Department of Orthopaedic Surgery

Highlights 2014

UPMC LIFE CHANGING MEDICINE

Contents

Department of Orthopaedic Surgery: Highlighting Translational Research

In its 105th year, the Department of Orthopaedic Surgery continues its mission of providing excellent care for our patients; the best education for our medical students, residents, and fellows; and leading science and clinical research.

In our department, we want to take basic science and translate what we learn into clinical practice as soon as it's feasible, and 2014 was no exception. We have continued to make significant progress in the understanding of bone diseases and ligament injuries, as well as in quality and the use of registry data. From hip preservation to carpal tunnel syndrome to developmental dysplasia of the hip, departmental research ranges from basic science to clinical trials and practice outcomes.

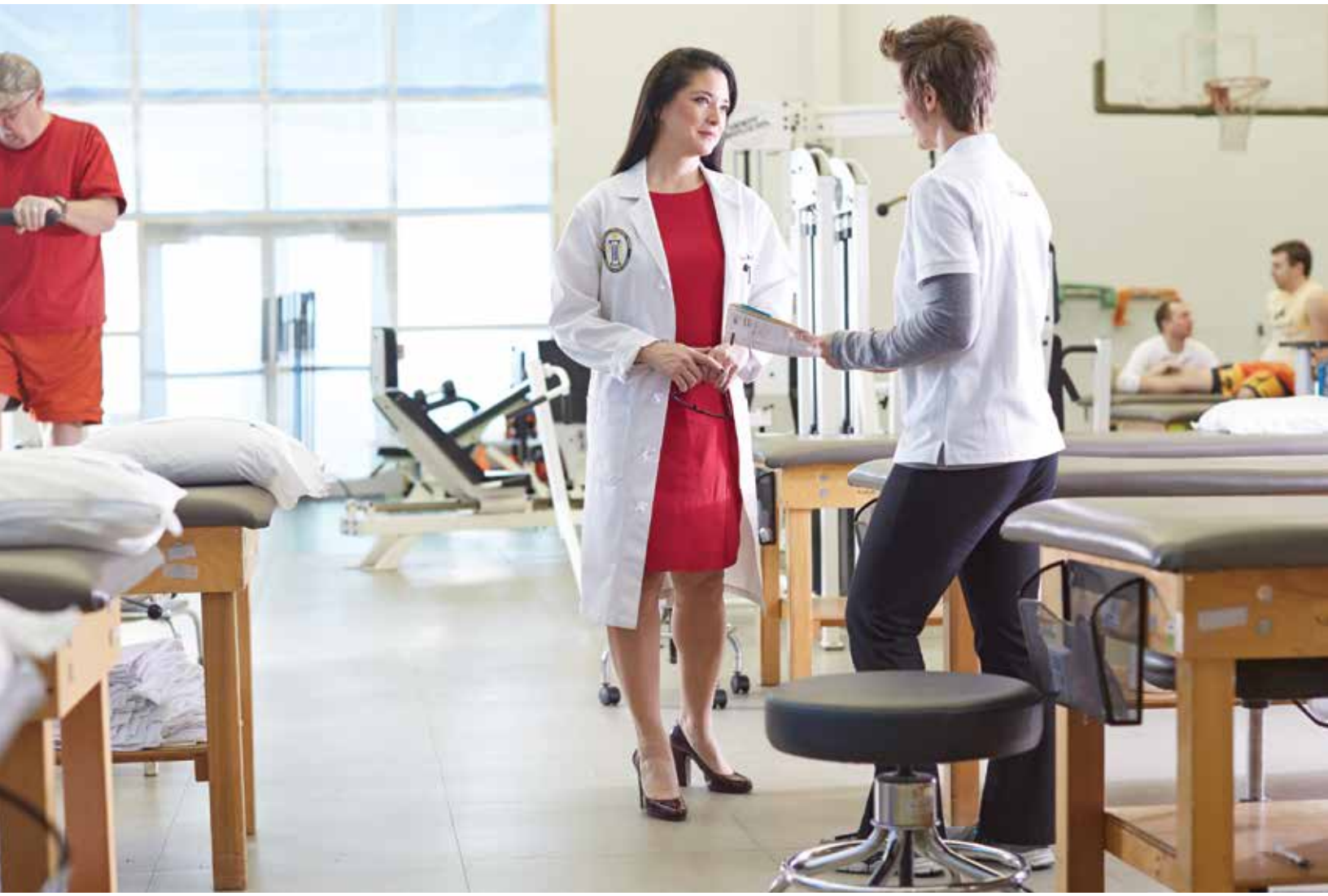
In March of 2014, on behalf of our entire department, I was thrilled to accept the 2014 Kappa Delta Elizabeth Winston Lanier Award at the AAOS and Orthopaedic Research Society annual meetings in New Orleans. The Kappa Delta Awards represent the "Nobel Prize of orthopaedics" and have been awarded to researchers in orthopaedics who have made leading discoveries in the field since 1947. The title of our award was "Anatomic ACL Reconstruction: A Changing Paradigm," and it represents more than a decade of work that has been performed in our department aimed at improving patient outcomes after ACL surgery. This is a prestigious honor that is truly indicative of the multidisciplinary collaboration that occurs at all levels of our department. We dedicate the award to the late Morey Moreland, MD, who spent hundreds of selfless hours helping us on the projects that were instrumental in contributing to the award.

Another important achievement in 2014, also with ties to Dr. Moreland, was the first full year of operation of the Orthopaedic Robotics Laboratory. The lab is a multidisciplinary collaboration, with a mission of preventing degenerative joint disease through improved diagnosis, repair, and rehabilitation procedures for musculoskeletal injuries, using state-of-the-art robotic technology.

One of our most important priorities is to share what we learn with others, so we actively publish, present, and provide education for future orthopaedic surgeons and investigators nationally and internationally through residency, fellowship, and instructional programs. The 16 fellows and 43 residents we have this year join the nearly 700 fellows we've trained from around the world. We are trained, and we train with very high integrity and credibility — the two words we practice by.

Sincerely,

Freddie H. Fu, MD, DSc (Hon.), DPs (Hon.)
Distinguished Service Professor
David Silver Professor and Chairman
Department of Orthopaedic Surgery



Thanks to ongoing innovations in instrumentation, imaging, and surgical techniques, hip arthroscopy has emerged as one of the fastest-growing fields in orthopaedic surgery. Today, it is at the forefront of hip preservation through such applications as the improved diagnosis and treatment of femoral acetabular impingement (FAI).

Vonda Wright, MD, associate professor of orthopaedic surgery, Division of Sports Medicine, and medical director of the UPMC Lemieux Sports Complex

Hip Preservation: Arthroscopic Medicine's New Frontier

Once used primarily for debridement, the minimally invasive techniques used in hip arthroscopy now treat soft tissue injuries, congenital anomalies, and bony malformations that need restructuring. "It represents the greatest advancement for hip preservation techniques in decades," says UPMC orthopaedic surgeon Vonda Wright, MD, who began performing hip arthroscopy in 2007. "We can treat hip injuries that, prior to hip arthroscopy, we previously couldn't treat. By reshaping the bones of the hip, or repairing the soft tissue, we are restoring anatomy and even possibly preventing joint replacement in the future."

When it comes to the overall health of the hip, one of the most important factors is the shape of the bones. When the hip cup is too open or closed — or when the femoral head is too egg-shaped — the result is FAI. "As the oval femoral head comes up and hits the cartilage layer, FAI can actually delaminate the cartilage layer off the bone," says Dr. Wright.

In recent years, a clearer link has been established between FAI and degenerative hip disease — including labral damage and osteoarthritis. "Early detection is critical to prevent serious problems later in life, but FAI is often mistaken for other problems, like back or pelvic pain. It can take months or even years to correctly diagnose," says Dr. Wright. "That kind of delay can be disastrous, leading to end-stage arthritis — even in a 17-year-old."

Cartilage Repair: Thinking "Outside the Box"

Determining the long-term viability of delaminated hip chondral flaps and the best way to fix them is currently a subject under review in hip arthroscopy. "One study looked at whether these flaps have living cells and concluded they were largely dead," says Dr. Wright. "But in our research, we preserved the tissue in a more biologic way and discovered that the flaps were more than 80 percent alive. That insight gave us the green light to focus on preserving that cartilage. If it's alive, we want to figure out how to use the patient's own cartilage to restore native anatomy."

Treating cartilage injuries is one of the most difficult challenges faced in hip arthroscopy. Dr. Wright currently is investigating ways to save and restore cartilage, such as resealing the cartilage flap down to the acetabular with a fibrin sealant, which she first successfully used on two dancers in 2012. Working with researchers at the University of Pittsburgh Stem Cell Research Laboratory, she is now attempting to grow cartilage tissue in the lab with the goal of using a 3D printer to reconstruct a viable piece of cartilage to place into the hip.

"Ultimately, I believe the answer, or solution, to heal many of these conditions will be found in our bodies and in our blood," says Dr. Wright. "We're thinking outside the box to find new techniques that will revolutionize treatment."

Multidisciplinary Care for Orthopaedic Traumas

The Integral Contributions of Sports Medicine to Hip Preservation

Many of the advancements in hip arthroscopy owe a special debt to athletes, whose complex hip injuries and other problems have helped to inform new applications and techniques in the field. Dr. Wright, who is a competitive athlete and the medical director for the new UPMC Lemieux Sports Complex (see page 5), says, "FAI is a common injury in athletes as they push their bodies to perform beyond the norm. But in the past, athletes had few options when there was something structurally wrong, whether the cause was abnormal wear on a joint or a traumatic injury. "This technology is a game changer."

For more than a decade, UPMC Sports Medicine, part of the Department of Orthopaedic Surgery, has helped to pioneer the science and surgical techniques used in arthroscopic hip preservation, with the goal of returning athletes of all ages to their desired activity and mobility levels after an injury or abnormal wear of the hip joint.

Through funding support from a grateful patient — a recreational athlete whose own condition required a total hip replacement — Dr. Wright established the **Hip Preservation Research Program**, which brings together the expertise of UPMC clinicians and scientists at the University of Pittsburgh in the Ferguson Laboratory for Orthopaedic and Spine Research, the McGowan Institute for Regenerative Medicine, the Orthopaedic BioDynamics Laboratory, and the Stem Cell Research Laboratory. "Our research focus includes the analysis of hip tissue pathologies, the study of biomechanics, and the gathering of clinical outcomes and data," says Dr. Wright.

Establishing the Long-Term Value of Hip Arthroscopy

While hip arthroscopy is being used with great results in the short term, its impact over the long term has yet to be established. Currently, Dr. Wright is doing research on hip outcomes over time, using data generated through the **Department of Orthopaedic Surgery Hip Arthroscopy Research Registry**. Patients complete both preoperative and follow-up questionnaires that consist of various historical and demographic questions, as well as recognized hip-specific outcome scales, such as the modified Harris Hip Score (mHHS) and International Hip Outcomes Tool-33 (iHOT-33). Patient responses, and radiographic and clinical findings also are added to the registry. "In addition to its importance for long-term outcomes, we plan to use this information to predict which patients typically report more favorable results following various arthroscopic hip procedures," says Dr. Wright. ■

"Ultimately, I believe the answer, or solution, to heal many of these conditions will be found in our bodies and in our blood. We're thinking outside the box to find new techniques that will revolutionize treatment." **Vonda Wright, MD**

Expanding the Legacy of Elite Sports Medicine: UPMC Lemieux Sports Complex

The UPMC Lemieux Sports Complex, opening summer 2015, is a partnership between UPMC and the Pittsburgh Penguins®. This 185,000-square-foot facility will serve as a comprehensive outpatient center for sports medicine services and will be the primary practice facility and training center for the Penguins, as well as their Tier 1 Elite youth programs. It will focus on sports medicine and hockey-related research, including injury prevention, training, treatment, and rehabilitation.

This multi-use facility will become a destination for athletes of all ages and skill levels seeking leading-edge injury prevention and treatment from experts in sports medicine. "It's a true partnership between elite hockey and elite sports medicine," says Vonda Wright, MD, medical director of the UPMC Lemieux Sports Complex. "We will have full clinical facilities with experts in orthopaedic surgery, sports performance, primary care sports medicine, physical therapy, athletic training, nutrition, sports psychology, concussion, and musculoskeletal radiology."

The Lemieux Complex also will house a sports performance center and an expansion of the UPMC Sports Medicine Concussion Program, with both clinical and research space. "We're expanding on the legacy of elite sports medicine at UPMC," Dr. Wright says. "We'll do novel research not only on how to prevent and treat injury, but also how to predict it."

Five research laboratories will come together at the UPMC Lemieux Sports Complex to form the Institute for Sports Performance and Innovative Research (InSPIRe). The core research initiatives of InSPIRe are concussion and traumatic brain injury (TBI), cell therapy and biologics, sports performance, BioDynamics, and material science. Research will aim to answer the prevention, performance, and protection research questions that are important to the futures of young and professional athletes. "This is the platform we'll use to diversify research in sports medicine and endow our researchers to do creative and out-of-the-box work," Dr. Wright says.

Fast Facts

- *185,000 square feet of total space*
- *54,000 square feet of clinical space*
- *1,500 square feet of hockey skills training space, with a RapidShot® Hockey Training System, three RapidHands® hockey training stations, and a 66-foot resistance skating lane*
- *Two full-size hockey rinks with approximately 1,500 total seats*
- *14 locker rooms*
- *Sports medicine clinic with 24 private patient rooms*
- *Physical therapy gym overlooking the Penguins practice rink*
- *On-site MRI and x-ray imaging*
- *Aquatic therapy*
- *Sprinting track and batting cages*
- *Café and retail space*

Orthopaedics is known for embracing the latest innovations in technology and surgical techniques. But how can these advancements best be evaluated and measured for their long-term value, particularly in a shifting health care landscape?

Adolph J. Yates Jr., MD, associate professor of orthopaedic surgery, Division of Adult Reconstruction

Unlocking the Value Proposition in Health Care

The answer lies in evidence-based medicine, says Adolph J. Yates Jr., MD, an orthopaedic surgeon in the Division of Adult Reconstruction, whose fascination with the numbers behind health care began as an undergraduate economics major.

New Standards for Measuring Quality

Increasing the value of care provided has gone from a set of theoretical goals to being a legislated requirement. Value-based purchasing is a quality incentive model established through the Patient Protection and Affordable Care Act (PPACA) to help reduce health care costs while promoting high-quality care for Medicare beneficiaries. Launched in 2012, value-based purchasing adjusts CMS payments to hospitals based on a number of clinical performance measures, some of which now use actual health care outcomes as opposed to processes. The model incentivizes physicians and hospitals to re-prioritize a broader set of captured variables, including patient readmission rates, patient safety, hospital-acquired conditions, and patient satisfaction.

One challenge, Dr. Yates says, is to be able to take considered advantage of new, proven tools and technologies and apply these in safe ways so as to achieve improved, cost-effective health care outcomes. Another challenge is assuring an institution's ability to parse real-time data and convert it to actionable intelligence to provide critical feedback peer-to-peer. The final challenge — and perhaps the most vexing — is how to fairly calculate the risks assumed in providing orthopaedic surgery to certain patient populations (see Page 9) so as to assure patient access to care.

To address these challenges, orthopaedic surgeons at UPMC — one of the largest nonprofit hospital systems in the country — are participating in an initiative, led in part by Dr. Yates, known as the **Total Joint Pathway**.

Advantage UPMC: Total Joint Pathway

The Total Joint Pathway (TJP) was developed based on the best evidence available along with, when needed, a consensus process using a team of providers. "This was then used to develop 'power order sets' in the electronic medical record for use during total joint admissions throughout UPMC," says Dr. Yates. The TJP and order sets encourage prudent use of best practices to maximize UPMC's efforts to reduce variability and limit adverse outcomes.

"The goal of the TJP is to achieve the most safe and effective care for the system as a whole," says Dr. Yates. Its success is to be measured by the creation of cost-efficiencies and reductions of events such as infections, thromboembolic events, and readmissions.

The basic structure of the TJP is informed by endorsed guidelines and continuously infused with new discoveries. It includes the processes of all surgeons who practice at UPMC, providing practitioners with the opportunity to actively engage and learn from one another.

Unlocking the Value Proposition in Health Care

Next Step: Creating an Internal Registry

National and specialty registries can be indispensable resources in accessing information on the long-term effectiveness of orthopaedic implantable devices, therapies, treatments, safety, and procedures. Yet a significant amount of time can elapse between the points during which data is entered, findings are revealed, and reports are issued.

Dr. Yates believes that one way of getting ahead of the curve is for UPMC to create its own internal orthopaedic registry. The registry would allow surgeons to review outcomes, effect change, and provide real-time intelligence that impacts patient care. It would also serve to fortify the data populating the TJP.

"UPMC stands out for its investment in informatics to better use data to protect and care for our patients," notes Dr. Yates. "Accurate data is key — you have to 'know what you need' in order to get it."

Defining the Value Proposition

Dr. Yates' efforts are focused on tracking and fully extracting value so as to influence and drive cost effectiveness — quality outcomes derived from care at an appropriate cost— both of which inform and determine hospital and physician reimbursements. It is no longer about cost efficiency, he says: it is about cost effectiveness.

Dr. Yates is expanding his purview to engage even more purposefully in the value debate. He believes strongly in what he terms the value multiplier effect, contending that the overall, long-term value to society of a joint replacement done right substantially exceeds the initial cost of surgery. His current research is taking a deeper dive into the broader value of joint replacement to reveal the indirect, long-term costs to individuals and to society when treatment is denied.

Leading Change

Dr. Yates' surgical expertise and his deep understanding of the complexities surrounding health care delivery have led to his active engagement with a number of professional groups and associations dedicated to the advancement of health care quality. These include the National Quality Forum (NQF), where Dr. Yates serves on the Surgery Steering Committee.

Dr. Yates is the chairman of the Evidence-Based Medicine Committee for the American Association of Hip and Knee Surgeons. He is also serving on technical expert panels for CMS for *Medicare.gov/PhysicianCompare* and the total joint cost measure being developed by the Yale Center for Outcomes Research and Evaluation (CORE), and he also is a member of the Medicare Evidence Development and Coverage Advisory Committee. He has just finished a term on the device panel for the Food and Drug Administration. As a volunteer for the American Academy of Orthopaedic Surgeons (AAOS), Dr. Yates recently finished helping with the writing of the Appropriate Use Criteria for Non-Surgical Treatment of Osteoarthritis of the Knee and is now serving on the work group for the Clinical Practice Guideline for Surgery for Osteoarthritis of the Knee. ■

"My goal is to deliver the best value and outcome in the safest way for all of my patients." **Adolph J. Yates Jr., MD**

Adolph J. Yates Jr., MD

The Growing Dilemma of Value Refugees

The best hospitals in the world work with higher risk groups. Dr. Yates' own practice includes cancer patients, transplant patients, and others who are inherently at higher risk and, as a result, predisposed to higher complication rates associated with surgery.

"In a medical landscape that focuses on value-based payments and moving benchmarks, we have to take a closer look at our high-risk patients," says Dr. Yates. "Current risk adjustments are not perfect, and the difference of being above or below a benchmark could come down to one or two physician practice patterns. The current model makes it tempting to treat higher-risk patients as a class. That, however, is the classic definition of discrimination: treating people as part of a group and not as individuals."

To mitigate institutional risk and hover above increasingly tighter reimbursement benchmarks, Dr. Yates says that a growing number of hospitals are seeking to shed risk by limiting access to elective orthopaedic surgery for vulnerable groups. One group in particular are the morbidly obese; a slippery slope could lead to subtle but real barriers to care for those suffering from other diseases with wide ranges of poorly defined risk, such as rheumatoid arthritis, lupus, or sickle cell anemia. Despite the traditional risk-benefit ratio being strongly in favor of surgery for such patients, hospitals will feel pressure to limit access because of the leveraged potential of large penalties based on very small marginal differences in complication rates.

Dr. Yates predicts that such practices will result in the unintended and potentially tragic consequence of creating "value refugees" — pools of people denied access to care based upon their high-risk profiles.

"We must not leave anyone behind," Dr. Yates says. "It's increasingly incumbent on orthopaedic surgeons to be champions of quality and health care value for all patients. Until we have perfect risk adjustments to keep the playing field level, it might be necessary to push for wider sets of condition-specific exclusion criteria so that apples are compared to apples."

"It's no longer enough to focus on your practice," he says. "You have to be involved in your hospital or hospital system — and try to find enough hours in the day to engage on a state and national level in professional societies where you can help make a difference."

A long-term outcome study of adults who, as children, underwent open reduction surgery for developmental dysplasia of the hip is yielding important new insights into the condition's lifelong implications for them and other family members.

James W. Roach, MD, professor of orthopaedic surgery and The William F. and Jean W. Donaldson Endowed Chair of Pediatric Orthopaedics at Children's Hospital of Pittsburgh of UPMC

Mapping the Ripple Effects of Developmental Dysplasia of the Hip

For pediatric orthopaedic surgeon James W. Roach, MD, research is a curiosity-led activity with no one endpoint. "You have to be open to the path your research takes," he says. "There's always some uncertainty about where you're going and exactly how you'll get there."

That philosophy has helped to guide his evolving interest in individuals and families who have a history of developmental dysplasia of the hip (DDH), and is reflective of the growing movement in pediatric orthopaedics to identify both the long-term outcomes of procedures in patients and the causality behind conditions such as DDH.

DDH is a spectrum of abnormalities involving the hip joint. "It ranges from frank dislocation to only mildly inadequate acetabular coverage of the femoral head, called acetabular dysplasia," says Dr. Roach, professor of orthopaedic surgery and The William F. and Jean W. Donaldson Endowed Chair of Pediatric Orthopaedics at Children's Hospital of Pittsburgh of UPMC. "Acetabular dysplasia has been linked to early hip osteoarthritis, which has been attributed as the cause for total hip arthroplasty (THA) in a significant number of adults."

When diagnosed early, DDH is a relatively simple condition to correct. But because DDH is asymptomatic, some patients go undiagnosed until they're walking.

"We could see the short-term impact on children a year or so after DDH surgery, but its long-term results weren't clearly established. We had no idea how DDH patients were doing at age 30, 40, and beyond," says Dr. Roach. "Assuming no underlying conditions, arthritis in the average person doesn't appear until around age 70. Do the hips of these patients approach a normal lifespan?"

Tracking Generations of DDH Patients

Before coming to UPMC, Dr. Roach served for nearly a decade on the medical staff and faculty of the University of Utah in Salt Lake City. After his arrival in Pittsburgh, Dr. Roach and his research colleagues continued using the Utah Population Database (UPDB) to identify and recruit adults who had undergone DDH surgery as children in the Salt Lake City area for follow-up study. And, to demonstrate a familial predisposition to DDH, their first-degree family members also were invited to participate in the study.

"Respondents came from all over the country and ranged in age from their 20s to their 60s," says Dr. Roach. The study's phenotyping approach included physical examinations, functional questionnaires, and pelvic radiographs. DNA samples also were collected.

The study's first report focused on the clinical outcomes of patients who underwent surgery as children to reduce a congenitally dislocated hip. "We learned that, as a group, the younger they were when they had their surgery, the better they fared as adults," says Dr. Roach.

Mapping the Ripple Effects of Developmental Dysplasia of the Hip

The study also took a closer look at participants in the study who, as children, had only one hip that was abnormal. Dr. Roach and his team discovered that the normal hip often developed acetabular dysplasia as the patient aged.

The Implication for Family Members

"We began to wonder if similar 'silent hip dysplasia' also was occurring in other family members," says Dr. Roach. Through their research, he and his co-investigators were able to establish a significant association of hip arthritis in supposedly normal first-degree relatives of patients with DDH.

"In our recently completed phenotyping studies on normal individuals from DDH families, we discovered that 26 percent of these relatives have acetabular dysplasia, many with symptoms of hip osteoarthritis," says Dr. Roach. "Our findings also suggest that the DDH phenotype is not just hip subluxation or dislocation, but also includes acetabular dysplasia."

Dr. Roach and his co-investigators are now performing genetic mapping and linkage analysis of the study's participants.

"Hopefully, through continued research and early intervention, it will be possible to reduce or prevent the need for total hip replacements among individuals within the DDH spectrum," says Dr. Roach. ■

"Hopefully, through continued research and early intervention, it will be possible to reduce or prevent the need for total hip replacements among individuals within the DDH spectrum." **James W. Roach, MD**

Kurt R. Weiss, MD

Orthopaedic Tumor Registry and Tissue Bank: Generating Novel Reagents for the Research of Rare Cancers

It is estimated that 12,000 new cases of soft tissue sarcoma (STS) were diagnosed in the United States in 2014. Unfortunately, about half of the adult patients diagnosed with STS eventually develop metastatic disease. Once a sarcoma metastasizes, the prognosis is poor.

A tremendous obstacle to the advancement of STS research and treatment is the small number of cell lines available to basic scientists, according to Kurt R. Weiss, MD, assistant professor of orthopaedic surgery in the Division of Musculoskeletal Oncology. In order to address this need, the division has initiated a novel tumor registry and tissue bank, supported by the Shadyside Hospital Foundation, the Sarcoma Foundation of America, Pittsburgh Cure Sarcoma, and the National Cancer Institute.

Through the **UPMC Musculoskeletal Oncology Tumor Registry and Tissue Bank**, orthopaedic surgeons Mark A. Goodman, MD, Richard L. McGough III, MD, and Dr. Weiss collect both patient data and sarcoma tissue. Tumor samples harvested at the time of surgery are transported to Dr. Weiss's Cancer Stem Cell Laboratory, where they are mechanically and enzymatically dissociated to begin novel sarcoma cell lines.

So far, more than 60 cell lines have been generated. "The idea is to figure out what the cancer cells are doing to travel to other areas of the body. The cell lines are huge resources in figuring out the biology of these rare diseases," says Dr. Weiss, a sarcoma survivor himself.

The strategy seems relatively straightforward but requires a unique environment to be successful. UPMC, which is home to a tertiary sarcoma center of excellence combined with a world-renowned biomedical research effort, provides the rare setting that allows sarcoma research to thrive. "Generally, the accepted model has been that centers that see a high clinical volume of sarcoma patients are the experts, but that clinical volume hardly ever intersects with basic science gravitas," says Dr. Weiss. "At UPMC, we have a foot in the lab and a foot in the clinic, so we can go back and see how a patient is doing and compare those results with other cell lines to find potential patterns."

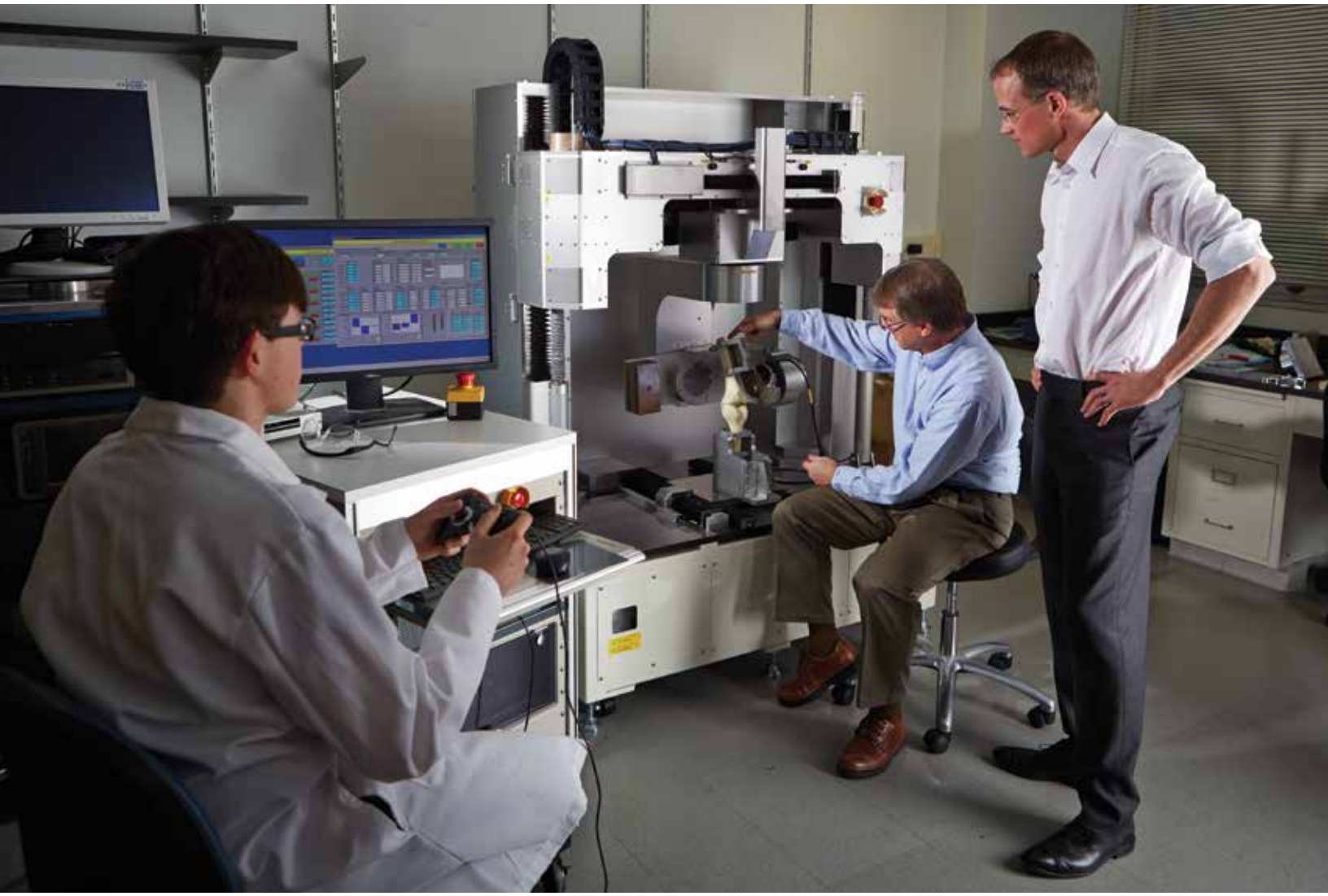
The tumor registry and tissue bank at UPMC is modeled after a similar database at the University of Toronto, where Dr. Weiss's fellowship mentors Jay Wunder, MD, and Peter Ferguson, MD, and their clinical research manager Anthony Griffin, have been collecting similar samples. "They've been banking data for years — before database was even a commonly used term," Dr. Weiss says. "I really learned from their system."

In 2014, the first peer-reviewed manuscript using UPMC's tumor registry and tissue bank was published in the *Journal of Cancer Therapy*. The authors evaluated the enzymatic activity of aldehyde dehydrogenase (ALDH) in cell lines derived from 10 consecutive bone sarcoma patients. "What we found was that the ALDH correlated perfectly with the metastasis rate," says Dr. Weiss.

This study illustrated the feasibility of using patient-derived sarcoma cell lines for translational studies and shed light on a potentially novel anti-metastatic sarcoma treatment. Dr. Weiss and his laboratory co-investigators currently are evaluating this strategy more rigorously in an animal model of osteosarcoma.

The potential for the UPMC Musculoskeletal Oncology Tumor Registry and Tissue Bank to support additional studies and collaborations is virtually unlimited. Sarcoma cell lines generated through the registry have the potential to benefit investigators from around the world.

"These cell lines, as well as clinical outcomes data from patients, will allow scientists to ask and answer new translational research questions and will pave the way for more effective treatments," says Dr. Weiss. "We want to figure out the biology of sarcomas so we can do something meaningful beyond giving patients the right drug; we want to put an end to these diseases."



A collaborative initiative between UPMC and the University of Pittsburgh, the Orthopaedic Robotics Laboratory features a novel robotic system dedicated to the biomechanical testing of major joints — it's one of only four such labs in the world and the only one outside of Japan.

Volker Musahl, MD, associate professor of orthopaedic surgery and medical director of the UPMC Center for Sports Medicine and **Richard Debski, PhD,** associate professor of bioengineering and orthopaedic surgery at the University of Pittsburgh

Using Robotic Technology to Prevent Degenerative Joint Disease

The lab uses state-of-the-art robotic technology to pioneer clinical solutions designed to prevent degenerative joint disease through diagnosis, repair, and rehabilitation. Among its first areas of focus: developing evidence-based research for optimal treatment of torn rotator cuffs.

It could be said that the new Orthopaedic Robotics Laboratory (ORL) is a "marriage made by Moreland." Two years before his death in 2011, Morey S. Moreland, MD — a beloved and brilliant surgeon, scientist, and medical educator — set into motion the creation of a state-of-the-art bioengineering/orthopaedic research facility.

"Dr. Moreland understood the potential the lab could have on both basic research and clinical outcomes. It was his vision that made the lab a reality," says Richard Debski, PhD, associate professor of bioengineering and orthopaedic surgery at the University of Pittsburgh. He and Volker Musahl, MD, orthopaedic surgeon and medical director of the UPMC Center for Sports Medicine, were recruited by Dr. Moreland to serve as co-directors of the ORL.

Dr. Musahl and Dr. Debski, who had partnered on several research projects earlier in their careers, built the lab from the ground up, taking more than 20 months from final design to the delivery of the robotic system. The centerpiece of the 1,500-foot research lab is a six-axis test robot, built in Japan, that offers high stiffness, universal programming language, and realistic loading conditions. Supporting equipment can measure joint contact pressures, tissue deformations and forces during joint loading, and tissue properties.

"The system offers a very powerful tool that promotes collaboration among investigators for knee, shoulder, spine, ankle, and hand research projects," says Dr. Debski. "We also are working with international researchers in Japan, Italy, and Sweden."

Applying Robotic Technology to Establish Optimal Torn Rotator Cuff Treatment

"As Americans age and remain active, we are seeing a growing number of patients with torn rotator cuffs," says Dr. Musahl. Ranked as one of the most prevalent musculoskeletal disorders based on data published by the American Academy of Orthopaedic Surgeons (AAOS), it is projected that these tears affect more than half of the population over age 65.

But there is a woeful lack of clear evidence for the optimal treatment of torn rotator cuffs. The course and timing of treatment remains controversial, including whether surgery ultimately is warranted.

In 2011, the AAOS issued 14 clinical practice guidelines while simultaneously acknowledging the absence of reliable evidence to support its recommendations. And when members of the

Using Robotic Technology to Prevent Degenerative Joint Disease

American Orthopaedic Society for Sports Medicine (AOSSM) were asked what questions they have that current literature is not addressing, the number one response was treatment of torn rotator cuffs.

"On any given day, half of the patients I see in my practice have torn rotator cuffs. Most are between 50 and 65 years of age, and their tears are not the result of an injury or accident," says Dr. Musahl. "Given the lack of evidence on treatment, though, as surgeons we currently use our best judgment to 'do the right thing' for our patients."

In the ORL, Dr. Musahl and Dr. Debski are studying cadavers of older individuals with rotator cuff tears, examining their size and location with the goal of helping surgeons to determine what forms and combinations of treatment — injections, physical therapy, or surgery — would be most effective. They also are building computational models that forecast various scenarios by varying the properties of the tear and surrounding tissue. The results of one study by Dr. Debski and Dr. Musahl, *Strain Distribution Due to Propagation of Tears in the Anterior Supraspinatus Tendon*, appeared in the October 2014 issue of the *Journal of Orthopaedic Research*.

Another research project focused on the impact of exercise therapy on torn rotator cuffs. Patients underwent 12 weeks of exercise therapy: six weeks with a physical therapist, and six

weeks of a home-based program that focused on restoring range of motion and strengthening the rotator cuff and scapular muscles. Patients had x-rays taken before and after physical therapy to assess improvements in shoulder movement. The results of this study will be presented at the Orthopaedic Research Society 2015 Annual Meeting.

The results of the research conducted in the ORL are moving the needle on the availability of evidence-based decision-making tools for surgeons regarding the treatment of rotator cuff tears. Future ORL research will focus on tear chronicity to determine how the age of a tear affects how it propagates and impacts surrounding tissue. ■

"On any given day, half of the patients I see in my practice have torn rotator cuffs. Most are between 50 and 65 years of age, and their tears are not the result of an injury or accident." **Volker Musahl, MD**

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Vonda Wright, MD

Vice-President, UPMC Orthopaedic Services
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Thomas Lozito, PhD

Stem Cell Research Center

Cancer/Stem Cell Lab
Kurt Weiss, MD
Xiaodong Mu, PhD

Growth & Development Lab
Johnny Huard, PhD
Xueqin Gao, MD, PhD
Hongshuai Li, MD, PhD
Aiping Lu, MD

Molecular Therapeutics Lab
Bing Wang, MD, PhD

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Anthony Kontos, PhD
Alicia Puskar, PsyD
Erin Reynolds, PsyD
Vanessa Fazio Sumrok, PhD

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Kevin Bell, PhD
Joon Lee, MD
Gwendolyn Sowa, MD, PhD
Nam Vo, PhD

MechanoBiology Lab
James H-C Wang, PhD
Jianying Zhang, PhD

Musculoskeletal Modeling Lab
Xudong Zhang, PhD

Neuromuscular Research Lab
Timothy Sell, PhD, PT

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Freddie Fu, MD
Patrick Smolinski, PhD

Orthopaedic Robotics Lab
Volker Musahl, MD
Richard Debski, PhD
Kevin Bell, PhD

Sports Orthopaedic Research Lab
Christopher Harner, MD
Xudong Zhang, PhD

Outcome Research
James Irrgang, PhD, PT, ATC

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Arvydas Usas, MD, PhD
Kia Washington, MD

Department Of Orthopaedic Surgery

Academic Organizational Structure

Freddie H. Fu, MD, *David Silver Professor and chairman*

Rocky Tuan, PhD, *Arthur J. Rooney Sr. Chair in Sports Medicine and executive vice chairman for orthopaedic research*

James Kang, MD, *UPMC Chair in Orthopaedic Spinal Surgery and executive vice chairman for clinical services*

Johnny Huard, PhD, *Henry J. Mankin Chair in Orthopaedic Surgery and vice chairman for musculoskeletal therapeutics*

Vincent Deeney, MD, *vice chairman for education and program director*

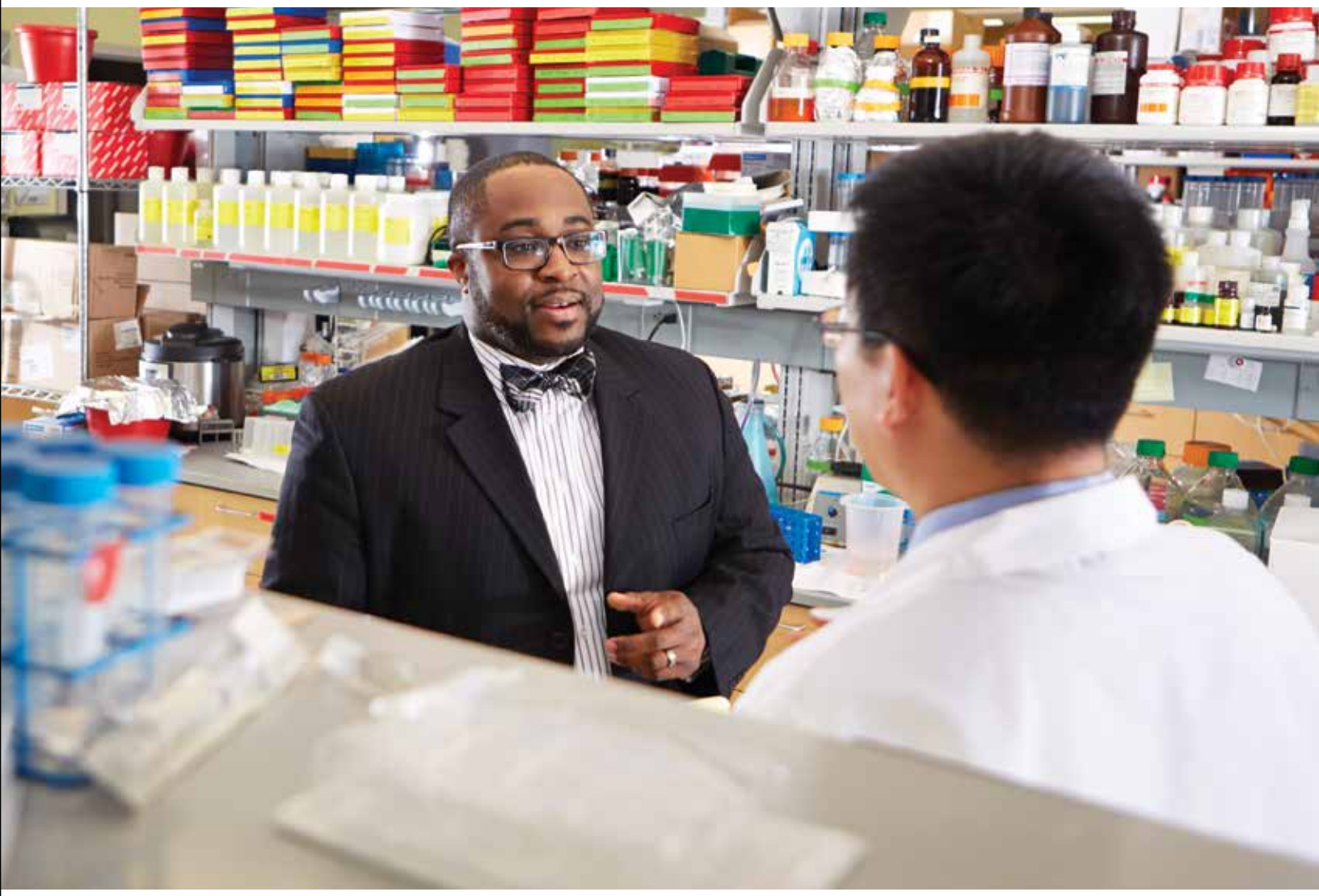
MaCalus Hogan, MD, *assistant residency director*

W. Timothy Ward, MD, *vice chairman for pediatric surgery*

William Donaldson III, MD, *vice chairman for administrative services*

Mark Baratz, MD, *vice chairman for community outreach*

James J. Irrgang, PhD, *director, clinical research*



A ruptured Achilles tendon can be devastating, starting with the injury — the dreaded snap or pop, and often, searing pain. Treatment is controversial, sometimes calling for surgery, then months of recovery, with no guarantee of a return to pre-injury function.

MaCalus V. Hogan, MD, assistant professor of orthopaedic surgery, Foot and Ankle Division

Advancing the Promise of Regenerative Bioengineering in Orthopaedics

For MaCalus V. Hogan, MD, a young surgeon-scientist who joined UPMC's Department of Orthopaedic Surgery in the fall of 2013, regenerative bioengineering holds the greatest promise for the successful treatment of torn tendons and ligaments and of other orthopaedic injuries and degenerative diseases. "Although we have yet to achieve a way to effectively regenerate a human tendon and return it to its normal condition after surgery, we're closer than ever before," he says.

Dr. Hogan's own future was foreshadowed in a football game during his senior year of high school when he suffered not an Achilles injury but an ankle fracture dislocation and syndesmotic injury. The opposing team's physician, orthopaedic surgeon A.E. Joiner, MD, performed an immediate ankle reduction on the field and surgery a week later. Dr. Joiner became a mentor to this young athlete and ultimately recommended him for medical school.

Dr. Hogan served as a National Institutes of Health (NIH) research fellow during his orthopaedic residency training. "It was during residency that I discovered I had a real passion for improving foot and ankle surgery outcomes through musculoskeletal tissue engineering," says Dr. Hogan. His special interest in regenerating injured tendon tissue won him a Resident Clinician Scientist Training Grant early in his career from the Orthopaedic Research and Education Foundation.

In 2013, Dr. Hogan was the lead scientist and co-recipient of the J. Leonard Goldner Award for best basic science research from the American Orthopaedic Foot & Ankle Society for developing an Achilles tendon gap defect model in rats. That promising research evaluated tendon regeneration using a bioresorbable nanofiber scaffold, along with adipose-derived mesenchymal stem cells (ADSCs) and growth differentiation factor-5 (GDF-5).

Bringing Diverse Expertise to New Research

Today, Dr. Hogan's research focus has expanded to include tendon and cartilage healing and repair, particularly through the development and optimization of orthobiologic strategies. He holds dual appointments at the University of Pittsburgh School of Medicine and the McGowan Institute for Regenerative Medicine.

"I was drawn to Pittsburgh because of the opportunity to embark on the ultimate academic career journey — practice medicine, teach, and continue my research. Most of all, I'm able to work alongside and learn from some of the country's leading pioneers in regenerative medicine and bioengineering," he says.

Advancing the Promise of Regenerative Bioengineering in Orthopaedics

In just over a year, Dr. Hogan became involved in a wide range of research initiatives, spanning basic to translational. Among his first collaborations was his research with James H-C. Wang, PhD, director of the MechanoBiology Laboratory within the Department of Orthopaedic Surgery at the University of Pittsburgh, who held one of the country's first NIH Research Project Grants (R01) to investigate the use of platelet-rich plasma (PRP) to treat musculoskeletal injuries. "Dr. Wang's initial R01 focused on PRP's potential in treating tendinopathy and degenerative tendon disorders," says Dr. Hogan. Dr. Hogan is now the principal investigator of an NIH Career Development Grant that builds on that initial research. "We're working together to optimize the healing effects of PRP and apply it in a tissue- or injury-specific manner. The future translation of orthobiologic applications such as PRP will depend on our ability to perform quality investigation through scientist and physician collaboration," he says.

Plantar fasciitis is another common problem that plagues many patients. Dr. Hogan and Dr. Wang are developing a human plantar fascia tissue bank and using this to investigate potential therapeutics. "We're taking human plantar fascia samples and testing them in the lab to identify the mechanobiology behind the disease." Through their research, they hope to improve treatment. According to Dr. Hogan, "if we're able to generate a healing cascade, it could revolutionize treatment and potentially avoid surgical intervention for patients."

Dr. Hogan and Dr. Wang are also collaborating with Rocky S. Tuan, PhD, founding director of the Center for Cellular and Molecular Engineering, to investigate the role of umbilical cord and amniotic membrane materials for the treatment of orthopaedic conditions.

"Our goal is to develop a foot and ankle research institute that integrates basic science research, translational investigation, and clinical outcomes assessment toward the improvement of foot and ankle care. Here at the University of Pittsburgh, we have all the pieces for success and the future is promising." ■

"If we're able to generate a healing cascade, it could revolutionize treatment and potentially avoid surgical intervention for patients." **MaCalus V. Hogan, MD**

Foot and Ankle Outcomes Platform

As part of the Department of Orthopaedic Surgery's commitment to enhanced quality and patient care, Dr. Hogan has led the development and implementation of a **Foot and Ankle Outcomes Platform** at UPMC, which officially launched in early 2015.

"Using the electronic medical record and tablets — and tying into MyUPMC, UPMC's online patient health portal — we're capturing patient-reported data to measure satisfaction and outcomes," says Dr. Hogan. "Our goal is to develop a registry platform and apply this data to improve both the quality and delivery of our care, as well as optimize the cost paradigm."

Outcomes will be collected across foot and ankle practices within UPMC, encompassing both academic and employed physicians. This represents a timely step forward through the platform's integration in the newly developed UPMC Foot and Ankle Center, which provides a unique added benefit. "The data collected offers us the opportunity to bridge the clinical and patient care components of our various practices and patient profiles," Dr. Hogan notes.

This pilot program is one of the first of its kind at UPMC, and Dr. Hogan is working with department and health system leadership toward the development and optimization of similar models for quality improvement systemwide. "This platform will allow us to improve not only the value and quality of care, but the overall patient foot and ankle care experience here at UPMC."

When used on the right patient, ultrasound is as accurate as electrodiagnostic testing — and quicker, less painful, and more cost-effective — in confirming a clinical diagnosis of carpal tunnel syndrome.

John Fowler, MD, assistant professor of orthopaedic surgery, Division of Hand and Upper Extremity Surgery

Rethinking the "Gold Standard" in Diagnosing Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is the most common upper-extremity medical condition in the United States. Every year, more than 4 million patients seek care for carpal tunnel syndrome, and upwards of 600,000 carpal tunnel releases are performed.

"For years, electrodiagnostic (EDX) nerve studies have been the unquestioned gold standard for diagnosing CTS," says John Fowler, MD, assistant professor of orthopaedic surgery, Division of Hand and Upper Extremity Surgery. "But there's clear evidence that we should rethink that dogma for our patients."

Dr. Fowler first took a closer look at EDX studies as a resident. "I'd order tests, and patients often would return months later without having it done," he says. "For some, it was a matter of cost; others simply didn't want to undergo the testing."

The American Academy of Orthopaedic Surgeons (AAOS) recommends confirmatory testing before performing surgery on patients with CTS. Ultrasound has long been used in Europe as a tool in diagnosing CTS and other musculoskeletal conditions, but specialists in the United States have been slow to adopt it.

"Given the option, which would you choose?" asks Dr. Fowler. "A painless, 30-second ultrasound or 45 minutes of mild electric shock and needles?"

A recent study led by Dr. Fowler set out to compare the accuracy, sensitivity, and specificity of ultrasound and EDX studies, using a validated clinical tool as the reference standard. James Irrgang, PhD, PT, ATC, FAPTA, director of clinical research in the department, assisted with the statistical analysis. The results appeared in the September 2014 issue of the *Journal of Bone and Joint Surgery*.

The six-item carpal tunnel symptoms scale (CTS-6), developed by Canadian orthopaedic surgeon Brent Graham, MD, assigns different values to six findings based on a patient's history and physical exam. Patients who score 12 points on the CTS-6 have been shown to have an 80 percent likelihood of having the condition.

CTS-6 takes into consideration such "classic" indicators as nocturnal symptoms, numbness predominant in the median nerve distribution, a positive Phalen test, a Tinel's sign at the wrist, thenar atrophy and/or weakness, and the loss of two-point discrimination.

"Using CTS-6 as the reference standard, we demonstrated that ultrasound had a sensitivity of 89 percent, a specificity of 89 percent, and an accuracy of 89 percent," says Dr. Fowler. Those numbers compare very favorably to EDX tests scores of 89 percent for sensitivity and 80 percent for specificity. But is ultrasound cost effective?

Rethinking the "Gold Standard" in Diagnosing Carpal Tunnel Syndrome

An earlier study by Dr. Fowler (published in March 2012 in *Clinical Orthopaedics and Related Research*) examined ultrasound's cost-effective value as a front-line test in diagnosing CTS. Even when accounting for false positives and false negatives, the results showed that, in the hands of a specialist, there are measurable cost savings with ultrasound testing.

Ultrasound is often criticized as being operator dependent, resulting in different readings when done by an experienced versus inexperienced operator. But that same study showed that after a brief learning curve of performing 15 to 20 ultrasounds, CTS readings were consistent.

Advancements in ultrasound technology now yield higher resolution images for better readings at an affordable price. "It's now possible to offer in-office ultrasounds that give patients and specialists immediate CTS confirmation," says Dr. Fowler.

There are some things ultrasound does not do well. Electrodiagnostic testing is much more effective at diagnosing conditions such as a pinched nerve in the neck or peripheral neuropathy. And it remains the test of choice when the diagnosis is unclear or there is a need to grade the extent of nerve damage.

"Ultimately, the question is 'Which test should specialists use as the reference standard?'" says Dr. Fowler. "For patients with classic symptoms, the pre-test probability of a CTS diagnosis is so high that some even argue neither test is necessary. But with the right patient, ultrasound is an extremely effective strategy that offers fast and painless testing with immediate results. And, given the volume of CTS patients seen annually, it also offers the potential of significant cost savings for the health care system." ■

"It's now possible to offer in-office ultrasounds that give patients and specialists immediate CTS confirmation." **John Fowler, MD**

About the Department

Founded in 1953 as a separate department of the University of Pittsburgh School of Medicine, the Department of Orthopaedic Surgery is committed to delivering the highest quality of diagnostic and therapeutic patient care to both adults and children for a diverse spectrum of orthopaedic disorders. To this aim, the department seeks to meet the needs of 21st century orthopaedic care not only by integrating the latest biological and technological advancements in orthopaedic science, but equally by leading the development of novel treatment modalities through distinguished basic science and clinical research programs. In addition, the Department of Orthopaedic Surgery seeks to be a leader in educating the next generation of orthopaedic surgeons through its residency and fellowship training programs, which include comprehensive, in-depth exposure to all specialties of orthopaedic care and advanced surgical experience.

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A world-renowned health care provider and insurer, Pittsburgh-based UPMC is inventing new models of accountable, cost-effective, patient-centered care. It provides more than $887 million a year in benefits to its communities, including more care to the region's most vulnerable citizens than any other health care institution. The largest nongovernmental employer in Pennsylvania, UPMC integrates more than 60,000 employees, more than 20 hospitals, more than 500 doctors' offices and outpatient sites, a more than 2.5-million-member health insurance division, and international and commercial operations. Affiliated with the University of Pittsburgh Schools of the Health Sciences, UPMC ranks No. 12 in the prestigious *U.S. News & World Report* annual Honor Roll of America's Best Hospitals — and No. 1 in Pennsylvania.

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