

UPMC Rehabilitation Institute

The McGowan Institute for  
Regenerative Medicine

University of Pittsburgh  
School of Health and  
Rehabilitation Sciences

University of Pittsburgh  
School of Medicine Center for  
Continuing Education in the  
Health Sciences

Rehabilitation Research &  
Development Center of  
Excellence at the Veterans  
Affairs Palo Alto Health Care  
System

**REGENERATE  
CONGREGATE  
EDUCATE**



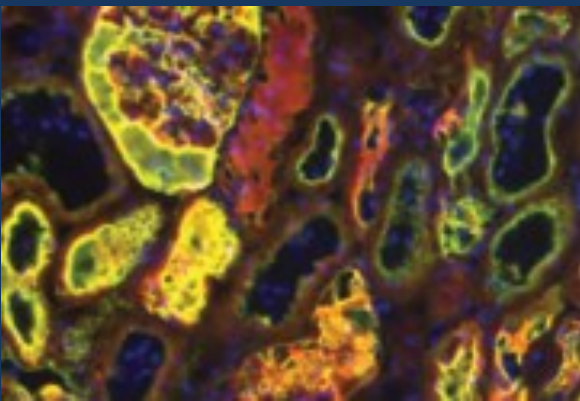
# Second Annual Symposium on Regenerative Rehabilitation

November 12—13, 2012

University Club

Pittsburgh, PA

University of Pittsburgh



## TABLE OF CONTENTS

Welcome	page 3
Course Directors and External Advisory Board	page 4
Organizers	page 5 – 6
Acknowledgements	page 7
Overview, Objectives, and Continuing Education	page 8
Agenda	pages 9 – 19
Speakers	pages 20 – 37
Disclosures	page 28
Exhibitors	page 39
Travel Awards	page 40 – 42



## Welcome

Welcome to the Second International Annual Symposium on Regenerative Rehabilitation, November 12 - 13, 2012 at the University Club, Pittsburgh, PA.

We live in exciting times where, more than ever before, the enthusiasm surrounding regenerative medicine is being matched with clinical deliverables, and the number of clinical trials in the field is growing dramatically. Basic science discoveries regarding cellular and molecular responses to mechanical loading following an injury or with a disease may provide important insight for the optimization of rehabilitation interventions. Conversely, an increased awareness of rehabilitation approaches by regenerative medicine scientists may help guide the development of their biological therapies.

This international Symposium, the only one of its kind, brings together world-renowned experts in the fields of regenerative medicine and rehabilitation with physicians, faculty, engineers, occupational and physical therapists, speech-language pathologists, students, postdoctoral fellows, residents, nurses and research staff.

During this Symposium, you will have multiple opportunities to interact with established specialists in regenerative rehabilitation. We encourage you to actively participate in discussions, share your perspective and ideas, ask questions and network.

We are excited that you decided to join our effort. We look forward to hearing your ideas as to how to advance regenerative rehabilitation towards becoming an established research and medical field.

Best wishes,

Fabrisia Ambrosio, PT, PhD  
Anthony Delitto, PT, PhD, FAPTA

Michael Boninger, MD  
William Wagner, PhD

Thomas Rando, MD, PhD

## Course Directors

### **Fabrisia Ambrosio, PhD, PT**

Assistant Professor  
Department of Physical Medicine and Rehabilitation  
University of Pittsburgh  
Pittsburgh, PA

### **Michael L. Boninger, MD**

Professor and Chair  
Department of Physical Medicine and Rehabilitation  
University of Pittsburgh  
Pittsburgh, PA

### **Anthony Delitto, PhD, PT, FAPTA**

Professor and Associate Dean of Research  
School of Health and Rehabilitation Sciences  
University of Pittsburgh  
Pittsburgh, PA

### **Thomas A. Rando, MD, PhD**

Professor  
Department of Neurology and Neurological Sciences  
Stanford University School of Medicine  
Palo Alto, CA

### **William R. Wagner, PhD**

Director, McGowan Institute for Regenerative Medicine  
Professor of Surgery, Bioengineering & Chemical  
Engineering  
University of Pittsburgh  
Pittsburgh, PA

## External Advisory Board

### **Steve L. Wolf, PhD, PT, FAPTA, FAHA**

Professor, Departments of Rehab Medicine,  
Medicine, Cell Biology  
Emory University School of Medicine  
Atlanta, GA

### **Richard K. Shields PT, PhD, FAPTA**

Professor and Head  
Department of Physical Therapy and  
Rehabilitation Sciences  
Carver College of Medicine  
University of Iowa  
Iowa City, IA



## Organized by:

### University of Pittsburgh School of Medicine

#### Center for Continuing Education in the Health Sciences

The purpose of the Center for Continuing Education in the Health Sciences is to advance the academic, clinical, and service missions of the University of Pittsburgh Schools of the Health Sciences and the University of Pittsburgh Medical Center through the continuing professional development of physicians, pharmacists, and other health professionals and the translation of biomedical knowledge into clinical practice.

<https://ccehs.upmc.com/>

### UPMC Rehabilitation Institute

The largest rehabilitation provider in Western Pennsylvania, the UPMC Rehabilitation Institute (RI) serves as the hub of a UPMC network of more than 70 rehabilitation facilities that combine clinical care and research to help patients regain independence and enhance their quality of life. The RI's academic partners are the Department of Physical Medicine and Rehabilitation at the University of Pittsburgh School of Medicine and the School of Health and Rehabilitation Science. These academic partners are national and international leaders in rehabilitation research and education.

<http://www.upmc.com/Services/rehab/rehab-institute/Pages/default.aspx>

### The McGowan Institute for Regenerative Medicine

The McGowan Institute for Regenerative Medicine is a partnership between the University of Pittsburgh and UPMC, and serves as a base for scientists and clinical faculty working in tissue engineering and biomaterials, cellular therapies, and medical devices and artificial organs.

McGowan's mission is the development of innovative clinical protocols and the commercial transfer of new technologies.

[www.mcgowan.pitt.edu](http://www.mcgowan.pitt.edu)

### University of Pittsburgh School of Health and Rehabilitation Sciences

Through academic research, technology design and rigorous training, the School of Health and Rehabilitation Sciences (SHRS) at the University of Pittsburgh educates the next generation of health professionals who will help others reach their fullest potential.

At SHRS, we are committed to providing the best learning experience and academic environment possible for our students. Instructional excellence is rigorously pursued. Class sizes are intimate, fostering intellectual exchange and discourse. Students are challenged to not just achieve but to excel. And they do. Graduates of SHRS programs are some of the most sought-after professionals.

Our faculty is world class. They are authors, clinicians, noted researchers, speakers and consultants. But foremost, they are teachers ... teachers who care passionately about their field and about their students. They want their students to succeed in the classroom and in their chosen professions.

An SHRS education is more than classroom lectures. It's hands-on learning either in a clinical setting or in the community. Through our strong relationship with the University of Pittsburgh Medical Center and other clinical partners, our students benefit from a wealth of experiences related to their particular field and area of interest. Students train in schools, hospitals, skilled nursing facilities, ambulatory care sites, and in home and community based settings.

Our many departments and programs listed here offer undergraduate, graduate and certificate degrees:

- Clinical Dietetics and Nutrition
- Communication Science and Disorders
- Speech Language Pathology
- Audiology
- Emergency Medicine
- Health Information Management
- Occupational Therapy
- Physical Therapy
- Physician Assistant Studies
- Prosthetics & Orthotics
- Rehabilitation Counseling
- Rehabilitation Science (undergraduate)
- Rehabilitation Science and Technology
- Sports Medicine/Athletic Training

<http://www.shrs.pitt.edu>



## University of Pittsburgh Department of Physical Medicine & Rehabilitation

### *Advancing the Science and Practice of Rehabilitation Medicine*

Our mission is to improve the lives of people with disabilities through the provision of the highest quality medical rehabilitative care, the education and training of outstanding future rehabilitation providers and innovators, and the conduct of cutting edge translational rehabilitation research.

Our research portfolio includes:

- neural engineering and neural prosthetics
- biologics as indicators of pain, injury and recovery
- axon regeneration
- Biomarkers for brain injury
- Medical homes for spinal cord injury care
- Motor learning using transcranial magnetic stimulation

Our physicians are experts in the fields of traumatic brain injury, spinal cord injury, sports and musculoskeletal medicine, pain medicine, stroke and many conditions that would benefit from rehabilitation care. We partner with patients to design and implement personalized approaches that maximize participation, recovery, and well-being.

<http://www.rehabmedicine.pitt.edu/>

## Rehabilitation Research & Development Center of Excellence at the Veterans Affairs Palo Alto Health Care System, Center for Tissue Repair, Regeneration, and Restoration

Dr. Rando has reconfigured the Rehabilitation R&D Center at the Palo Alto VA as the "Center for Tissue Repair, Regeneration, and Restoration" (CTR3). This center focuses on three general tissue compartments- neuroepithelial, neuromuscular, and musculoskeletal- and pursues research at the levels of stem cell biology, biomedical engineering, and clinical/translational research.

The VA Palo Alto Rehabilitation Research and Development Center reflects a long-standing commitment by the Department of Veterans Affairs to advance the well being of American veterans through support of a full spectrum of rehabilitation research, from concept to clinic.

A firm scientific understanding of the underlying impairment and a multi-disciplinary team creates a strong basis for developing new clinical treatments that reduce the disability of veterans and improve the effectiveness and efficiency of healthcare delivery by VA clinicians.

# A Special Thanks To...



American Physical Therapy Association



The Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)



National Institute of Arthritis and Musculoskeletal



National Institute of Neurological Disorders and Stroke (NINDS)



University of Pittsburgh Department of Orthopaedic Surgery



UPMC Centers for Rehab Services



University of Florida Department of Physical Therapy



Emory University



Duquesne University Department of Physical Therapy



Journal of Rehabilitation Research and Development



University of Iowa Department of Physical Therapy and Rehabilitation Sciences

# COURSE OVERVIEW AND OBJECTIVES

## Overview

Medical advances in the field of Regenerative Medicine are accelerating at an unprecedented rate. Regrowing a lost limb, restoring function to a diseased organ, or harnessing the body's natural ability to heal itself are becoming part of our reality instead of a distant promise. Technologies, such as cellular therapies, bioscaffolds, and artificial devices, are now in use or are being tested in clinical trials throughout the country.

- How do we as clinicians and rehabilitation professionals work with the patient regenerative medicine team to maximize patient outcomes and to help fully translate research?
- How do we as investigators in the field of Regenerative Medicine make the most of these revolutionary results?

Few opportunities are available to bring together scientists and clinicians working in these two currently quite disparate fields: rehabilitation science and regenerative medicine. However rehabilitation science and regenerative therapies have to work closely in order to achieve a successful outcome for the patient. This situation created the need for open cross disciplinary work and collaborative communication. This symposium provides the opportunity for researchers and clinicians from around the world to gather and learn about the latest developments, share ideas and concepts and create sustainable collaborations. The Second Annual Scientific Symposium on Regenerative Rehabilitation will bring together world-renowned experts in the fields of regenerative medicine and rehabilitation.

## Objectives

During this course, participants will:

- Interact with cutting-edge researchers.
- Learn of the status of translating scientific discoveries into clinical practice.
- Network with colleagues and potential collaborators.
- Raise questions, debate implications, plan follow-up studies, and discuss results.
- Share the status of their own research and clinical observations.
- Meet with presenters to learn about their thinking and future research directions.

## Continuing Education Credit

*The University of Pittsburgh School of Medicine is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.*

*The University of Pittsburgh School of Medicine designates this live activity for a maximum of **16.0** AMA PRA Category 1 Credits™. Each physician should only claim credit commensurate with the extent of their participation in the activity.*

*Other health care professionals are awarded **1.6** continuing education units (CEU's) which are equal to **16.0** contact hours.*

*The University of Pittsburgh Department of Physical Therapy is a pre-approved provider of Continuing Education by the Pennsylvania State Board of Physical Therapy and this course is approved for 16 general credits, 0 hours direct access.*



# Agenda—Day 1

## Monday, November 12

6:30 AM Registration and Light Breakfast

7:00 AM **Sunrise Workshop- Regenerative Medicine 101**  
*Stephen F. Badylak, DVM, PhD, MD*

Don't know much, or anything about regenerative medicine? That's okay. Join us for this one hour crash course on regenerative medicine.

8:00 AM **Welcome**  
*William Wagner, PhD*  
*Fabrisia Ambrosio, PhD, PT*

8:10 AM **Introduction**  
*Steve L. Wolf, PhD, PT, FAPTA, FAHA*

8:25 AM **Signature Seminar #1**  
**Brain Computer Interfaces: Tapping Into "Thoughts" to Increase Independence**  
*Andrew B. Schwartz, PhD*  
*Michael Boninger, MD*  
*Elizabeth C. Tyler-Kabara, MD, PhD*

A better understanding neural population function would be an important advance in systems neuroscience. The change in emphasis from the single neuron to the neural ensemble has made it possible to extract high-fidelity information about movements that will occur in the near future. This ability is due to the distributed nature of information processing in the brain. Neurons encode many parameters simultaneously, but the fidelity of encoding at the level of individual neurons is weak. However, because encoding is redundant and consistent across the population, extraction methods based on multiple neurons are capable of generating a faithful representation of intended movement. The realization that useful information is embedded in the population has spawned the current success of brain-controlled interfaces. Since multiple movement parameters are encoded simultaneously in the same population of neurons, we have been gradually increasing the degrees of freedom (DOF) that a subject can control through the interface. Our early work showed that 3-dimensions could be controlled in a virtual reality task. We then demonstrated control of an anthropomorphic physical device with 4 DOF in a self-feeding task. Currently, monkeys in our laboratory are using this interface to control a 7-DOF arm, wrist and hand to grasp objects in different locations and orientations. Our recent data show that we can extract 10-DOF to add hand shape and dexterity to our control set.

9:55 AM Coffee Break

10:15 AM—

12:30 PM

## **Session A—Mechanotransduction as a Tool in Tissue Healing**

10:15 AM

### **Plenary Talk**

#### **Capitalizing on Tissue Regenerative Capacity to Improve Health after Spinal Cord Injury**

*Richard K. Shields, PT, PHD, FAPTA*

11:00 AM

### **Mechanical Forces in Wound Healing and Inflammation**

*Geoffrey C. Gurtner, MD, FACS*

Mechanical forces have been suspected to play a critical role in wound healing and fibrosis but the precise mechanisms have remained poorly understood. Recent studies have demonstrated that mechanical forces can significantly impact the biologic response to injury and fibrosis. Our laboratory has used a stress-loaded murine wound model, and has identified a critical role for fibroblast specific focal adhesion kinase (FAK) in the development of hypertrophic scars. To confirm the importance of this pathway in humans, we have developed a stress-shielding polymer dressing which is able to offload wound tension, and has demonstrated a highly significant reduction in scar formation in several clinical trials.

Further work has demonstrated that integrated mechanical and chemical signaling networks translate physical cues into an environment that prolongs inflammation and leads to pathologic scar formation. As such, conceptual frameworks to understand cutaneous repair have expanded beyond traditional cell-cytokine models to include dynamic interactions driven by mechanical force and the extracellular matrix. Strategies to manipulate these biomechanical signaling networks using both device and pharmacologic approaches have tremendous potential to reduce scar formation and promote skin regeneration.

11:30 AM

### **Mechanobiology to Enhance the Regenerative Potential in the Intervertebral Disc**

*Gwendolyn Sowa, MD, PhD*

Intervertebral disc degeneration (IDD) is the most common diagnosis in patients with low back pain, which represents a significant cause of morbidity, with a lifetime incidence of greater than 80%. Both mechanical loading and inflammation have been implicated in disc degeneration and the associated matrix loss. Because there are key interactions between inflammatory and mechanical signaling pathways, understanding the mechanisms has the potential to lead to rational design of treatment protocols, which is the long term goal of this work. Mechanical stimulation can have both beneficial and detrimental effects on matrix homeostasis. Our previous work has demonstrated that long durations of mechanical stimulation facilitates catabolic and limits anabolic activity (detrimental), while short durations of stimulation can limit catabolic activity and facilitate anabolic signals (beneficial) in both annulus fibrosus cells under tensile strain and nucleus pulposus cells under compression. Identification of the response to loading will help inform regenerative approaches to disc degeneration, as it is likely that biologic approaches will be facilitated by properly directed mechanical loading. In addition, enhanced understanding of the responses to mechanical loading will reveal appropriate biomarkers, which may be used to assess response to treatment. These advances have the potential to allow for rational design of improved exercise and pharmacologic interventions.

12:00 PM

### **Translational Approaches to Tissue Engineered Muscle Repair (TEMR)**

*George J. Christ, PhD*

Despite the well-documented capacity of skeletal muscle for self-repair and regeneration following injury, there are still a variety of congenital disorders, acquired diseases, and traumatic injuries that result in irrecoverable loss of muscle function. Among these, volumetric muscle loss (VML) injury, characterized by a degree of muscle tissue loss that exceeds the

endogenous regenerative capacity of muscle, thus resulting in permanent functional and cosmetic deficits, is prominent. Current treatment for VML injuries is limited to surgical muscle transfers, which are associated with poor engraftment and donor site morbidities. To address this unmet medical need we are pursuing proof-of-concept studies for development of a sheet-like, cell-based tissue engineering approach referred to as a **Tissue Engineered Muscle Repair (TEMR)** technology. To establish proof of concept for this approach, a VML injury was created in a murine model by surgically excising  $\approx 50\%$  of the latissimus dorsi (LD) muscle, and the injury was then treated by implanting a **TEMR** construct ( $\sim 1 \times 3 \text{ cm}$ ). TEMR constructs are created by seeding  $\approx 1$  million MPCs/ $\text{cm}^2$  on a decellularized bladder acellular matrix (BAM scaffold) and subsequently preconditioning the construct in a bioreactor *in vitro* (i.e., 10% cyclic mechanical stretch for 5-7 days). In short, bioreactor preconditioning increases the regenerative response observed following **TEMR** implantation *in vivo*. Specifically, implantation of **TEMR** constructs at the injured site restored contractile force generation to  $\sim 60\text{-}70\%$  of native control within 2 months post implantation; as determined by physiological studies of force generation on retrieved tissue. **More recently we have documented that** an additional round of MPC seeding of the scaffold during bioreactor preconditioning results in enhanced myotube formation due to increased myoblast fusion as occurs during **exercise *in vivo***. Force generation on retrieved LD muscles *in vitro* revealed that these **dual seeded, “exercised” TEMR** constructs promoted both an accelerated (i.e., increased muscle contraction was now observed at 1 month post-implantation rather than 2 months) as well as prolonged functional recovery, at fully twice the magnitude of **TEMR** constructs that were seeded only a single time. This recovery was mediated via enhanced repair of native tissue and *de novo* regeneration of new muscle fibers. Such observations open the door to diverse methods (e.g., pharmacological or gene-based approaches) for manipulating the cellular phenotype and composition of TEMR constructs for improved functional outcomes. Moreover, when coupled with rehabilitative measures, this approach could further advance the field. We have recently submitted a briefing document to the FDA for treatment of secondary cleft lip (CL) deformities using the TEMR technology. Our initial conversation with the FDA was very favorable, and we believe we have identified a clear path forward to clinical application.

12:30 PM

**Lunch**

1:30 PM

**Signature Seminar #2**

**Measurement, Modeling, and Rational Modulation of Inflammation and Wound Healing**

*Yoram Vodovotz, PhD*

*Katherine Verdolini Abbott, PhD*

Properly-regulated inflammation is central to homeostasis, but in adequate or overly-robust inflammation can lead to disease. Like many biological processes, inflammation and its various manifestations in disease are multi-dimensional. The advent of multiplexed platforms for gathering biological data, while providing an unprecedented level of detailed information about the dynamics of complex biological systems such as the inflammatory response, has paradoxically also flooded investigators with data they are often unable to use. Systems approaches, including data-driven and mechanistic computational modeling, have been used to decipher aspects of the inflammatory responses that characterize trauma/hemorrhage and sepsis. Through combined data-driven and mechanistic modeling based on Luminex™ datasets, computational models of acute inflammation in mice, rats, swine, and humans were generated. These studies suggest that acute inflammation goes awry when the positive feedback loop of inflammation  $\rightarrow$  tissue damage/dysfunction  $\rightarrow$  inflammation, driven by damage-associated molecular pattern molecules, fails to resolve under the influence of anti-

inflammatory/pro-healing mediators. This positive feedback loop also underlies agent-based computational models of inflammation and tissue injury in skin and liver, leading to tissue-realistic simulations and tissue-specific outcomes including chronic non-healing wounds and liver fibrosis, cirrhosis, and hepatocellular carcinoma, respectively. These systems-based insights have led to novel, rationally-designed therapies based on a biohybrid framework.

2:00—5:30 PM

## Session B—Impact of Rehabilitation Strategies on Cell Therapies

2:00 PM

### Plenary Talk

#### Pompe Disease: Treatment and Recovery

*David D. Fuller, PhD*

*Barbara K. Smith, PhD, PT*

**Title:** The Importance of Targeting the Central Nervous System (CNS) for Treatment of Respiratory Insufficiency in Pompe Disease

Deficiency of acid  $\alpha$ -glucosidase (GAA), a lysosomal enzyme responsible for degradation of glycogen is a prominent pathological signature of the type of muscular dystrophy associated with Pompe disease. The early onset or severe form of Pompe disease is associated with complete GAA deficiency, and untreated infants typically succumb to cardiorespiratory failure within the first year. Juvenile and adult onset forms of the disease are characterized by reduced GAA activity and progressive respiratory failure. Although motor problems in Pompe disease have historically been attributed to muscular pathology, glycogen accumulation in the CNS has been documented in Pompe tissues and in various Pompe animal model.

Over the last several years our group has been examining the impact of CNS pathology on breathing in a transgenic mouse model of Pompe Disease (the *Gaa*<sup>-/-</sup> mouse). This work has shown glycogen accumulation in phrenic motoneurons, which innervate the diaphragm (i.e., the major muscle of inspiration) and reduction in ventilation. Additional histological and biochemical studies of tissue obtained from a Pompe patient who suffered progressive ventilatory insufficiency revealed pathology in putative phrenic motoneurons and extensive glycogen accumulation in the spinal cord. The potential for a neural substrate contribution to respiratory insufficiency in Pompe disease raises considerations about the current clinical approach involving enzyme replacement by intravenous delivery. That strategy does not lend to CNS treatment since the recombinant GAA enzyme does not cross the blood-brain-barrier. Accordingly, Pompe patients undergoing enzyme replacement therapy would continue being at risk for developing motor dysfunction. The case for neural involvement in respiratory insufficiency is further strengthened by our recent experience with two ventilator-dependent Pompe patients (Smith, Byrne et al, in review). Following placement of chronic intramuscular electrodes for diaphragm pacing, the patients have been removed from ventilator support for periods of up to 12 hours. If contractile dysfunction of the diaphragm were the primary cause of the patients breathing problems then direct muscle stimulation would not be effective.

We reasoned that gene transfer approaches would be ideally suited targeted gene delivery to both muscle and CNS tissue. Thus, we have conducted a series of gene transfer studies using the *Gaa*<sup>-/-</sup> mouse model. When recombinant adeno associated virus (AAV) vectors encoding GAA were delivered *intravenously* to young *Gaa*<sup>-/-</sup> mice we observed sustained improvements in both cardiac and respiratory function. AAV-GAA vectors also improve diaphragm contractility, ventilation, and possibly phrenic neural outflow when delivered directly to the diaphragm. In addition, we recently discovered that direct spinal injection of (AAV encoding GAA restores spinal GAA enzyme activity and increases ventilation in adult *Gaa*<sup>-/-</sup> mice. Collectively, our results are consistent with the overall hypothesis that CNS

pathology contributes to ventilatory dysfunction in *Gaa*<sup>-/-</sup> mice, and by extension, Pompe disease. Based on the accumulation of evidence from animal models, we were able to initiate an open label Phase I/II clinical trial in which rAAV2/1 encoding human GAA is being delivered directly to the diaphragm potentially lower motor neurons by retrograde transport in children with Pompe disease.

**Title:** An Alternative Management Strategy for Ventilatory Failure in Children with Pompe Disease: Emphasis on Recovery

Pompe disease is an inherited neuromuscular disease characterized by a deficiency of the acid alpha-glucosidase (GAA) enzyme. A severe deficiency or absence of GAA results in accumulation of glycogen in the heart, liver, nerves, and especially the striated muscles (1, 2). Children with the most severe phenotype present in infancy with cardiomyopathy, respiratory compromise, weakness and hypotonia, and historically they experienced fatal cardiorespiratory compromise within the first year of life (3). Intravenous recombinant GAA enzyme replacement therapy (ERT), given alternate weekly, has been found to increase survival and partially reverse cardiomyopathy in severely affected children (4). While ERT has become the standard of clinical care for Pompe disease, its longer-term efficacy has been diminished by a loss of motor milestones (5-7) which we hypothesize is due to ineffective targeting of neural tissue (8). The diaphragm muscle is particularly resistant to treatment, and most children eventually require support with mechanical ventilation, despite chronic ERT (6, 7). Respiratory failure remains the primary cause of death in Pompe disease (9).

Traditionally, the management of progressive respiratory insufficiency for severe neuromuscular diseases focused on providing passive modalities that performed airway clearance and alleviated the work of breathing (10). This approach often utilized increasingly higher levels of mechanical ventilation support as patients grew or developed acute exacerbations. However, an extensive body of animal and human research indicates that even short periods of mechanical ventilation promote diaphragmatic oxidative stress, atrophy and weakness (11, 12). Therefore, reliance on diaphragmatic rest may be counter-productive to emerging regenerative therapies for neuromuscular diseases (13-15). In contrast to conventional strategies, the primary goal of our group has been to follow an approach that may directly correct phrenic neural pathology or improve residual motor unit function. We have implemented a three-tiered approach which includes exercise training, gene replacement therapy, and direct diaphragm pacing, aimed at restoring the ventilatory function of affected children.

Supported by preclinical findings that adeno-associated virus gene therapy (AAV1-GAA) robustly increased phrenic activity and ventilation of treated animals (16, 17), we initiated a phase I/II clinical trial of AAV1-GAA intramuscular gene transfer to the diaphragm, in children with chronic ventilatory failure. To distinguish the effects of increased activity from those of AAV1- GAA, the study design included a pre-operative respiratory muscle strengthening regime previously shown to facilitate ventilator weaning in ICU patients (18, 19). Subjects received direct, intramuscular gene delivery ( $1 \times 10^{12}$  vg) by a thorascopic approach, and then continued exercise training after gene transfer. We repeated safety, developmental, and ventilatory functional tests every 90 days for the first post-operative year. As an alternative to gene therapy, a diaphragm pacemaker was implanted in two ventilator-dependent patients who did not meet study criteria (Smith, Byrne et al, in review). Results to date affirm the safety of these therapeutic approaches and reveal a rehabilitative benefit on phrenic motor unit activation and unassisted breathing function. Collectively, the findings support the hypothesis that neural deficits contribute to ventilatory insufficiency in Pompe. Our long-term objective is to propel a shift in ventilatory management in Pompe disease from a mode of diaphragmatic rest and artificial support, to a creating permissive environment

where patients utilize their muscles of breathing within their innate capabilities. These therapeutic strategies may offer some value for rehabilitation and management of ventilatory failure in other neurodegenerative conditions.

3:30 PM

### **Poster Teasers**

- *Yoonsu Choi, Georgia Institute of Technology*
- *Emily Friedrich, Carnegie Mellon University*
- *William Henry Jones III, Georgia State University*
- *Ana Claudia Mattiello-Sverzut, University of São Paulo*
- *Jaci Bliley, University of Pittsburgh*
- *Ting-Hsien (Tom) Chuang, University of California, San Diego*

3:40—4:30 PM

### **Posters and Coffee Break**

4:30 PM

### **Cellular Therapies for Peripheral Nerve Regeneration**

*Kacey G. Marra, PhD*

Peripheral nerve injuries can occur due to trauma (including battlefield injuries, violence and vehicular accidents), as well as tumor removal or disease states. While there are several hollow tube nerve guides on the market, none are cleared for nerve gaps > 3 cm in humans. The use of an autograft is currently the gold standard, but there are several disadvantages with the use of an autograft, including potential lack of sufficient tissue and mismatch of cable diameter leading to underwhelming functional recovery. We have developed biodegradable conduits to enhance repair. In addition to the incorporation of cells within the conduits, we also examine the encapsulation of neurotrophic factors within double-walled polymeric microspheres and embedded within the walls of the nerve guide. After demonstrating success in a critical-sized rat sciatic nerve defect model, our next step is to examine the nerve guide in a non-human primate model. After identifying the appropriate gap size of 5 cm in the median nerve, extensive animal training begins. Functionality assessment also includes electrophysiology measurements, including somatosensory-evoked potentials and nerve conduction velocity. Histological analysis is conducted to determine the degree of axonal regeneration. In summary, we are currently examining the novel nerve guides first in a rat sciatic nerve defect model, followed by implantation into a non-human primate median nerve defect model.

5:00 PM

### **Tendinopathy, Exercise, and PRP Treatment**

*James H-C. Wang, PhD*

Tendons, such as patellar and Achilles tendons, transmit large muscular forces to bone to enable joint movements. As a result, tendon injury is common in both occupational and athletic settings. Once injured, tendon healing is slow and forms scar tissues. Moreover, in the case of chronic injury (or tendinopathy), injured tendons often do not heal at all. In fact, the restoration of normal structure and function to injured tendons is one of the greatest challenges in orthopaedic/sports medicine.

Our group has a long standing interest in better understanding the cellular and molecular mechanisms of tendinopathy and its treatment. In this presentation, I will present our data showing that excessive mechanical loading of tendons increase the cellular production of PGE<sub>2</sub>, a cellular inflammatory mediator in injured tissues such as tendons, and that PGE<sub>2</sub> induces differentiation of tendon stem cells, a newly discovered tendon cell, into non-tenocytes. I will also show that exercise is beneficial, because it reduces the formation of



fatty tissues in aging tendons, as evidenced in our mouse treadmill running study. Furthermore, I will present our recent work on the use of platelet-rich plasma (PRP) to repair injured tendons. Our data show that PRP treatment promotes differentiation of TSCs into active tenocytes and that, like NSAIDs, PRP has anti-inflammatory properties. Finally, the presentation will close with our perspectives regarding the role of mechanical loading in the stem-based mechanisms on the repair or regeneration of injured tendons.

5:30 PM

**Signature Seminar #3**

**Stem Cell Therapies – Hype or Hope?**

*Albert D. Donnenberg, PhD*

Embryonic stem cells, adult tissue stem cells, induced pluripotent stem cells. So many choices and so many promises: Cures for neurodegenerative diseases, heart disease, leukemia, blindness, multiple sclerosis, lymphoma, autism; Younger skin, younger cartilage, younger everything; Tendon repair, muscle repair, bone repair, wound healing; More effective aesthetic surgery; Stem cell based anti-inflammatory therapy for Crohn's disease, graft versus host disease, acute lung injury. What to believe and what to trust? This talk will examine the claims, promises and politics of stem cell therapy from the perspective of evidence-based medicine, scientific hypothesis and just plain hype.

6:15—6:30 PM

**Wrap Up Day 1**

*Steve L. Wolf, PhD, PT, FAPTA, FAHA*

## Agenda—Day 2

## Tuesday, November 13

8:00—9:00 AM

**Keynote Address**

**A Clinician-Scientist's Perspective on Tissue Regeneration for Soft Tissue Repair:  
Focus on Sports Injuries**

*Scott Rodeo, MD*

This talk will address the current challenges in soft tissue repair, including meniscus, articular cartilage, tendon, and ligament. Strategies for augmentation of innate repair processes and well as tissue regeneration will be reviewed. Specific techniques to be reviewed include use of pluripotent cells, cytokines, extracellular matrix scaffolds, and platelet-rich plasma. Other emerging techniques including tissue engineering and gene therapy approaches will be reviewed. Finally, techniques for application of these emerging techniques for specific sports injuries will be discussed.

9:00—10:30 AM

**Signature Seminar #4**

**Regenerative Rehabilitation in Military Medicine**

9:00 AM

### **Plenary Talk**

#### **Stem Cells for the Treatment of Muscle Injury and Disease**

*Thomas A. Rando, MD, PhD*

Stem cell regeneration of injured or diseased tissue holds great promise as a means to restore structure and function. For skeletal muscle, this would include restoration of muscle mass due to injury or, secondarily, to neurologic conditions such as spinal cord injury, stroke, and ALS. With age, sarcopenia contributes substantially to disability associated with frailty. In each of these conditions, maintenance or restoration of muscle mass would potentially ameliorate associated functional limitations. Furthermore, integrating regenerative therapies with rehabilitative physical therapies is likely to synergize the benefit of each.

One of the approaches we have taken in a path to translation for this regenerative rehabilitation approach has been in a mouse model of volumetric muscle loss (VML). VML is a common consequence of blast injuries in soldiers, leading to sustained impairment of function as there is currently no treatment, either in the acute setting of the chronic phase, for this condition. We have focused on chronic VML to model the more challenging problem for regenerative therapy. Initially using murine cells, we have recently developed protocols for the isolation of human muscle stem cells from operative samples which we can purify by flow cytometry. We have also devised protocols to express reporter genes in muscle stem cells so that we can follow them non-invasively following transplantation. In order to enhance the ability of purified stem cells to engraft and contribute to muscle repair after transplantation, we have developed novel artificial muscle fibers (AMFs) reconstituted from recombinant proteins and designed to have both physical and biochemical characteristics of native muscle fibers. Freshly isolated muscle stem cells are seeded onto the AMFs and transplanted into muscles of immunodeficient mice. We have been able to achieve high levels of engraftment and reconstitution using these methods, and at levels that are scalable to large animals and humans. We are currently working to optimize the conditions of cell maintenance, AMF characteristics, and transplantation parameters to achieve ever increasing efficacies as assessed both anatomically and physiologically, and we are currently testing the benefit of concurrent physical activity on the success of the stem cell mediated tissue restoration.

9:40 AM

### **Rehabilitation and Regenerative Medicine for Combat Related Extremity Trauma**

#### **Animal: rodent and large animal models**

*Thomas J. Walters, PhD*

9:50 AM

### **Regenerative Medicine and Its Implications for Combat Casualty**

*Paul F. Pasquina, MD*

10:00 AM

### **IED Sequelae in DoD Wounded Warriors - Peripheral Nerve and Muscle Regeneration Requirement**

*John Dudley Malone, MD, MPH*

10:10 AM

### **Panel Discussion**

10:30— 10:45 AM

### **Break**

10:45 AM—  
1:00 PM

### **Session C—Training the Transplant: Implications for Treatment of Neurological Pathologies**

10:45 AM

### **Plenary Talk**

#### **Spinal Cord Injury and Regenerative Rehabilitation**

*Paul J. Reier, Ph.D.*

*Heather H Ross, PhD, MPT*

Rehabilitation strategies are crucial for restoration of function following incomplete spinal cord injury (SCI). Even with the benefit of rehabilitation-based improvements, recovery remains less than optimal due at least in part to extensive tissue damage. Regenerative medicine approaches that can provide cells for remyelination or new tissue substrates for restoring useful synaptic connections have thus been sought to address neural recovery. In that context, transplantation of therapeutic stem/progenitor cells offers important possibilities. However, these strategies are currently limited by major technical hurdles including limited survival of donor cells and low grey matter yield (and therefore neuronal replacement) following grafting in the injured spinal cord. Another significant challenge is related to reconstruction of functionally beneficial circuitry.

Current strategies aim to overcome these challenges by using innovative rehabilitation paradigms to condition pre- and post-transplant therapeutic cell populations. The overarching goal of this work is to enhance recovery through the development of protocols that combine regenerative medicine with rehabilitation-based approaches to increase survival, engraftment and connectivity of transplanted cells. A brief introduction of neural stem cell identity and utility in regenerative rehabilitation will be presented. This will be followed by theoretical underpinnings and proof of concept data outlining how physiological and activity-based approaches could improve the robustness and connectivity of cell grafts through pre-transplant priming effects and/or by the introduction of patterned activity around post-transplant cells. The talk will conclude with a brief discussion of how this early work can direct future laboratory and clinical efforts.

12:00 PM

### **Molecular Neurorehabilitation**

*S. Thomas Carmichael, MD, PhD*

The principles of recovery from stroke in neurorehabilitation involve important aspects of physical medicine. Occupational, physical and speech therapy promote activity-dependent and task-focused behavioral therapies that lead to the limited recovery in this disease. However, the targeted pharmacological approaches so characteristic of molecular medicine have not been available in neurorehabilitation. Recent basic science studies support novel therapeutics for neural repair in stroke. These include activation of molecular memory programs, selective growth factor stimulation, induction of brain growth promoting cellular programs, blockade of growth inhibitors induced by stroke and targeted delivery of cell therapies. When combined with physical rehabilitation these may stimulate greater recovery in stroke.

12:30 PM

### **Exploring the Intersection of Regenerative Medicine, Neuroprosthetics and Rehabilitation**

*Ravi V. Bellamkonda, PhD*

Functional recovery after a traumatic injury is dependent on a complex set of variables. These include the extent of the initial injury, our ability to modulate inflammation in the acute setting, the regenerative capacity of the tissue involved, and ultimately our ability to maximize endogenous functional capacity with or without assistive technologies.

Currently, there are exciting developments in three disparate fields of research that

potentially have a direct bearing on functional outcomes for people with traumatic injuries when applied synergistically. These fields include Regenerative medicine, Neuroprosthetics and Rehabilitation. In my talk, I will illustrate some state of the art technologies and discoveries that may, together, shape the future of patient care after traumatic injury. I will use specific examples from our laboratory in building such an synergistic approach, including peripheral nerve repair, modulation of inflammation, and tapping the endogenous regenerative capacity of the nervous system for designing better neural interfaces. My talk will attempt to place our laboratory's work in the context of other relevant advances in the field including stem cell therapy.

1:00—2:30 PM

## **Lunch and Posters**

2:30 PM

### **Signature Seminar #5**

#### **Regenerative Rehabilitation in Education**

##### **Building a Bridge from Rehabilitation to Regenerative Medicine**

*Joel Stein, MD*

The promise of regenerative medicine is tantalizing, yet its substantial clinical realization remains some years in the future. Fundamental laboratory research continues to yield new insights into the body's innate mechanisms of development and regeneration, and innovative techniques to create induced pluripotent stem cells have suggested a mechanism to circumvent some of the difficult ethical issues that have hampered the field's development in the past.

At the same time, some clinicians anxious to harness the power of regenerative medicine have begun using autologous preparations of pluripotent cells as a regenerative treatment. While intriguing and potentially valuable, these techniques have not yet been subjected to rigorous clinical trials to establish safety and efficacy. The field of regenerative medicine is working to find the right balance between methodical stepwise advances in the lab, and the introduction of new therapies before they are fully vetted.

Regenerative medicine has applications in a multitude of specialties within medicine, and its most appropriate "home" within an academic medical center remains to be determined. The Department of Rehabilitation and Regenerative Medicine at Columbia University is in the process of establishing a laboratory science research program in stem cell biology within a previously exclusively clinical department. The department is endeavoring to both create a center of research activity within the department, as well as establish a cross-departmental structure to help stem researchers in a variety of departments collaborate more effectively. The ultimate goal is to accelerate the translational research that will lead to clinical trials in regenerative therapies, and ultimately to new treatments for our patients.

##### **Regenerative Medicine and Rehabilitation: Implications for the Physical Therapy Education Process**

*Anthony Delitto, PhD, PT, FAPTA*

Presenting and integrating up to date basic and applied information is always a challenge in any professional education program. It is particularly challenging introducing and integrating new and innovative material such as that in the regenerative rehabilitation area across the 200+ professional physical therapy programs. Using the Guide for Physical Therapy Practice's general categorization of patient management (Musculoskeletal, Neuromuscular, Cardiopulmonary and Integumentary), a standardized model curriculum in regenerative

rehabilitation will be presented in which contributions in germane areas can be sought from renowned experts are solicited and placed in a repository that can be shared through teleeducational methods. Included in the presentations will be suggestions of how to integrate this material in each area of practice.

3:30 PM

### Signature Seminar #6

#### **The Role of “Inflammation” and Mechanical Loading in the Constructive Remodeling of Biologic Scaffold Materials**

*Stephen F. Badylak, DVM, PhD, MD*

*Fabrisia Ambrosio, PT, PhD*

A wide variety of biologic scaffold materials are available for the repair and reconstruction of soft tissues. Clinical outcomes have been mixed for reasons that are only partially understood. Factors known to affect the remodeling response include the extent and rate of scaffold degradation, modulation of the host innate immune response, recruitment of endogenous stem and progenitor cells, and epigenetic factors such as mechanical loading that play a critical role in the tissue remodeling events.

This presentation will focus upon two of these factors: 1.) the host cellular response to the xenogeneic material, and 2.) mechanical loading. These two events are closely linked. The mechanical loading (rehabilitation) applied to the remodeling scaffold/tissue affects the outcome both directly and indirectly. This presentation will include a discussion of the impact of these processes upon outcomes and the role of “regenerative rehabilitation”.

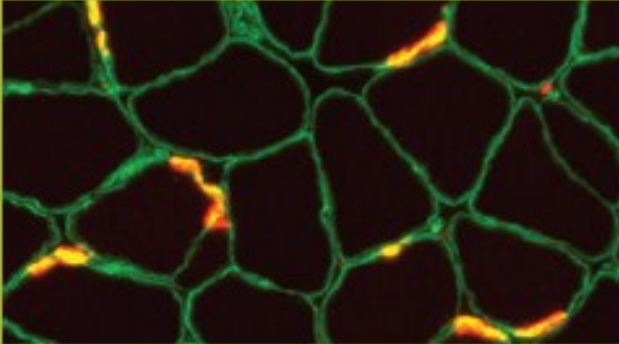
4:30—4:45 PM

### **Wrap-up and Final Comments**

4:45 PM

### **Symposium Adjournment**

# Speakers





## Course Directors

**Fabrisia Ambrosio, PhD, PT**

Assistant Professor  
Department of Physical Medicine and Rehabilitation &  
Director, Cellular Rehabilitation Laboratory  
University of Pittsburgh  
Pittsburgh, PA

**Michael Boninger, MD**

Professor and Chair Department of Physical Medicine  
and Rehabilitation  
University of Pittsburgh  
Pittsburgh, PA

**Anthony Delitto, PhD, PT, FAPTA**

Professor and Associate Dean of Research  
School of Health and Rehabilitation Sciences  
University of Pittsburgh  
Pittsburgh, PA

**Thomas A. Rando, MD, PhD**

Professor  
Department of Neurology and Neurological Sciences  
Stanford University School of Medicine  
Palo Alto, CA

**William R. Wagner, PhD**

Director, McGowan Institute for Regenerative Medicine  
Professor of Surgery, Bioengineering & Chemical  
Engineering  
University of Pittsburgh  
Pittsburgh, PA

## External Advisory Board

**Steve L. Wolf, PhD, PT, FAPTA, FAHA**

Professor, Departments of Rehab Medicine, Medicine,  
Cell Biology  
Emory University School of Medicine  
Atlanta, GA

**Richard K. Shields PT, PhD, FAPTA**

Professor and Head  
Department of Physical Therapy and Rehabilitation  
Sciences  
Carver College of Medicine  
University of Iowa  
Iowa City, IA

## Guest Faculty

**Ravi V. Bellamkonda, PhD**

Carol Ann and David D Flanagan Chair in Biomedical  
Engineering & GCC Distinguished Scholar  
Georgia Institute of Technology and Emory School of  
Medicine

**S. Thomas Carmichael, MD, PhD**

Professor and Vice Chair for Research and Programs  
Department of Neurology  
David Geffen School of Medicine  
UCLA

**George J. Christ, PhD**

Program Director of Education & Training Programs  
Wake Forest Institute for Regenerative Medicine  
Wake Forest School of Medicine

**David D. Fuller, PhD**

Associate Professor  
Dept. of Physical Therapy  
McKnight Brain Institute  
University of Florida

**Geoffrey C. Gurtner, MD, FACS**

Professor and Associate Chairman of Surgery  
Professor (by courtesy) of Materials Science and  
Engineering  
Stanford University School of Medicine

**John Dudley Malone, MD, MPH**

Head Clinical Investigations Department  
Naval Medical Center San Diego (NMCSD)/ Research  
Program Manager Navy Medicine West

**Paul F. Pasquina, MD**

COL, U.S. Army Medical Corps  
Chief, Department of Orthopaedics and Rehabilitation

**Thomas A. Rando, MD, PhD**

Professor  
Department of Neurology and Neurological Sciences  
Stanford University School of Medicine

**Paul J. Reier, PhD**

Professor of Neuroscience  
Investigator, McKnight Brain Institute  
College of Medicine  
University of Florida

**Scott Rodeo, MD**

Co-Chief, Sports Medicine and Shoulder Service  
Professor, Orthopaedic Surgery, Weill Medical  
College of Cornell University  
Attending Orthopaedic Surgeon, The Hospital for  
Special Surgery  
Associate Team Physician, New York Giants  
Football

**Heather H Ross, PhD, MPT**

Research Assistant Professor  
Department of Physical Therapy  
Program in Stem Cell Biology & Regenerative  
Medicine  
University of Florida

**Richard K. Shields, PT, PHD, FAPTA**

Professor and Chair  
Dept of Physical Therapy and Rehabilitation  
Sciences  
Carver College of Medicine  
University of Iowa

**Barbara K. Smith, PhD, PT**

Research Assistant Professor  
Department of Physical Therapy  
University of Florida

**Joel Stein, MD**

Simon Baruch Professor and Chair  
Department of Rehabilitation and Regenerative  
Medicine Columbia University College of  
Physicians and Surgeons  
Professor and Chief  
Division of Rehabilitation Medicine  
Weill Cornell Medical College  
Physiatrist-in-Chief  
New York-Presbyterian Hospital

**Thomas J. Walters, PhD**

Research Physiologist/Principle Investigator  
Department of Extremity Trauma and  
Regenerative Medicine  
United States Army Institute of Surgical Research

**Steve L. Wolf, PhD, PT, FAPTA, FAHA**

Professor, Departments of Rehab Medicine,  
Medicine, Cell Biology  
Emory University School of Medicine

## Local Faculty

**Fabrisia Ambrosio, PhD, PT**

Assistant Professor  
Departments of Physical Medicine & Rehabilitation,  
Physical Therapy, Orthopaedic Surgery and Microbiology  
and Molecular Genetics  
University of Pittsburgh

**Stephen F. Badylak, DVM, PhD, MD**

Professor, Department of Surgery  
Deputy Director of the McGowan Institute for  
Regenerative Medicine,  
University of Pittsburgh

**Michael Boninger, MD**

Professor and Chair  
Department of Physical Medicine and Rehabilitation  
University of Pittsburgh  
Director, UPMC Rehabilitation Institute

**Anthony Delitto, PhD, PT, FAPTA**

Professor and Associate Dean of Research  
School of Health and Rehabilitation Sciences  
University of Pittsburgh  
Pittsburgh, PA

**Albert D. Donnenberg, PhD**

Professor of Infectious Disease and Microbiology,  
Graduate School of Public Health  
Professor of Medicine, School of Medicine  
University of Pittsburgh

**Kacey Marra, PhD**

Associate Professor  
Depts. of Surgery & Bioengineering  
Co-Director, Adipose Stem Cell Center  
University of Pittsburgh

**Andrew B. Schwartz, PhD**

Professor of Neurobiology  
University of Pittsburgh

**Gwendolyn Sowa, MD, PhD**

Assistant Professor  
Physical Medicine & Rehabilitation  
Assistant Dean of Medical Student Research,  
School of Medicine  
University of Pittsburgh

**Elizabeth C. Tyler-Kabara, MD, PhD**

Assistant Professor  
Department of Neurological Surgery  
University of Pittsburgh

**Katherine Verdolini Abbott, PhD**

Professor of Communication Science and Disorders  
School of Health and Rehabilitation Sciences  
University of Pittsburgh

**Yoram Vodovotz, PhD**

Professor of Surgery, Immunology, Computational and  
Systems Biology, Clinical and Translational Science, and  
Communication Science and Disorders  
University of Pittsburgh

**William Wagner, PhD**

Director, McGowan Institute for Regenerative Medicine  
Professor of Surgery, Bioengineering and Chemical  
Engineering  
University of Pittsburgh

**James H-C. Wang, PhD**

Professor of Orthopaedic Surgery  
Director of the MechanoBiology Laboratory in the  
Department of Orthopaedic Surgery  
University of Pittsburgh School of Medicine



# Speaker Biographies

## **Fabrisia Ambrosio, PhD, PT**

University of Pittsburgh

Dr. Fabrisia Ambrosio graduated with a Master of Science in Physiology-Endocrinology from Laval University in Québec City, Québec and a Master of Physical Therapy from the Medical College of Pennsylvania and Hahnemann University. In 2005, Dr. Ambrosio graduated with a PhD in Rehabilitation Science & Technology from the University of Pittsburgh. Also in 2005, she accepted a position as a faculty member in the Department of Physical Medicine & Rehabilitation at the University of Pittsburgh. She holds secondary appointments in the Departments of Physical Therapy, Orthopaedic Surgery, and Microbiology and Molecular Genetics at the University of Pittsburgh, and is a faculty member of the McGowan Institute for Regenerative Medicine.



Dr. Ambrosio's research has the long-term goal of developing regenerative rehabilitation approaches to improve the skeletal muscle healing and functional recovery. As the Director of the Cellular Rehabilitation Laboratory, her laboratory investigates the underlying mechanisms by which targeted and specific mechanotransductive signals can be used to enhance donor and/or endogenous stem cell functionality in mouse and human models.

## **Stephen F. Badylak, DVM, PhD, MD**

University of Pittsburgh



Dr. Stephen Badylak, DVM, PhD, MD is a Professor in the Department of Surgery, and deputy director of the McGowan Institute for Regenerative Medicine. Dr. Badylak has practiced both veterinary and human medicine. Dr. Badylak began his academic career at Purdue University in 1983, and subsequently held a variety of positions including service as the Director of the Hillenbrand Biomedical Engineering Center from 1995-1998. Dr. Badylak served as the Head Team Physician for the Athletic Department for 16 years (1985-2001), a position in which rehabilitation medicine was a critical component of his practice.

Dr. Badylak holds over 50 U.S. patents, 200 patents worldwide, has authored more than 250 scientific publications and 20 book chapters. He has served as the Chair of the Study Section for the Small Business Innovative Research (SBIR) at the National Institutes of Health (NIH), and as chair of the Bioengineering, Technology, and Surgical Sciences (BTSS) Study Section at NIH. Dr. Badylak is now a member of the College of Scientific Reviewers for NIH. Dr. Badylak has either chaired or been a member of the Scientific Advisory Board to several major medical device companies.

Dr. Badylak is a Fellow of the American Institute for Medical and Biological Engineering, a charter member of the Tissue Engineering Society International, currently president of the Tissue Engineering Regenerative Medicine International Society (TERMIS), and a founding International Fellow of this same Society. He is also a member of the Society for Biomaterials. Dr. Badylak is the Associate Editor for Tissue Engineering for the journal Cells, Tissues, Organs, and serves on the editorial board of several other journals.

Dr. Badylak's major research interests include:

- Tissue Engineering and Regenerative Medicine
- Biomaterials and Biomaterial/Tissue interactions
- Developmental Biology and its Relationship to Regenerative Medicine

- Relationship of the Innate Immune Response to Tissue Regeneration
- Biomedical Engineering as it Relates to Device Development and Biomaterials
- Clinical Translation of Regenerative Medicine

## **Ravi V. Bellamkonda, PhD**

Georgia Institute of Technology and Emory School of Medicine

Prof. Bellamkonda is the Associate Vice President for Research at Georgia Institute of Technology and the Carol Ann and David D Flanagan Professor of Biomedical Engineering and GCC Distinguished Scholar.

As Associate Vice President for Research, Prof. Bellamkonda has focused on designing programs to encourage and nurture faculty/staff innovation. Prof. Bellamkonda's research involves an active exploration of the interplay of biomaterials and the nervous system in applications such as neural interfaces, nerve repair and brain tumor therapy. Prof. Bellamkonda is specifically interested in mechanisms of inflammation and healing around implanted neural electrodes and how electrode design influences these important processes to affect function.



## **Michael Boninger, MD**

University of Pittsburgh



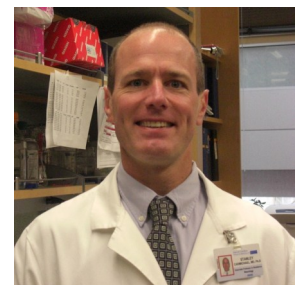
Michael Boninger, MD is professor and chair in the Department of Physical Medicine & Rehabilitation and the Director of UPMC Rehabilitation Institute. He also serves as medical director of Human Engineering Research Laboratories ([www.herl.pitt.org](http://www.herl.pitt.org)) and holds secondary appointments in the Departments of Rehabilitation Sciences and Technology and Bioengineering. Dr. Boninger is also the director of the University of Pittsburgh Model Center on Spinal Cord Injury, a National Institute for Disability and Rehabilitation Research Center of Excellence. His overriding research area is on technology that improves the lives of individuals with spinal cord injury and other physical disabilities. Focused research areas include biomechanics, neuroprosthetics, cumulative trauma disorders, and wheelchairs. He also works to promote careers in medical research.

Dr. Boninger has an extensive publication record of over 20 book chapters and 183 published papers spanning 18 years. He is the Principle Investigator of the NIH funded Rehabilitation Medicine Scientist Training Program (RMSTP), a \$6 million grant providing training funds for clinician researchers across the country, and serves as the president of the Association of Academic Physiatrists. Dr. Boninger holds 4 US patents, was inducted in the National Spinal Cord Injury Association Hall of Fame in 2006, and has won numerous awards including the 2011 A. Estin Comarr Award from the Academy of Spinal Cord Professionals. Dr. Boninger's students have also won over 45 national awards.

## **S. Thomas Carmichael, MD, PhD**

UCLA

S. Thomas (Tom) Carmichael is a neurologist and neuroscientist in the Department of Neurology at the David Geffen School of Medicine at UCLA. Dr. Carmichael is Professor and Vice Chair in the Department, with active laboratory and clinical interests in stroke and neurorehabilitation, and how the brain repairs from injury. He received his M.D. and Ph.D. degrees from Washington University School of Medicine in 1993 and 1994, and completed a Neurology residency at Washington University School of Medicine, serving as Chief Resident in 1997-1998. Dr. Carmichael was a Howard Hughes Medical Institute postdoctoral fellow at UCLA from 1998-2001, studying mechanisms of axonal sprouting, with a clinical emphasis





on neurorehabilitation and stroke. He has been on the UCLA faculty since 2001. Dr. Carmichael's laboratory studies the molecular and cellular mechanisms of neural repair after stroke and other forms of brain injury. This research focuses on the processes of axonal sprouting and neural stem cell responses after stroke, and on neural stem cell transplantation. Dr. Carmichael is an attending physician on the Neurorehabilitation and Stroke clinical services at UCLA.

Dr. Carmichael has published foundational papers on stroke recovery that have defined mechanisms of plasticity and repair. These findings include the fact that the stroke produces stunned circuits that limit recovery, but can be restored to normal functioning with newly identified experimental drugs. His work has identified a novel brain "growth program" that is activated by stroke and leads to the formation of new connections. These studies have also identified how this growth program changes with age, and how specific molecules in the aged brain block the formation of new connections and of recovery. This and other work has led to new directions in stroke therapeutics, including therapies with stem cell and tissue engineering applications. Dr. Carmichael is in the midst of stroke stem cell development applications with the FDA and with biotechnology companies. His stroke neural repair findings have led to partnerships with the pharmaceutical industry towards new drug therapies.

## **George J. Christ, PhD**

### **Wake Forest**

Dr. George J. Christ. Dr. Christ is Professor of Regenerative Medicine and Translational Science and Head of the Program in Cell, Tissue and Organ Physiology, as well as the Director of Education and Training Programs at the Wake Forest Institute for Regenerative Medicine. He is an Affiliate Faculty in the Molecular Medicine and Molecular Genetics Programs, as well as the Virginia Tech/Wake Forest School for Biomedical Engineering and Sciences. He also holds appointments in the Depts. of Urology and Physiology & Pharmacology and the Sticht Center for Aging. He is the former Director and founder of the Institute for Smooth Muscle Biology at the Albert Einstein College of Medicine.



Dr. Christ is expert in muscle physiology. He is the Past Chairman of the Division of Systems and Integrative Pharmacology of the American Society of Pharmacology and Experimental Therapeutics (ASPET), and Past President of the North Carolina Tissue Engineering and Regenerative Medicine Society (NCTERMS), and a member of the AUA Research Council. He currently serves on the Executive Committee of the Division for Integrative Systems, Translational and Clinical Pharmacology of ASPET. He is the Specialty Chief Editor for the Journal of Integrative and Regenerative Pharmacology and is also an Assistant Editor of Investigative Urology for the Journal of Urology and the Associate Editor for Basic Research for the International Journal of Impotence Research. He is an ad-hoc reviewer for 16 other journals. Dr. Christ has authored more than 200 scientific publications. He has served on both national and international committees related to his expertise in muscle physiology, and has also served on NIH study sections in the NIDDK, NICHD, NCRR and NHLBI. He has chaired working groups for both the NIH and the World Health Organization.

Dr. Christ is a co-inventor on more than 24 patents (national and international) that are either issued or pending, related to gene therapy for the treatment of human smooth muscle disorders and tissue engineering technologies. He is a Co-Founder and Directing Member of Ion Channel Innovations, LLC., a development stage biotechnology company pioneering the use of gene therapy for the treatment of human smooth muscle disorders. Ion Channel Innovations, LLC that has completed a Phase I clinical trial for a gene therapy treatment for smooth muscle dysfunction, and also conducted a Phase I clinical trial for bladder overactivity. In addition, he is a co-founder and board member of Creative Bioreactor Design, Inc., another early stage biotechnology company in the expanding field of regenerative medicine/tissue engineering.



## **Anthony Delitto Ph.D, PT, FAPTA**

University of Pittsburgh

Dr. Anthony Delitto is a professor and Associate Dean for Research in the School of Health and Rehabilitation Sciences at the University of Pittsburgh. He is also the Director of Research Comprehensive Spine Center at UPMC as well as Vice President for Education and Research Centers for Rehabilitation Services (formerly CORE Network). Dr. Delitto earned his BS in Physical Therapy from SUNY-Buffalo and his MHS/PT and PhD in Psychology from Washington University in St. Louis, Missouri.



Dr. Delitto is primarily interested in conducting evidence-based studies in rehabilitation settings, particularly in populations who have musculoskeletal dysfunction (e.g., low back pain). Previous research projects studied the functional impact of PENS for 65+ chronic low back pain, which aimed to test the effectiveness of PENS in reducing the pain intensity in community-dwelling older adults with CLBP and of combining PENS with a general conditioning and aerobic exercise program (GCAE) to improve the pain-related disability of these patients. Dr. Delitto also conducted a randomized clinical trial of treatment for lumbar spinal stenosis, which compared patient outcomes and evaluated gender differences after non-surgical or surgical treatment for lumbar spinal stenosis.

Dr. Delitto is the president of the Section on Research in the American Physical Therapy Association as well as on the Doctoral Research Awards Committee and Scientific Review Committee of the Foundation for Physical Therapy. He is a member of the International Advisory Board of the New Zealand Centre for Physiotherapy Research, University of Otago; the Medical and Scientific Committee of the Arthritis Foundation, Western Pennsylvania Chapter; and the ALS Association, Western Pennsylvania Chapter. He is a recipient of the Lucy Blair Service Award, which is presented by the American Physical Therapy Association and which honors the member whose contributions to the Association as a whole have been of exceptional value, as well as the John HP Maley Award, which the Association gives to those who provide outstanding contributions to leadership in research.

## **Albert D. Donnenberg, PhD**

University of Pittsburgh



Dr. Albert Donnenberg is a Professor of Infectious Disease and Microbiology in the Graduate School of Public Health and a Professor of Medicine in the School of Medicine at the University of Pittsburgh. He is also an Adjunct Professor of Biotechnology at the Université Paris Diderot. In addition to teaching, Dr. Donnenberg is the Director of the University of Pittsburgh Cancer Institute Flow Cytometry Facility as well as both the UPMC Hematopoietic Stem Cell Laboratory and the University of Pittsburgh Cancer Institute Flow Cytometry Facility. He is also the Co-Leader of the UPCI Cancer Stem Cell Program.

Dr. Donnenberg received his Bachelor's degree from the University of Colorado – Boulder and his PhD from the Johns Hopkins University School of Hygiene and Public Health, where he studied infectious disease epidemiology. Dr. Donnenberg spent many years at Johns Hopkins, where he became an Associate Professor of Immunology and Infectious Diseases, before he came to the University of Pittsburgh.

Dr. Donnenberg's research focuses are: immunologic consequences of autologous transplantation in systemic sclerosis; haplo-identical HSCT; use of bone marrow derived and peripheral blood derived stem and progenitor cells for regenerative therapy; the cancer stem-cell hypothesis; the identification of therapeutic targets on cancer stem cells; and technological advances in flow cytometry. He is on the editorial board of Clinical and Applied Immunology Reviews, and he is certified as an inspection team leader of the College of American Pathologists.

## David D. Fuller, PhD

University of Florida



David D. Fuller, Ph.D is an Associate Professor in Physical Therapy at the University of Florida. Throughout his career, Dr. Fuller has been highly involved in research relevant to neuroplasticity, CNS disease and trauma. He maintains an active research program and is currently the PI of three NIH grants and collaborates on several others. The Fuller laboratory focuses on clinically relevant problems with high translational potential. For example, recent work using a mouse model of Pompe disease has contributed to the first clinical trial of gene transfer to the human diaphragm. Dr. Fuller has also been a leader in the area of respiratory neuroplasticity and rehabilitation following cervical spinal cord injury. The Fuller laboratory is actively investigating the impact of cervical spinal cord injury on the neural regulation of respiratory motoneurons and interneurons, and is also focused on developing cellular transplant strategies to enhance the recovery of respiratory function. Dr. Fuller has published 65 peer-reviewed articles in leading journals, has served on National Institute of Health Study Sections, serves on the editorial board of the Journal of Applied Physiology, and is an Associate Editor for Frontiers in Respiratory Physiology.

## Geoffrey C. Gurtner, MD, FACS

Stanford University

Dr. Geoffrey C. Gurtner is a Professor of Surgery at Stanford within the division of Plastic Surgery. He was formerly the Program Director of Plastic Surgery at the NYU School of Medicine. Dr. Gurtner is a *magna cum laude* graduate of Dartmouth College and an AOA graduate of the University of California-San Francisco School of Medicine. He completed a general surgery residency at the Massachusetts General Hospital/Harvard Medical School program, a plastic surgery residency at the NYU School of Medicine and received advanced training in microsurgery at the University of Texas-MD Anderson Cancer Center. Dr. Gurtner is double boarded in general surgery and plastic surgery. He is the author of over 100 peer-reviewed publications and is also an Editor for the most widely read textbook in the field, *Grabb & Smith's Plastic Surgery*. Dr. Gurtner's NIH funded laboratory seeks to understand the role the physical environment (both mechanical and chemical) plays in determining how organisms respond to injury. This has led to the development of new technologies which are the foundation of several early stage Silicon Valley start-up companies.



## John Dudley Malone, MD, MPH

Naval Medical Center San Diego (NMCSD)



Dr. Malone, originally from Cleveland, Ohio, received his Medical Degree from Ohio State University, Columbus, and upon graduation commenced active duty military service in the United States Navy Medical Corps. He completed his medicine internship at the Naval Medical Center San Diego (NMCSD), Internal Medicine Residency at Portsmouth Naval Hospital, and Infectious Disease Fellowship at the National Naval Medical Center (NNMC). During his 30 year U.S. Navy career, he held the positions of Head, HIV/AIDS Unit; Head, Infectious Diseases Division NNMC; Chairman, Internal Medicine Department and Director for Medical Services, NMCSD; and Commanding Officer, Medical Treatment Facility, USNS Mercy Hospital Ship.

After retiring in 2004 at the rank of Captain (O-6), Dr. Malone obtained a Masters in Public Health from the Uniformed Services University of Health Sciences (USUHS), Bethesda, MD, and became a member of the Pacific Northwest National Laboratory, Richland, Washington, as Program Manager, Center for Biological Monitoring and Modeling. After 2 years, he joined the Center for Disaster and Humanitarian Assistance Medicine, USUHS, as a liaison to Global Emerging Infections Surveillance and Response of the Armed Forces Health Surveillance Center.

Returning to his home in San Diego, CA and the U.S. Navy, in August of 2011, Dr. Malone assumed the responsibility of Head, Clinical Investigations Department, Naval Medical Center San Diego, and Research Program Manager, Navy Medicine West. He is currently responsible for 325 clinical research protocols and a \$6.6M budget.

Dr. Malone is a Professor of Medicine, Uniformed Services University of the Health Sciences, with over 50 publications and 80 formal presentations. He is a Fellow, Infectious Diseases Society of America; Fellow, American College of Physicians; and Fellow, American College of Physician Executives.

## **Kacey Marra, PhD**

University of Pittsburgh

Kacey Marra, Ph.D., is an Associate Professor in the Department of Plastic Surgery, and is recognized for her interdisciplinary research in the design, synthesis, characterization and assessment of polymeric biomaterials. Kacey joined the Department of Surgery as an Assistant Professor in November 2002. Prior to that appointment she was with Carnegie Mellon University as a Research Scientist at the Institute for Complex Engineered Systems (ICES), and an associated faculty member in the Department of Biomedical Engineering (1998-2002), and the Department of Materials Science Engineering (2000-2002). In 1996-7, Kacey was a post-doctoral fellow at the Emory University School of Medicine, with advisor Elliot Chaikof, M.D., Ph.D. At Emory, Kacey worked on the synthesis of novel synthetic blood vessels.



## **Paul F. Pasquina, MD**

COL, U.S. Army Medical Corps



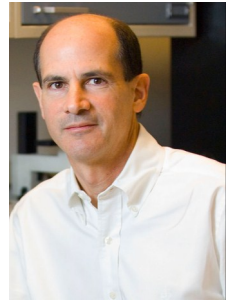
Colonel Pasquina, M.D. is the Chief of the Department of Orthopaedics and Rehabilitation at Walter Reed National Military Medical Center and the Director of the Center for Rehabilitation Sciences Research (CRSR) at the Uniformed Services University of the Health Sciences (USUHS).

He is a graduate of the United States Military Academy at West Point and USUHS. In addition to being board certified in Physical Medicine & Rehabilitation (PM&R), he is also board certified in Electrodiagnostic Medicine and Pain Medicine. He completed a fellowship in sports medicine and remains interested in all aspects of musculoskeletal medicine especially as it applies to individuals with disabilities. He is the specialty consultant to the Army Surgeon General for Physical Medicine & Rehabilitation and a Secretarial appointee on the Department of Veterans Affairs (VA) Advisory Committee for Prosthetics and Special Disabilities Programs.

Dr. Pasquina has authored multiple book chapters, journal articles and policy papers. He has served as the PM&R Residency Program Director and Medical Advisor to the North Atlantic Regional Medical Command for quality healthcare. He has received multiple military awards, as well as awards for teaching and mentorship, including the U.S. Army's "A" Proficiency Designation for academic excellence, the Order of Military Medical Merit, and Honorary Fellow of the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA). Rehabilitation Engineering and Assistive Technology Society of North America Rehabilitation Engineering and Assistive Technology Society of North America

**Thomas A. Rando, MD, PhD**  
Stanford University School of Medicine

Thomas A. Rando is Director of the Glenn Laboratories for the Biology of Aging and Professor of Neurology and Neurological Sciences at Stanford University School of Medicine. He is also Chief of Neurology at the Palo Alto VA Medical Center where he is Director of the Rehabilitation Research & Development Center of Excellence whose focus is the emerging field of regenerative medicine. Rando's research concerns the basic biology of stem cells and how they function in adult tissue homeostasis, in degenerative diseases, and in aging. Groundbreaking work from his lab showed that the age-related decline in stem cell function is due primarily to influences of the aged environment rather than to intrinsic aging of stem cell themselves. Rando has received numerous awards, including a Paul Beeson Physician Faculty Scholar in Aging from the American Federation for Aging Research and a Scholar Award from the Ellison Medical Foundation. In 2005 he received the prestigious NIH Director's Pioneer Award for his work at the interface between stem cell biology and the biology of aging.



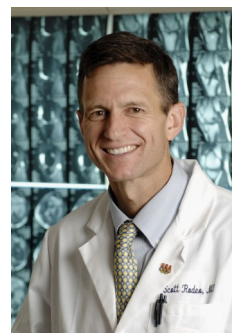
**Paul J. Reier, PhD**  
University of Florida



Dr. Reier has a long-standing interest in spinal cord injury (SCI) research which has had continued NIH and private funding throughout his career at the University of Florida. His research program centers on clinically-relevant experimental models of SCI with significant pre-clinical implications. The major focus is on the effect of mid-to-high cervical SCIs on breathing and forelimb function in rodent models with emphasis on neural tissue transplantation and neuroprosthetic repair/neuroplasticity. In 1992, Dr. Reier and his colleagues were the first to conduct a clinical trial in the U.S. which explored the safety and feasibility of fetal neural tissue intraspinal transplantation in a small cohort of SCI subjects with progressive, post-traumatic syringomyelia. That study was, in many respects, the predecessor of current clinical trials investigating safety of intraspinal stem cell grafts in SCI and ALS.

**Scott Rodeo, MD**  
Weill Medical College of Cornell University  
The Hospital for Special Surgery  
New York Giants Football

Dr. Scott Rodeo is the Associate Team Physician for the New York Giants and is the Co-Chief, Sports Medicine and Shoulder Service at the Hospital for Special Surgery. He is Professor of Orthopaedic Surgery at Cornell University and is an Attending Surgeon at the Hospital for Special Surgery and the New York-Presbyterian Hospital. Rodeo served as a Team Physician for the United States Olympic Team in 2004, 2008, and 2012. Rodeo graduated cum laude from Stanford University, where he completed his undergraduate work while on an athletic scholarship. He completed medical school graduating with honors from Cornell University Medical College.





## **Heather H Ross, PhD, MPT**

University of Florida



Heather Ross is a Research Assistant Professor in the Department of Physical Therapy at the University of Florida and a member of the Program for Stem Cell Biology and Regenerative Medicine. Dr. Ross earned a Ph.D. in Anatomy and Neurobiology from Virginia Commonwealth University in 2006. She then worked as a postdoctoral fellow for Dr. Eric Laywell in the University of Florida's Department of Anatomy and Cell Biology. Dr. Ross's research interests are centered on the combinatorial approach of neural stem/progenitor cell therapies and rehabilitation strategies following neural insult. Specifically, Dr. Ross is studying whether progenitor cell transplant coupled with cell- and systemic-based modulation, including rehabilitation approaches, can synergize to optimally promote cell engraftment and subsequent motor function following spinal cord injury.

The long-term goal of this work is to further the basic understanding of neural stem/progenitor cell regulation, while pioneering study into the interplay between stem cell biology, neural cell replacement/recruitment therapies, and rehabilitation. Dr. Ross also maintains an interest in the ability of thymidine analogs to target the cancer stem cell and treat primary/recurrent brain cancers.

## **Andrew B. Schwartz, PhD**

University of Pittsburgh

Dr. Schwartz received his Ph.D. in Physiology from the University of Minnesota in 1984, with a thesis entitled "Activity in the Deep Cerebellar Nuclei During Normal and Perturbed Locomotion." He then went on to a postdoctoral fellowship at the Johns Hopkins School of Medicine where he worked with Dr. Apostolos Georgopoulos, who was developing the concept of directional tuning and population-based movement representation in the motor cortex.



In 1988, Dr. Schwartz began his independent research career at the Barrow Neurological Institute in Phoenix. There, he developed a paradigm to explore the continuous cortical signals generated throughout volitional arm movements. After developing the ability to capture a high fidelity representation of movement intention from the motor cortex, Schwartz teamed up with engineering colleagues at Arizona State University to develop cortical neural prosthetics. Schwartz moved from the Barrow Neurological Institute to the Neurosciences Institute in San Diego in 1995 and then to the University of Pittsburgh in 2002.

Recently, the neural prosthesis work has progressed to the point that monkeys can control motorized arm prostheses in a self-feeding task and to orient a prosthetic hand to operate a doorknob with an extension to hand shaping. In collaboration with clinical colleagues at the University of Pittsburgh, this technology is now being used by paralyzed subjects to operate a high-performance prosthetic arm and hand.

## **Richard K. Shields, PT, PHD, FAPTA**

University of Iowa

Dr. Shields received a bachelor's degree in biology, a master's degree in Physical Therapy (Mayo Clinic), and a PhD in Exercise Science (University of Iowa). Dr. Shields developed clinical expertise by managing the acute spinal cord injury (SCI) program at the University of Iowa Hospitals and Clinics for several years. During this time he developed several lines of research exploring the muscular, skeletal, and neural adaptations associated with reduced activity. These studies now include cellular and molecular regulation of tissue in response to therapeutic doses of mechanical stress after paralysis. His work is currently funded by the National Institutes of Health, the Department of Veterans Affairs, the Neilsen Foundation, and the Carver Foundation. Dr. Shields



has published over 70 scientific papers and delivered over 400 scientific presentations. He was the recipient of the Iowa Chapter Clinical Research Award, the APTA Neurology Section Research Excellence Award, the University of Iowa Outstanding Mentor and Teaching Award, the Mayo Clinic Outstanding Alumnus Award, the APTA Williams Research Award, and was named an APTA Catherine Worthingham Fellow for his research. He is currently professor and chair of the Physical Therapy and Rehabilitation Science Department, within the Carver College of Medicine, at the University of Iowa.

## **Barbara K. Smith, PhD, PT**

University of Florida



Dr. Barbara Smith is a Research Assistant Professor in the Department of Physical Therapy at University of Florida and a member of UF's Program in Respiratory Neurobiology, Physiology and Rehabilitation. Dr. Smith received her physical therapy clinical degree from the University of Pittsburgh. Her interest in using exercise to improve dyspnea and ventilatory function led her earn to a post entry-level Master of Health Science Degree from the University of Florida. She later returned to Florida to study exercise interventions to promote respiratory muscle strengthening and ventilator weaning in critical care, and completed a PhD in Rehabilitation Science in 2010. Dr. Smith's doctoral work was supported by a Scot C. Irwin-endowed Promotion of Doctoral Studies scholarship from the Foundation for Physical Therapy. Following post-doctoral training in basic respiratory physiology, she was accepted into the K12 Rehabilitation Research Career Development program.

Dr. Smith's current work with mentor Barry J. Byrne, MD, PhD focuses on measurements of diaphragm motor function in ventilator-dependent patients and therapeutic interventions to prevent or reverse ventilatory failure. Specifically, she is studying changes in strength and independent ventilation, in order to differentiate the effects of respiratory muscle exercises from gene replacement therapy for Pompe disease. She also maintains interests in cardiopulmonary responses to inspiratory muscle exercises and the use of non-invasive imaging to evaluate diaphragm function. Dr. Smith serves on the Consortium for Congenital Muscular Dystrophy and is a member of the Respiratory Advisory Committee for the NeuroRecovery Network supported by the Christopher and Dana Reeve Foundation. She is the Research Committee Chair of the Acute Care Section, American Physical Therapy Association. Her longer-term career objective is to further the understanding of respiratory muscle plasticity in neuromuscular disease, while studying the integrative roles of regenerative therapeutics and rehabilitation.

## **Gwendolyn Sowa, MD, PhD**

University of Pittsburgh

Dr. Gwendolyn Sowa, MD, PhD is an Associate Professor in the Department of Physical Medicine and Rehabilitation and Co-Director of the Ferguson Laboratory for Orthopaedic and Spine Research at the University of Pittsburgh, where she also holds joint appointments in the Departments of Orthopaedic Surgery and Bioengineering. Using her background in biochemistry, Dr. Sowa currently performs molecular laboratory based, translational, and clinical research, investigating the effect of motion on inflammatory pathways and the beneficial effects of exercise. She is Co-Director of the Ferguson Laboratory for Orthopaedic and Spine Research, a 3000 square foot laboratory fully equipped to perform molecular assays including gene expression analysis, protein analysis, cell and organ culture, histology, and cellular and spinal biomechanical testing. In addition, she is the clinical core leader for the multi-disciplinary Rehabilitation Engineering Research Center on Spinal Cord Injury at the University of Pittsburgh, where she coordinates recruitment of subjects with acute traumatic spinal cord injury, collection of clinical data as well as serum and urine samples for inflammatory modeling to examine the potential for inflammatory signatures for predicting prognosis and the risk for secondary complications. She also investigates the role of serum biomarkers in intervertebral disc degeneration and back pain. She has received national recognition for her research, including the 2003 Sarah Baskin





Award for Excellence in Research from the Rehabilitation Institute of Chicago, the 2005 Electrode Store Best Paper Award, the 2008 Excellence in Research Writing Award from the Association of Academic Physiatrists, Young Investigator Award Winner at the OABiomarker Global Initiative in 2009, and President's Citation Award from the Academy of Physical Medicine and Rehabilitation in 2010. She has presented her award winning work at national and international meetings with over 100 published abstracts. She has authored and co-authored over 40 original papers. She has received funding to support her research program from the NIH/NIAMS, NIDRR, North American Spine Society, Physiatric Association of Spine, Sports and Occupational Rehabilitation, The Pittsburgh Foundation, and the American Geriatrics Society. In addition, she is active in teaching medical students, medical residents, post-doctoral fellows, having trained over 40 trainees on research projects, 11 of who have won awards for their work, including the prestigious Outstanding Paper Award at the International Society for the Study of the Lumbar Spine Annual Meeting in 2008. She was named the University of Pittsburgh Department of Physical Medicine and Rehabilitation Teacher of the Year Award in 2007 and was recently named the Young Academician of the Year by the Association of Academic Physiatrists in 2009. She is also actively involved in training future clinician scientists as an Assistant Dean for Medical Student Research. She is a peer reviewer for four journals, and is an associate editor for *PM&R*. In addition, she is a board certified physiatrist, and active member of the Association of Academic Physiatrists, the American Academy of Physical Medicine and Rehabilitation, the North American Spine Society, and the International Society for the Study of the Lumbar Spine. In addition to her research activities, she currently spends approximately 25% of her time treating outpatients with musculoskeletal and spinal disorders in the University of Pittsburgh Department of Physical Medicine and Rehabilitation.

## **Joel Stein, MD**

Columbia University College of Physicians and Surgeons

Weill Cornell Medical College

New York-Presbyterian Hospital



Dr. Stein obtained his undergraduate degree from Columbia University, and his MD from the Albert Einstein College of Medicine. He then completed a residency in Internal Medicine at Montefiore Hospital in the Bronx, followed by a residency in Physical Medicine and Rehabilitation at NewYork Presbyterian Hospital. He was on the staff of Spaulding Rehabilitation Hospital in Boston, MA from 1992-2008, and served as Chief Medical Officer of Spaulding from 2000-8. Since 2008 he has served as the Simon Baruch Professor and Chair of the Department of Rehabilitation and Regenerative Medicine at the Columbia University College of Physicians and Surgeons, Professor and Chief of the Division of Rehabilitation medicine at Weill Cornell Medical College, and Physiatrist-in-Chief at NewYork-Presbyterian Hospital. Dr. Stein's primary clinical and research interests are in the area of stroke rehabilitation, with a particular focus on the use of robotic and other technologies to facilitate recovery after stroke. He has numerous

publications in the area of stroke rehabilitation, including scientific papers, review articles, and book chapters. Dr. Stein has authored/co-authored two books on stroke for the lay public, and has served as an editor of a comprehensive medical textbook on the subject entitled "Stroke Recovery and Rehabilitation."

## **Elizabeth C. Tyler-Kabara, MD, PhD**

University of Pittsburgh

Dr. Elizabeth Tyler-Kabara is a Case Member at the McGowan Institute of Regenerative Medicine and an Assistant Professor in the Department of Neurological Surgery at the University of Pittsburgh. She holds a Bachelor's Degree in biomedical and electrical engineering from Duke University, where she graduated cum laude. After completing her undergraduate studies, she earned both her MD and PhD from Vanderbilt University where she graduated in



1997. Following medical school Dr. Tyler-Kabara first arrived at the University of Pittsburgh where she completed her internship in General Surgery.

Dr. Tyler-Kabara is a member of several professional organizations including the American Association of Neurological Surgeons, American Medical Associations and Congress of Neurological Surgeons. At the present time, Dr. Tyler-Kabara is pursuing clinical interests in restorative neurosurgery with a focus on applications in pediatric patients. However, she has been featured in several publications for her work in blending her clinical interests with research in the field of neuronal microelectrode interfaces and synaptic connectivity of neuronal transplants.

Currently, Dr. Tyler-Kabara is conducting research in funded by a grant from the Walter L. Copeland Fund of The Pittsburgh Foundation. As part of this research, she is working to further characterize adult derived stem cells being used by others in the laboratory for potential treatments for demyelinating diseases and brain tumors. This process has included comparisons with primary neuronal cultures. Additionally, in collaboration with Drs Kondziolka, Marion, Dixon, and Gobbel, she is launching a large study, funded by the Margot Anderson Foundation and the Walter L. Copeland Fund of The Pittsburgh Foundation, to compare adult derived stem cells and bone marrow stromal cells in the treatment of traumatic brain injury.

### **Katherine Verdolini Abbott, PhD**

University of Pittsburgh

Dr. Verdolini Abbott received her M.S. degree in Speech and Hearing Sciences from Indiana University in 1983, and her Ph.D. in Experimental Psychology—Cognitive Science from Washington University in St. Louis in 1991. Before coming to the Department of Communication Science and Disorders at the University of Pittsburgh in 2001, she held academic appointments in the Departments of Speech and Hearing, and Music, at the University of Iowa, and in the Department of Otolaryngology at Harvard Medical School, where she was also Director of Speech Pathology at Brigham and Women's Hospital and Beth Israel Deaconess Medical Center. She has received numerous research funding awards as Principal Investigator and Co-Investigator from the National Institute on Deafness and Other Communication Disorders. Her research interests pertain to voice and voice disorders.



Specific interests have included effects of hydration and dehydration on laryngeal performance, the biomechanics of phonation, pathways and mechanisms mediating relations between emotions and vocal performance, and effects of tissue mobilization on acute and chronic stages of vocal fold wound healing. In this last domain, her most recent funded efforts have involved an aim to integrate physical and biological models of vocal fold wound healing, and computational modeling. She is a member of the American Speech-Language-Hearing Association, from whom she received highest Honors in 2009, and of the Lessac Training and Research Institute, for which she is Executive Board Member. She is past Editor for Speech for the Journal of Speech, Language and Hearing Research, and standing member of several NIH study sections.

### **Yoram Vodovotz, PhD**

University of Pittsburgh

Dr. Yoram Vodovotz is the Director of the Center for Inflammation and Regenerative Modeling. He is also a Professor of Surgery, Immunology, Computational and Systems Biology, Clinical and Translational Science, and Communication Science and Disorders at the University of Pittsburgh. Dr. Vodovotz's research interests include the biology of acute inflammation in shock states (e.g. septic and hemorrhagic shock) as well as in chronic diseases and wound healing. He is also interested in the cross-regulation of the inducible nitric oxide synthase and the cytokine transforming growth factor- $\beta$ 1 in various disease states, including malaria infection, cancer, sepsis, and neurodegenerative diseases. His main

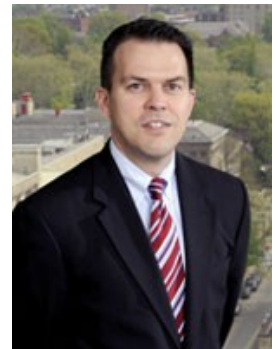


current area of interest revolves around the use of mathematical modeling to unify and gain insight into the plethora of biological interactions that characterize these inflammatory conditions. As the Director of the Center for Inflammation and Regenerative Modeling at the McGowan Institute for Regenerative Medicine, he has been involved in the mathematical modeling of acute inflammatory states (e.g. septic or hemorrhagic shock, wound healing), including cellular and physiological elements, as part of a large, interdisciplinary collaborative team. He is also a co-founder of Immunetrics, Inc., which is commercializing aspects of this work. He has published over 140 manuscripts, and is funded by the National Institutes of Health, National Institute for Disability Rehabilitation Research, the Pittsburgh Tissue Engineering Initiative, and the Commonwealth of Pennsylvania.

## **William Wagner, PhD**

### **University of Pittsburgh**

Dr. William R. Wagner is the Director of the McGowan Institute for Regenerative Medicine as well as a Professor of Surgery, Bioengineering and Chemical Engineering at the University of Pittsburgh. He also serves as the Director of Thrombosis Research for the Artificial Heart and Lung Program, and Deputy Director of the NSF Engineering Research Center on "Revolutionizing Metallic Biomaterials". He holds a B.S. (Johns Hopkins Univ.) and Ph.D. (Univ. of Texas) in Chemical Engineering. Dr. Wagner is the Coordinator for the Cellular and Organ Engineering track for Bioengineering graduate students, and currently teaches in the areas of biomaterials and tissue engineering.



Professor Wagner is the Founding Editor and Editor-in-Chief of one of the leading biomaterials journals, "Acta Biomaterialia", and currently serves on the editorial boards of the "Journal of Biomedical Materials Research part A", "Biotechnology and Bioengineering", and the "Journal of Tissue Engineering and Regenerative Medicine". Dr. Wagner is also a past president of the American Society for Artificial Internal Organs (ASAIO; 2010-2011) and serves on the Executive Board of the International Federation of Artificial Organs (IFAO). He is a fellow and former vice president of the American Institute for Medical and Biological Engineering (AIMBE; 2000) and has also been elected a fellow of the Biomedical Engineering Society (2007), the International Union of Societies for Biomaterials Science and Engineering (2008) and the American Heart Association (2001). He has served as Chairman for the Gordon Research Conference on Biomaterials: Biocompatibility & Tissue Engineering as well as for the First World Congress of the Tissue Engineering and Regenerative Medicine International Society (TERMIS). In 2006 he was selected to the "Scientific American 50", the magazine's annual list recognizing leaders in science and technology from the research, business and policy fields. In 2011 he was awarded the Society for Biomaterials Clemson Award for Applied Research. He has served on numerous NIH and NSF study sections, is a member of the NIH College of Reviewers, and has been a member of external review committees for national and international organizations focused on bioengineering and regenerative medicine. His research has generated numerous patents and patent filings that have resulted in licensing activity, the formation of a company, and University of Pittsburgh Innovator Awards in 2007, 2008, 2009 and 2010.

Dr. Wagner's research interests are generally in the area of cardiovascular engineering with projects that address medical device biocompatibility and design, tissue engineering, and targeted imaging. His research group is comprised of graduate students in Bioengineering and Chemical Engineering as well as post-doctoral fellows with backgrounds in surgery, polymer chemistry, or engineering. Dr. Wagner and his group enjoy working across the spectrum from in vitro to clinical studies. The McGowan Institute and the University of Pittsburgh Medical Center are uniquely positioned to allow such broad-based projects to flourish and complement one another. Researchers within Dr. Wagner's group are afforded the opportunity to observe first-hand the clinical successes and failures of currently employed cardiovascular devices while concurrently working on projects that attempt to describe the current modes of failure, test solutions for the current device shortcomings, or develop technologies that may find application as future cardiovascular therapies. The front-line experience afforded by the clinical environment has proven invaluable in the learning experience of group members, not to mention the input such experience has on the creative environment.

**James H-C. Wang, PhD**  
University of Pittsburgh



Dr. James H-C. Wang is an Associate Professor and Director of the MechanoBiology Laboratory within the Department of Orthopaedic Surgery at the University of Pittsburgh.

Dr. Wang received his BS degree in Solid Mechanics and his M.S. degree in Biomechanics from Tongji University in Shanghai, China. He came to the USA in 1991 to attend the University of Cincinnati, where he received his Ph.D. in Bioengineering in 1996. After fellowships at Texas University Health Science Center in El Paso, Texas, Johns Hopkins Medical School and Washington University in St Louis, Dr. Wang joined the University of Pittsburgh and the MSRC in 1999.

Due to his research efforts, Dr. Wang has been featured in several publications and was the recipient of the Hulda Irene Duggan Arthritis Investigator Award by the Arthritis Foundation in 2001. Primarily, his research is in the area of cellular and tissue mechanobiology. He is specifically interested in studying cellular biological responses and extracellular matrix remodeling under repetitive mechanical loading, and improving the biological, biochemical and biomechanical properties of the healing tendon and ligament with functional tissue engineering. In addition, he is interested in probing and controlling individual cellular phenotype expression with MEMS technology. Currently, through funding by the National Institute of Health (NIH), the Arthritis Foundation and the Whitaker Foundation, Dr. Wang is directing several projects including:

- A multidisciplinary study of the pathophysiology of tendinitis
- Microarray (Gene-Chip) analysis of differential gene expression in human tendon fibroblasts subjected to cyclic mechanical stretching
- Regulation of tendon fibroblasts contraction to enhance biological, biochemical and biomechanical properties of the healing tendon
- Application of cellular force monitor to studying extracellular matrix remodeling by mechanical forces
- The effects of cell organization on biochemical compositions of extracellular matrix

**Thomas J. Walters, PhD**  
United States Army Institute of Surgical Research

Thomas J. Walters, PhD joined the US Army Institute of Surgical Research in San Antonio, TX to start a program focused on combat related muscle trauma in 2000. As part of the Institutes Extremity Trauma and Regenerative Medicine Research Program his research focus is aimed at applying tissue engineering and regenerative medicine approaches to improve muscle healing with the goal of improving limb salvage following extremity trauma. With a background in exercise physiology and muscle plasticity, he is keenly aware of the role of altered activity on the properties of skeletal muscle. Based on this background, He has sought to promote a better understanding of the synergy between physical activity and regenerative medicine through a program of animal research and clinical research with his colleagues at the Brooke Army Medical Center Department of Orthopaedics and Rehabilitation and the Center for the Intrepid.



Dr. Walters received a Bachelor of Arts from SUNY Geneseo in 1979 and a MS and PhD from University of Texas at Austin in 1986 and 1989, respectively. Skeletal muscle plasticity and aging was his main areas of research while in graduate school. He was a post doctoral fellow at the School of Aerospace Medicine at Brooks AFB where his research focused on thermal stress. He continued this research focus as a staff scientist in at Brooks AFB until returning to muscle physiology when he joined the US Army Institute of Surgical Research in 2000.

**Steve L. Wolf, PhD, PT, FAPTA, FAHA**  
Emory University School of Medicine

Steve received his AB in Biology from Clark University, his physical therapy certificate from Columbia University, MS in physical therapy from Boston University and his Ph.D. in neurophysiology from Emory University. He has defined the selection criteria for the application of EMG biofeedback to restore upper extremity function among chronic patients with stroke. These findings became the inclusion criteria for most constraint induced movement therapy stroke studies. He recently completed his role as Principal Investigator for the NIH nationally funded EXCITE Trial, the first multi-center Phase III non-surgical, non-pharmacological, upper extremity stroke rehabilitation study ever funded by the NIH. Steve's interests in feedback also led to the comparison of center of pressure biofeedback



with Tai Chi for falls reduction in older adults. He has over 200 publications and 700 national and international presentations on these topics. He has served in multiple administrative and leadership capacities for the American Physical Therapy Association and for groups associated with the promotion of research and clinical service within neurorehabilitation. He is the recipient of the Marian Williams Award for Research Golden Pen Award, Georgia Merit Award, Physical Therapy Association of Georgia; Catherine Worthingham Fellowship; Robert C. Bartlett Recognition Award, Foundation for Physical Therapy; Distinguished Service Award, Section on Clinical Electrophysiology; Helen J. Hislop Award for Excellence in Contributions to Professional Literature; Lucy Blair Service Award; Section on Geriatrics outstanding published paper award; Neurology Section, Outstanding Researcher Award; Mary McMillan Lecturer. He has been a keynote speaker for many organizations and as a commencement speaker for several institutions and has served on several study sections and advisory boards for the NIH.



## Faculty Disclosure

Faculty for this activity have been required to disclose all relationships with any proprietary entity producing health care goods or services, with the exemption of non-profit or government organizations and non-health related companies.

No relevant financial relationships with commercial entities were disclosed by:

- ◆ Fabrisia Ambrosio, PhD, MPT
- ◆ Ravi V. Bellamkonda, PhD
- ◆ George J. Christ, PhD
- ◆ Anthony Delitto, PhD, PT, FAPTA
- ◆ David D. Fuller, PhD
- ◆ John Dudley Malone, MD, MPH
- ◆ Kacey Marra, PhD
- ◆ Paul F. Pasquina, MD
- ◆ Thomas A. Rando, MD, PhD
- ◆ Paul J. Reier, PhD
- ◆ Heather H. Ross, PhD, MPT
- ◆ Andrew B. Schwartz, PhD
- ◆ Richard K. Shields, PT, PhD, FAPTA
- ◆ Barbara K. Smith, PhD, PT
- ◆ Thomas J. Walters, PhD
- ◆ William Wagner, PhD
- ◆ James Wang, PhD
- ◆ Steven L. Wolf, PhD, PT, FAPTA, FAHA

The following information was disclosed:

Stephen F. Badylak, DVM, PhD, MD  
Grant/Research Support: NellOne, CR Bard

Michael Boninger, MD  
Consultant: On DSMB for StemCell, Inc.

S. Thomas Carmichael, MD, PhD  
Grant/Research Support: Biotime Inc.  
Consultant: Biogen Idec

Albert Donnenberg, PhD  
Consultant: Beckman Coulter Scientific  
Advisory Board

Geoffrey C. Gurtner, MD, FACS  
Consultant: KCI  
Stockholder: Neodyne Biosciences, Tautona Group

Scott Rodeo, MD  
Stockholder: Cayanne Medical

Gwendolyn Sowa, MD, PhD  
Other: Speaker honorarium: Cytonics

Joel Stein, MD  
Grant/Research Support: Tibion, Inc.,  
Tyromotion, Inc., Myomo, Inc.

Elizabeth C. Tyler-Kabara, MD, PhD  
Grant/Research Support: DARPA, NINDS

Katherine Verdolini Abbott, PhD  
Consultant: Multi-voice Dimensions

Yoram Vodovotz, PhD  
Stockholder: Immunetrics, Inc.

## Disclaimer Statement

The information presented at this CME program represents the views and opinions of the individual presenters, and does not constitute the opinion or endorsement of, or promotion by, the UPMC Center for Continuing Education in the Health Sciences, UPMC / University of Pittsburgh Medical Center or Affiliates and University of Pittsburgh School of Medicine. Reasonable efforts have been taken intending for educational subject matter to be presented in a balanced, unbiased fashion and in compliance with regulatory requirements. However, each program attendee must always use his/her own personal and professional judgment when considering further application of this information, particularly as it may relate to patient diagnostic or treatment decisions including, without limitation, FDA approved uses and any off-label uses.



## Exhibitors

We gratefully acknowledge support from the following to support this activity:

### ASTYM Treatment

[astym.com](http://astym.com)

### McGowan Institute for Regenerative Medicine

[www.mcgowan.pitt.edu](http://www.mcgowan.pitt.edu)

### University of Pittsburgh Department of Physical Medicine & Rehabilitation

[www.rehabmedicine.pitt.edu](http://www.rehabmedicine.pitt.edu)

---

## Travel Awards

Thanks to the generous support by the Eunice Kennedy Shriver National Institute of Child Health and Human Development, the National Institute of Neurological Disorders and Stroke and the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health, we were able to provide travel grants to a total of 20 attendees.

The grant was intended to provide opportunities for graduate students, medical fellows and residents, post-doctoral fellows, rehabilitation clinicians, and junior investigators to participate in the Second Annual Symposium on Regenerative Rehabilitation, to be held in Pittsburgh on Nov 12-13, 2012.

Congratulations to all of our recipients!




## Travel Award Recipients

### Domestic Awardees



<p><b>Lindsey Anderson</b> University of Southern California, Los Angeles, CA</p>	
<p><b>Julie Barnett</b> University of Texas Health Science Center of San Antonio School of Health Professions</p>	
<p><b>Jignasha Chaudhari</b> Northern Illinois University</p>	
<p><b>Heth Chikani</b> Northern Illinois University</p>	
<p><b>Yoonsu Choi</b> Georgia Institute of Technology, Atlanta GA Department of Biomedical Engineering</p>	
<p><b>Ting-Hsien (Tom) Chuang</b> University of California, San Diego Dept. of Orthopaedic Surgery</p>	

<p><b>Matthew Criscuolo, PT, CKTP</b> United Care Medical, PLLC at The Bay Street Medical Pavilion</p>	
<p><b>Garrett Fitzpatrick</b> University of Florida Gainesville, FL</p>	
<p><b>Emily Friedrich</b> US Army Institute for Surgical Research</p>	
<p><b>Andrew Harris Gordon, MD, PhD</b> The Johns Hopkins Hospital</p>	
<p><b>Sarah Greenhagen</b> Northern Illinois University '13</p>	
<p><b>Min H. Huang, PT, PhD, NCS</b> Physical Therapy Department University of Michigan-Flint</p>	
<p><b>William Henry Jones III</b> Georgia State University</p>	
<p><b>Kristina Kalyan</b> University at Buffalo Buffalo, NY</p>	

<p><b>Leanne Chandler Olsen</b> RehabCare Brunswick, ME</p>	
<p><b>Dale Perdue</b> Bluegrass Community &amp; Technical College</p>	
<p><b>Laura Elizabeth Stanley</b> Proaxis Therapy Greenville, SC</p>	

## International Awardees



<p><b>Camila Basile Carballo</b> Federal University of Rio de Janeiro, UFRJ Rio de Janeiro, Brazil</p>	
<p><b>Ana Claudia Mattiello-Sverzut</b> University of São Paulo, Ribeirão Preto São Paulo, Brazil</p>	
<p><b>Gisane Faria Novaes</b> Municipal Hospital Dr. Waldemar Tebaldi Sao Paulo, Brazil</p>	