this fall, again with the support of Dr. Calloway-Starks, Max Starks, and his Steelers teammates.



Recent contributions by IRR faculty

Following is a sampling of recent presentations by IRR faculty members.

Association of Academic Physiatrists 2010 Annual Meeting Bonita Springs, Fla., April 6 to April 10

2010 Electrode Store Best Paper by a Medical Student

Alcinto Guirand, University of Pittsburgh School of Medicine: Tuning Algorithms for Control Interfaces for Users with Upper Limb Impairments. Mentor: Brad Dicianno, MD, assistant professor, Department of Physical Medicine and Rehabilitation.

Instruction

Rory Cooper, PhD, professor and chair, Department of Rehabilitation Sciences and Technology, School of Health and Rehabilitation Sciences, "Assistive Technology and Applications."

Gary Chimes, MD, PhD, assistant professor, Department of PM&R, member of the course planning team, "The Skeletal Muscle: Foundation of Movement, Function, and Exercise."

Fabrisia Ambrosio, PhD, MPT, assistant professor, Department of PM&R, "Strength Training & Performance Enhancement: Impact on Health and Sports Medicine."

Gary Chimes, MD, PhD, assistant professor, Department of PM&R, "Residents/Fellows Workshop."

Paper Presentation

Gwendolyn Sowa, MD, PhD, assistant professor, Department of PM&R, Gene Therapy for Intervertebral Disc Degeneration.

Shaun Darrah, BS, and Julieanne Garringer, BA, University of Pittsburgh, School of Medicine recipients of 2009 Rehabilitation Research Experience for Medical Students (RREMS), were mentored by Amy Wagner, MD, associate professor and vice chair of research, Department of PM&R. Mr. Darrah presented Modeling Genetic Susceptibility to Seizures after TBI. Ms. Garringer presented Impact of Aromatase Genetic Variation on Hormone Levels and Functional Outcome After TBI.

Poster Grand Rounds

Steven Brose, DO, Spinal Cord Injury Medicine fellow, Department of PM&R, presented "Counterstrain Manual Medicine for the Treatment of Cervical Pain: A Randomized Controlled Trial and Sham Research Tool."

Poster Presentations

Gwendolyn Sowa, MD, PhD, Department of PM&R, presented "Bupivacaine Toxicity in Intervertebral Disc Tissue," "Compression Affects Matrix Homeostasis in Intervertebral Discs," and "Non-Invasive Tools to Assess Molecular Responses to Treatment for Disc Degeneration."

Brad Dicianno, MD, MS, Human Engineering Research Laboratories, University of Pittsburgh and Department of Veterans Affairs, and Adult Spina Bifida Clinic, Department of PM&R, presented "Hospitalizations of Adults with Spina Bifida and Congenital Spinal Cord Anomalies."

John Baber, DO, Department of PM&R, and Todd Franco, DO, Medical Rehabilitation, Inc., The Washington Hospital, presented "Ultrasound Guided Platelet Rich Plasma Therapy (PRP) for Patellofemoral Pain and Osteochondral Defect."

Steven Brose, DO, Heather Pauli, DO, Corinne Layne Stuart, DO, Department of PM&R, presented "Counterstrain Manual Medicine for the Treatment of Cervical Pain: A Randomized Controlled Trial and sham Research Tool."

Jason Fogg, DO, Department of PM&R, Todd Franco, DO, Medical Rehabilitation, Inc., The Washington Hospital, presented "Platelet-Rich Plasma Injection in Biceps Femoris Strain with Micro-tearing on Musculotendinous Junction."

Justin Hong, Department of PM&R, Brad Dicianno, MD, Department of PM&R and Human Engineering Research Laboratories, VA Medical Center, Pittsburgh, Dianne Collins, PhD, Department of Rehabilitation Science and Technology, Amol Karmarkar, PhD, Human Engineering Research Laboratories, VA Medical Center, Pittsburgh, presented "Predictors of Depression in Adult Spina Bifida."

Mohammed Khan, MD, and Mary Ann Miknevech, MD, Department of PM&R, presented "Heterotopic Ossification: A Case of Significant Morbidity in the Adult Non-traumatic Amputee."

Jerome Lee, MD, Michael Munin, MD, and Mohammed Mawla, DO, Department of PM&R, Vijay Gorantla, MD, PhD, Galen Wachtman, MD, and W.P.A. Lee, MD, Department of Plastic and Reconstructive Surgery, presented "A Unique Case of Rehabilitation Following Bilateral Hand Transplantation in a Previous Quadruple Amputee: A Case Report."

Mohammed Mawla, DO, Michael Munin, MD, Kristi Henzel, MD, PhD, and Tiffany Calloway, MD, Department of PM&R, presented "Discovery of Myotonic Dystrophy after Routine Work-up for Dysphagia Post Cardiac Transplant: A Case Report."

Matthew Pauli, DO, Brad Dicianno, MD, and Heather Pauli, DO, Department of PM&R, presented "Spastic Paraparesis as a Complication of Sjogren's Syndrome."

Geeta Sathe MD, and Brad Dicianno MD, Department of PM&R, presented "Rehabilitation of Progressive Wilson's Disease after Liver Transplantation."

Recently published

A small sample of representative papers by IRR faculty members

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Verizon grant funds smart phones for patients with spina bifida

The Verizon Foundation has awarded an \$8,500 grant to the Department of Physical Medicine and Rehabilitation to fund smart phones for patients with spina bifida as part of a new telerehabilitation wellness program.

Medical advancements allow many people with spina bifida to live well into adulthood, and those who outlive caregivers may be without support to maintain necessary medical regimens. Local patients find support at the Adult Spina Bifida Clinic at the UPMC IRR, one of only five specialty clinics of its kind in the nation.

With help from the Verizon Foundation, the clinic will begin a pilot spina bifida wellness program delivered by way of smart phones. The program will use a model created by the University of Pittsburgh School of Health and Rehabilitation Sciences' Rehabilitation Engineering Research Center on Telerehabilitation — funded by the National Institute on Disability and Rehabilitation Research — which has developed a high-speed communication network between providers and patients using smart phones and other devices (see article on page 8 for more details).



Left to right) William Carnahan, Verizon; Clinic Director Brad Dicianno, MD; Michael McCue, PhD; Tom Laughlin, Verizon

A wellness coordinator from the clinic will be able to check in remotely with patients via their smart phones, ensuring that they follow their prescribed medical and rehabilitation regimens. The smart phones will deliver automated messages reminding patients to take medications and complete other daily tasks. Patients will be prompted to respond once tasks are completed or to ask for assistance. Work also is being done to allow patients to view test results, refill prescriptions, make appointments, and access medical records via their smart phones.

Grant awarded to Rehabilitation Engineering Research Center on Telerehabilitation



David Brienza, PhD
Professor

*Department of Rehabilitation
Science and Technology*

Director, RERC-TR



Michael McCue, PhD
Associate Professor and
Vice Chairman

*Department of Rehabilitation
Science and Technology*

*Director,
Rehabilitation Counseling Program
Co-director, RERC-TR*

The University of Pittsburgh's School of Health and Rehabilitation Sciences (SHRS) has successfully obtained a five-year, \$4,750,000 grant from the federal government's National Institute on Disability and Rehabilitation Research to continue its innovative Rehabilitation Engineering Research Center on Telerehabilitation (RERC-TR). The only research center of its kind, the RERC-TR will apply informatics technology to develop an accessible, scalable, cost-effective, extensible, open, and secure infrastructure to connect service providers, rehabilitation applications, and consumers. A main emphasis of the center will be to investigate the value and effectiveness of rehabilitation services delivered in consumer homes, workplaces, and communities.

"The results of this telerehabilitation work should open the floodgates where previously developed solutions can be brought out of isolation created by the limitations of the information systems in which they were created," says David Brienza, PhD, director of the RERC-TR and professor of rehabilitation science and technology.

Co-director Michael McCue, PhD, indicated that the RERC-TR aims at extending the reach of rehabilitation systems to meet the needs of people with disabilities through incorporating capacity-building projects in areas such as cognitive and vocational rehabilitation and prevention and management of secondary conditions.

According to Clifford Brubaker, PhD, dean of SHRS, "The collective work of our faculty continually strives to make our world more accessible and usable for all people with disabilities.

The RERC-TR will enable us to reach out to the disability community in ever more innovative ways. This grant further establishes the University of Pittsburgh as a leader in developing and delivering the best in rehabilitation services to the persons who need them the most."

The RERC-TR will use the telerehabilitation infrastructure developed at Pitt as the vehicle for its research and development. For example, Brad Dicianno, MD, medical director of the adult Spina Bifida clinic at UPMC, is using this technology in the area of prevention and management of secondary conditions in young adults with spina bifida. The center will connect UPMC nurses and wellness coordinators to patients in the community, (as described in the article on page 7).

In another project, web-based Interface Design Assistant (IDA) will provide separate interfaces for practitioners and consumers. Practitioners will use IDA to configure individual assessment plans and review data from those assessments. Consumers will use IDA to complete the assessment plan and review results of their assessment. Another example is the use of mobile devices such as smart phones to provide supports to persons with cognitive disabilities from traumatic brain injury or other conditions in the settings when and where these individuals encounter cognitive challenges. The RERC-TR plans to track the efficacy of projects and develop a mechanism to pool data from external projects through the development of a uniform data set.

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.

AFFILIATE LINKS

UPMC Institute for Rehabilitation and Research
<http://irr.upmc.com>

School of Medicine, Department of
Physical Medicine and Rehabilitation
<http://www.rehabmedicine.pitt.edu>

School of Health and Rehabilitation Sciences, Department
of Rehabilitation Science & Technology
<http://www.shrs.pitt.edu/rst>

UPMC Center for Assistive Technology
<http://www.com/Services/IRR/aboutus/cat>

Human Engineering Research Laboratories
<http://www.herlpitt.org>

UPMC

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