

# ADVANCES IN REHABILITATION MEDICINE



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## Columbia RunLab: Optimizing Performance and Preventing Injury

There's more to running than meets the eye, as runners are finding out at Columbia RunLab, a center for biomechanical running analysis at NewYork-Presbyterian/Columbia University Medical Center. The Columbia RunLab offers high-level personalized evaluation and education to runners of all levels and experience to optimize their performance and prevent injury.

"Runners usually come into my office with some kind of joint or muscle pain," says **Christopher J. Visco, MD**, Ursula Corning Associate Professor, and Vice Chair of Education in the Department of Rehabilitation and Regenerative Medicine. "At the core of why they're developing these issues is an abnormality of their biomechanics – the way they run. Whether they have just started running or have been running for a long time, the likelihood of developing an injury increases dramatically if they've got poor running biomechanics."

**"Patients today are more interested in pushing the boundaries of what is possible. In many ways it requires the most finely tuned system to do that in terms of both diet and nutrition, as well as the actual body mechanics."**

— Dr. Christopher J. Visco

"From the physician's standpoint, if we correct whatever is going on – whether it be a tendon or a muscle problem – that's only as good as we can get medically," adds Dr. Visco. "We need the other piece, which is training in a way that the runner can actually improve those underlying issues as well. That's where the Columbia RunLab is an invaluable resource for our patients."

Dr. Visco cites other critical elements that must be in balance in order to prevent injuries. "We need to know all the pieces to the puzzle. What is their



*Dr. Christopher J. Visco and Dr. Colleen M. Brough*

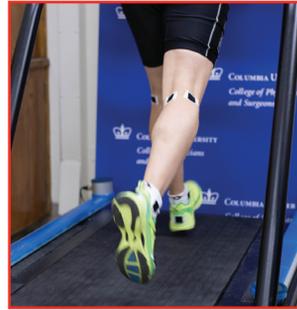
nutrition like? Do they have stressors? We ask about sleep. You can train at a very high level, but if this is accompanied by an appropriate diet, time away from stress, and enough sleep, runners are more likely to remain injury-free."

Opened in October 2016, Columbia RunLab was developed by its Founder and Director, **Colleen M. Brough, PT, DPT, MS, OCS**, a board certified orthopedic clinical specialist in physical therapy in the Department of Rehabilitation and Regenerative Medicine at NewYork-Presbyterian/Columbia. An expert in orthopedic physical therapy, sports injury prevention, and screening, Dr. Brough has spent more than 15 years as a physical therapist in the global running community working with elite athletes, as well as novices, and is herself an avid runner.

"We created the RunLab with several goals in mind," says Dr. Brough. "One is to provide a personalized medicine experience specifically for running athletes who want to improve their performance or who want to manage or prevent an injury. It's a very intimate and dynamic experience focusing on education and clinical excellence."

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## Columbia RunLab: Optimizing Performance and Preventing Injury (continued from page 1)



A component of Columbia University’s Doctoral Degree Program of Physical Therapy, the RunLab fosters student development, with doctoral candidates participating in all aspects of the program. “One of our primary goals was to offer our doctoral students a chance to develop their skills in a clinical teaching and learning environment,” says Dr. Brough, who is also an Assistant Professor of Rehabilitation and Regenerative Medicine in Columbia University’s Program in Physical Therapy and Co-Director of Clinical Education.

**“We created the RunLab to provide a personalized medicine experience specifically for running athletes who want to improve their performance or who want to manage or prevent an injury.”**

**— Dr. Colleen M. Brough**

The Columbia RunLab also works with underprivileged and special needs running groups throughout the community. “We are proud to offer pro bono running analyses to those who use running in a meaningful way, for example, the Wounded Warrior Project,” says Dr. Brough. “Many of our veterans use endurance running to manage PTSD symptoms. The Achilles Group, which offers running coaches to individuals who are severely disabled to help them cross the finish line, is also among the organizations we plan to work with.”

### The RunLab Experience

The RunLab uses state-of-the-art technology to collect information about running mechanics, including stride length, step length, cadence, and foot strike. Four runners at a time participate in an analysis session. “In the first half of the program, each runner moves through different examination stations,” says Dr. Brough. “We assess foot and ankle mechanics and examine specific strength and flexibility using the FMS – functional movement screen – made famous by the NFL for preseason screening. We also use 2D video analysis to gather running metrics and spatial temporal parameter data in real time.”

The second half of the program involves a roundtable discussion. “This is where the magic happens,” says Dr. Brough, who along with the doctoral students who conducted the examinations, physicians who may have observed the session, and the four runners gather together to view each runner’s video projected on a large screen.

“The physical therapists describe in real time the mechanics of the participant’s running form and how that relates to the physical exam performed,” says Dr. Brough. “Most importantly, we discuss

how this relates in the context of research. What does the literature suggest is relevant?”

Runners have been very engaged, says Dr. Brough. “They’re learning in the moment and also learning about the other runners they’re seeing on video. By the end of the evening everyone has this common language and a good grasp of what the research suggests is important in terms of injury and performance.”

Dr. Brough categorizes runners into two types. “First, the ‘overstriders.’ When their foot first hits the ground we’re looking for the contact angle, how bent the foot is, and if they’re landing relatively foot-flat. How bent is their knee? They also should land like a spring – not stiff as a board. How far forward is that foot from their center of gravity? Are they reaching very far out with their heel, or is their foot landing under their body? If you incorporate these elements into a run you can minimize the impact that the lower extremity experiences. This is significant in the context of injury prevention, but also very important in the context of boney stress injuries.”

### Running Injury Patterns

Overstriders	Medial Collapsers
Increased vertical displacement	Pelvic drop and increased hip adduction angle
Decreased step rate / cadence	Crossover
Decreased knee flexion at initial contact	Trunk lean
Increased contact angle	Asymmetrical arm swing with abduction
Foot placement forward of center of mass	Dynamic knee valgus

Source: *Current Concepts in Running Analysis: An Evidence-Led Approach*, Colleen M. Brough, PT, DPT, MS, OCS, Columbia RunLab

“As the foot of a ‘medial collapser’ hits the ground and they start to load the limb, we often see a drifting in of the knee toward midline, a drop of the pelvis, or a lean of the trunk,” explains Dr. Brough. “These very specific pathomechanics, namely dynamic knee valgus and pelvic drop, have been linked to injuries and are commonly associated with weakness or poor recruitment of the gluteus maximus, the gluteus medius, and the deep core muscles. Running is a series of standing on one leg and then the other. You never have two feet on the ground at the same time, and when it comes to injury, everything is revealed when the runner loads the leg and moves into mid-stance.”

*(continued on page 3)*

## Research Update: Rehabilitation Robotics in Cerebral Palsy

A research team led by **Sunil K. Agrawal, PhD**, Professor of Mechanical Engineering and Rehabilitation/Regenerative Medicine, Columbia University, has shown that a robot-driven device – Tethered Pelvic Assist Device (TPAD) – created by the Robotics and Rehabilitation (ROAR) Laboratory at Columbia University helps strengthen muscles and improve coordination in children with cerebral palsy. The device is able to apply desired forces and moments on the pelvis in any direction of the space. The pilot study has been published in the July 26, 2017 issue of *Science Robotics*.

A subset of children with cerebral palsy exhibit crouch gait, which is caused by a combination of weak extensor muscles that do not produce adequate forces to keep posture upright, coupled with tight flexor muscles that limit the joint range of motion. In particular, the soleus muscle plays an important role in preventing knee collapse during the middle of the stance phase when the foot is on the ground. Critical to standing and walking, the soleus muscle keeps the shank upright during the mid-stance phase of the gait to facilitate extension of the knee. It also provides propulsive forces on the body during the late-stance phase of the gait cycle.

“One of the major reasons for crouch gait is weakness in the soleus muscles,” says Dr. Agrawal. “We hypothesized that walking with a downward pelvic pull would strengthen extensor muscles, especially the soleus, against the applied downward pull and would improve muscle coordination during walking. We took an approach opposite to conventional therapy with these children. Instead of partial body weight suspension during treadmill walking, we trained participants to walk with a force augmentation.”

The researchers evaluated six children diagnosed with CP who exhibit crouch gait during 15 brief training sessions over a six-week period. The children wore the TPAD belt as they walked on the



Dr. Sunil K. Agrawal

treadmill, while cameras captured real-time motion data. The researchers programmed the TPAD to apply an additional downward force through the center of the pelvis to intensively retrain the activity of the soleus muscles.

“TPAD is a unique device because it applies external forces on the human body during walking,” says **Jiyeon Kang**, PhD candidate and lead author of the paper. “The training with this device is distinctive because it does not add mass/inertia to the human body during walking.”

The researchers found that their training was effective, enhancing both the children’s upright posture and improving their muscle coordination. In addition, their walking features, including step length, range of motion of the lower limb angles, toe clearance, and heel-to-toe pattern, improved.

“Feedback from the parents and children involved in this study was consistent,” says **Heakyung Kim, MD**, A. David Gurewitsch Professor, and Director, Pediatric Physical Medicine and Rehabilitation, NewYork-Presbyterian. “They reported improved posture, stronger legs, and faster walking speed, and our measurements bear that out. We think that our robotic TPAD training with downward pelvic pull could be a very promising intervention for these children.”

(Source: *Columbia Engineering*, adapted from an article by Holly Everts)

### Reference Article

Kang J, Martelli D, Vashista V, Martinez-Hernandez I, Kim H, Agrawal SK. Robot-driven downward pelvic pull to improve crouch gait in children with cerebral palsy. *Science Robotics*. 26 Jul 2017; Vol. 2, Issue 8, eaan2634.

### For More Information

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## Columbia RunLab: Optimizing Performance and Preventing Injury (continued from page 2)

“In a cohort of runners,” notes Dr. Brough, “you will find high rates of hamstring strain, Achilles tendinitis, plantar fasciitis, hip flexor strain or hip flexor tendinitis, or patella femoral pain syndrome. It doesn’t matter where the actual pain location is. All of these runners seem to have the same common presentation. That’s what we look for when we videotape them.”

**“The Columbia RunLab helps to prevent injuries by identifying early on what might predispose runners to developing back, foot, ankle, or knee pain because of their running style.”**

— Dr. Anna-Christina Bevelaqua

**Anna-Christina Bevelaqua, MD**, a Columbia physiatrist who specializes in sports medicine, often refers her patients to the RunLab for analysis if they are concerned about their gait or if they

have sustained injuries. “I was very excited when Colleen brought this program to Columbia,” says Dr. Bevelaqua. “The RunLab helps to prevent injuries by identifying early on what might predispose runners to developing back, foot, ankle, or knee pain because of their running style.”

Dr. Bevelaqua notes that while many runners are athletic and strong, they often have no gluteal strength or very poor core strength. “Sometimes running doesn’t affect all of the muscles that you need to strengthen to prevent injury,” says Dr. Bevelaqua, who encourages runners to cross-train to build strength in other muscles. “The RunLab is a way to identify those weaknesses early on so that the runner can correct those deficits and, hopefully, have an injury-free running career.”

### For More Information

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## Affiliations Broaden Residency Training Experience

NewYork-Presbyterian's comprehensive rehabilitation medicine residency training programs are further enhanced by the diverse training opportunities offered at our highly regarded affiliated hospitals: Memorial Sloan Kettering Cancer Center, Hospital for Special Surgery, Bronx VA Hospital, Helen Hayes Hospital, and Blythedale Children's Hospital.

"Educationally, our residency and fellowship programs continue to compete effectively for the most qualified applicants and provide exceptional clinical training," says **Joel Stein, MD**, Psychiatrist-in-Chief, NewYork-Presbyterian. "We are proud of our rigorous training programs, which have a diverse and broad curriculum that dives deep into all areas of physical medicine and rehabilitation and is further strengthened by the varied inpatient and outpatient experiences at our affiliates."

### Memorial Sloan Kettering Cancer Center



*Dr. Theresa A. Gillis*

"The relationship with NewYork-Presbyterian is long-standing and has been very fruitful," says **Theresa A. Gillis, MD**, Chief, Rehabilitation Medicine Service, Memorial Sloan Kettering Cancer Center and Associate Professor of Clinical Rehabilitation Medicine, Weill Cornell Medicine. "We have two residents at any given time from NewYork-Presbyterian, one senior and another more junior, who are at different levels of their learning, sophistication, and understanding of the field."

Through the affiliation with Memorial Sloan Kettering,

NewYork-Presbyterian's residents are exposed to rehabilitation principles for individuals with cancer who are in the midst of their treatment, as well as cancer survivors, including some long-term survivors who are dealing with the aftereffects of their treatment.

"Oncologists help patients survive, but we can help patients thrive," says Dr. Gillis. "Our patients have fluctuating needs and impairments over time. Some are dealing with very sudden declines in function and uncertainty about their prognosis. We need to define in concert with the patients what are achievable goals in that setting. Survivors may experience a tremendous amount of anxiety if they develop a new symptom. We assist in diagnosing what is actually occurring, differentiating the aches and pains that can develop in any of us as we age, versus tumor recurrence or treatment sequelae. Our goal is to facilitate their recovery through physical therapy, medications, and lifestyle changes and guide them as they transition to their 'new normal.'"

The first-year six-week rehabilitation medicine residency rotation at Memorial Sloan Kettering Cancer Center provides outpatient experience with adult patients with neurological and musculoskeletal side effects of cancer and its treatment; the second-year rotation focuses on electrodiagnostics in addition to outpatient management.

"Dr. Stein and I are of the same mind in that we want the field of rehabilitation medicine to advance and to improve patient access to skilled rehabilitation physicians and therapists," continues Dr. Gillis. "Rehabilitation medicine is such a young field, and it is certainly the case that we do not yet have an adequate population of physicians and therapists with this skill set. The specialty needs to grow and it is in everyone's interest to have physicians educated and proficient."

### Hospital for Special Surgery

NewYork-Presbyterian's second- and third-year rehabilitation medicine residents rotate through Hospital for Special Surgery (HSS), an orthopedic specialty hospital with additional services in rheumatology and neurology. HSS is located adjacent to NewYork-Presbyterian/Weill Cornell Medical Center, and the two institutions have long had a collaborative clinical, research, and academic relationship.

Residents who rotate through the Department of Psychiatry are able to build skills and knowledge of the indications and techniques for advanced

physiatric care of musculoskeletal injuries. "I think a major benefit of an HSS resident rotation is the incredible number of clinicians all focused around nonsurgical, musculoskeletal care," says **Joel Press, MD**, who was appointed Psychiatrist-in-Chief at HSS in September 2016 and Professor of Clinical Rehabilitation Medicine at Weill Cornell Medicine. Dr. Press oversees a department of 17 psychiatrists and four fellows. "The residents' exposure to such a vast range of musculoskeletal disorders cannot be underestimated. There is interaction with the orthopedic surgeons throughout the rotation, including interdisciplinary teaching conferences. Our grand rounds are open to everyone from the Weill Cornell campus and vice versa. In addition to the numerous educational exchanges, there is a growing number of research opportunities."

NewYork-Presbyterian residents gain experience in sports injuries, lumbar and cervical spine disorders and related interventional treatments, and hip preservation, and they participate in specialty clinics focused on sports medicine, spine, pediatric cerebral palsy, and scoliosis. They are also exposed to outpatient care and electrodiagnostics, which are supervised by an attending psychiatrist with expertise in musculoskeletal and sports injuries.

Dr. Press hails from the Rehabilitation Institute of Chicago, where he served as Medical Director of its Spine and Sports Rehabilitation Center. "Rehabilitation medicine is a small specialty and a lot of us know each other," says Dr. Press, who, in fact, trained **Christopher J. Visco, MD**, now Residency Program Director and the Sports Medicine Fellowship Director for the Department of Rehabilitation and Regenerative Medicine at Columbia. "Working with Chris Visco and Joel Stein, colleagues who I've known for many years, and participating in the training of residents in their great program, is an added bonus to my role at HSS."



*Dr. Joel Press*

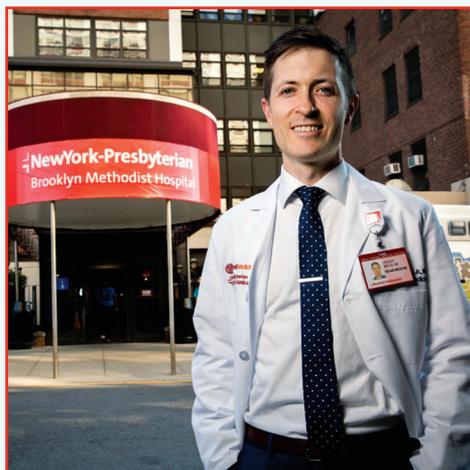
## A Focus on Faculty: Highlighting a Range of Expertise

### Vincent F. Miccio, Jr., MD

Reading *A World to Care for: The Autobiography of Howard A. Rusk, MD*, during medical school was pivotal for Vincent F. Miccio, Jr., MD. “Dr. Rusk was considered the father of rehabilitation medicine,” says Dr. Miccio, a physiatrist who joined the Department of Rehabilitation Medicine at NewYork-Presbyterian/Weill Cornell Medical Center in August 2017. “The book was quite inspiring and pushed me to explore rehabilitation as a medical student. I found the specialty to be a hidden gem.”

After earning his medical degree at the University of Massachusetts Medical School, Dr. Miccio completed a residency in physical medicine and rehabilitation at NewYork-Presbyterian. There he served as Educational Chief Resident. He then went on to complete a fellowship in pain medicine at NewYork-Presbyterian/Columbia University Medical Center.

“I am a specialist in interventional pain medicine, but first and foremost, I am a rehabilitation physician,” says Dr. Miccio. “Just five years ago most physicians would be treating chronic pain with opioids. Today we are taking a multimodal approach with medications that target different receptors, targeted interventions and injections, and also emphasizing psychological support.”



“As the pendulum swings away from opioids, people are looking more into the realm of neuromodulation,” says Dr. Miccio, who also has expertise in neuromodulation therapy. “In the pain world, spinal cord stimulation is becoming more popular. The newest generation of stimulators have very good data and show promise in their ability to help patients who want to avoid using narcotic medications to control chronic pain.”

Dr. Miccio practices at the Weill Cornell Medicine Center for Comprehensive Spine Care, as well as at NewYork-Presbyterian Brooklyn Methodist Hospital, which is opening a new comprehensive spine center this fall. “At Brooklyn Methodist, I’m excited to work with specialists in orthopedic surgery, neurosurgery, neurology, rheumatology, podiatry, and psychiatry,” says Dr. Miccio. “Patients will receive all of the services they need under one roof and, in some cases, on the same day. My goal is to link up with the medical resources that we have in Manhattan without losing that community feel of Brooklyn Methodist.”

#### For More Information

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### Asad R. Siddiqi, DO

Board certified in rehabilitation medicine and primary care sports medicine, Asad R. Siddiqi, DO, specializes in the comprehensive management of acute and chronic sports injuries, concussion care, and injury prevention. “People tend to think about the high level athlete when they think about sports medicine, but there is so much more to the field,” says Dr. Siddiqi, a physiatrist in the Department of Rehabilitation and Regenerative Medicine at NewYork-Presbyterian/Columbia University Medical Center. “My personal philosophy was best expressed by legendary track and field coach, Bill Bowerman, who once said, ‘If you have a body, you are an athlete.’ I apply my skills to help all of my patients optimize not only their function, but their performance as well. Being able to help people maintain a high level of physical activity and mobility throughout their lives is very gratifying to me.”

While attending medical school at A.T. Still University of Health Sciences – School of Osteopathic Medicine in Arizona, Dr. Siddiqi cultivated an interest in sports medicine and functional optimization. During his residency in physical medicine and rehabilitation at New York University Langone’s Rusk Rehabilitation, he provided sideline and training room medical coverage for PSAL/CHSAA football, the New York City and Brooklyn marathons, the 2012 Ironman US Championships,



LIU-Brooklyn Athletics, and St. Joseph’s College athletics. Dr. Siddiqi then pursued a fellowship in primary care sports medicine at the Steadman Hawkins Clinic of the Carolinas at Greenville Health System.

“A large majority of sports injury is nonsurgical in nature,” says Dr. Siddiqi. “I enjoy using all the tools at my disposal – physical therapy, medications, injections, and the expertise of my surgical colleagues – to get them back to living the best life possible. Most importantly, I love the privilege and challenge of joining them on

the road to recovery in my role as a partner, coach, and resource.”

“Training in rehabilitation medicine taught me to look at injury through a functional lens. My sports medicine specialty training has rounded out my understanding of the injury continuum,” adds Dr. Siddiqi. “In our field we see a lot of the late effects of acute musculoskeletal complaints. By the time these individuals come to us, they are asking a question that may not have a simple answer. Whether my patient is a professional athlete or a person who lives for their weekly pickup game at the local recreation center, I just want to help them answer these questions and keep them moving.”

#### For More Information

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**CLINICAL INNOVATIONS**

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NYP OnDemand

OTOLARYNGOLOGY  
Gene Therapy for Hearing Loss