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UFE: A fibroid treatment
Diagnostic Radiology
Chief Residents
2008-2009

(LEFT TO RIGHT) Jason Stephenson, MD; Jonathan Baker, MD; Travis Hillen, MD.

Photograph by MIR Photography Lab
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ON THE COVER Michael Darcy, MD, leads a team of interventional radiologists who provide an alternative to hysterectomy for women with uterine fibroids. Photograph by Tim Parker.
NINDS funds stroke research center

As program director and principal investigator, Colin Derdeyn, MD, professor of radiology, of neurology, and of neurological surgery, received a $9.3 million grant from the National Institute of Neurological Disorders and Stroke (NINDS)—a part of the National Institutes of Health (NIH)—to develop new methods for diagnosing and treating stroke. Provisions of the five-year grant allow for establishing a Specialized Program for Translational Research in Acute Stroke (SPOTRIAS) Center at Washington University Medical Center. The Medical Center’s efficient, high-volume acute stroke treatment team and Mallinckrodt Institute’s reputation as a leader in radiology were recognized as major strengths of their successful application.

Co-investigators for the Washington University SPOTRIAS Center are from the following groups:

• Department of Emergency Medicine—Larry Lewis, MD; David Tan, MD; Douglas Char, MD
• Department of Neurology—Abdullah Nassief, MD; Jin-Moo Lee, MD, PhD; David Carpenter, MD; Allyson Zazulia, MD; Michael Diringer, MD; Mark Goldberg, MD
• Department of Neurosurgery—Gregory Zipfel, MD; Ralph Dacey, MD; Robert Grubb, MD
• Department of Pathology—Mark Watson, MD, PhD
• Department of Radiology—Katie Vo, MD; Tom Videen, PhD
• Division of Biostatistics—Philip Miller, PhD; Gina D’Angelo, PhD; Paul Thompson, PhD
• Occupational Therapy Program—Lisa Connor, PhD
• University of North Carolina—William Powers, MD; Weili Lin, PhD.

In addition to Washington University in St. Louis, the following institutions comprise the SPOTRIAS research center network: Columbia University; Harvard University; University of California, Los Angeles; University of California, San Diego; University of Cincinnati; University of Texas, Houston; and an NIH stroke treatment program in Washington, DC.

SNM award named for Welch

In June at the 55th Annual Meeting of the Society of Nuclear Medicine (SNM), the Radiopharmaceutical Sciences Council announced the creation of the Michael J. Welch Award, which will be given annually for significant contributions to the field of radiopharmaceutical sciences. The first recipient will be announced at the 2008 SNM meeting.

The award’s namesake is a pioneer in the field of radiopharmaceutical chemistry who specializes in the synthesis of new radioactive chemicals for medical imaging. Welch, professor of radiology, of chemistry, and of molecular biology and pharmacology, joined the Mallinckrodt Institute faculty in 1967 and was a member of the team that developed positron emission tomography in the early 1970s.

Of note

Carolyn Anderson, PhD, professor of radiology, of biochemistry, and of chemistry, was elected vice president of the Society of Nuclear Medicine’s Molecular Imaging Center (MICoE) of Excellence. She will assume the MICoE presidency in 2010.

Colin Derdeyn, MD, professor of radiology, of neurology, and of neurological surgery, was elected president-elect of the Society of NeuroInterventional Surgery. He will be appointed president of the Society in 2010.

Bennett Greenspan, MD, instructor in radiology, was elected to a two-year term as president of the Society of Nuclear Medicine’s Academic Council.

Marcus Kessler, MD, nuclear medicine chief resident, was appointed to a one-year term on the Magnetic Resonance Committee and the Diagnostics Committee of the Society of Pediatric Radiology.
Your teenage son complains of pain in one leg, that it’s keeping him up at night. Growing pains, you think, and tell him the pain will go away. Not necessarily. What he may be experiencing is an osteoid osteoma, a noncancerous bone-forming tumor that occurs most often in the long bones of the lower extremities. The femur, or thighbone, is the most common location, although the tumor can occur in almost any bone—especially the bones of the hand and sometimes the lower spine. Regardless of the location, these tumors can be very painful.

by Mary Jo Blackwood, MPH, CHES
Osteoid osteomas occur when certain cells divide uncontrollably, forming a small, brownish-red, gritty mass partially comprised of bone. The growing tumor displaces healthy bone tissue with its abnormal, hard tissue. These growths generally emerge during the teenage years or early adulthood (ages 5 through 25), are found more often in males than in females (2:1 ratio), and account for approximately 10 percent of all benign tumors. The good news is the tumors typically do not progress in size beyond a half inch in diameter, do not harm the bone, and do not become malignant. However, pain caused by the tumor can rob patients of sleep and comfort.

“Osteoid tumors are found in many parts of the bone: the outer portion, near the surface under the periostium fibrous coating; even in the medullary cavity inside the bone shaft where marrow is stored,” says Louis Gilula, MD, a musculoskeletal interventional radiologist at Mallinckrodt Institute. “The lesion itself is an inflammatory mixture created by the pressure of the tumor and the chemicals it forms.”

SYMPTOMS
Depending on its location, the osteoma can have different symptoms:
- Dull or sharp pain that worsens at night
- Pain usually relieved by aspirin or other anti-inflammatory drugs
- Limping
- Painful scoliosis or muscle spasms, and other nerve symptoms like sciatica (when the tumor is in the spine)
- Muscle atrophy from not using the limb to avoid pain.

Gilula says that typically these osteoid osteomas occur as one tumor unilaterally, a characteristic that distinguishes them from the growing pains of youth, which tend to be bilateral.

“Typically, they occur in one spot and rarely recur,” he says. “The tumors might—but rarely—go away, within 36 months on average, without any treatment. However, because of the associated pain, patients generally don’t want to wait. No one knows why these growths develop. Generally the bone is not damaged, unless the tumors occur on or near a growth plate, which could cause bone deformity because of the mass. The decision to treat, in most cases, is based on the patient’s level of pain.”

DIAGNOSIS
Diagnosis may be made by using one—or a combination—of the following tests:
- X rays
- Computed tomography
- Magnetic resonance imaging
- Fluoroscopy
- Bone scan
- Complete blood count
- Blood test.

Initial diagnosis is usually made by X ray, which can detect the bony growth of the tumor. “We want to locate the radiolucent nidus, or center of the osteoma,” says Gilula. “The growth is usually a round shape, but it may be oblong, conforming to some bony structure. Once the diagnosis is made, the condition can be treated.”
PERCUTANEOUS RF ABLATION

Traditionally, an osteoid osteoma was surgically removed by an orthopaedic surgeon. But musculoskeletal interventional radiologists—like Gilula and Daniel Wessell, MD, PhD, instructor in radiology in Mallinckrodt Institute’s Musculoskeletal Radiology section—are using a minimally invasive procedure called percutaneous radiofrequency (RF) ablation. Gilula, a professor of radiology, of orthopaedic surgery, and of plastic and reconstructive surgery, has been using percutaneous RF ablation to treat these noncancerous tumors since 1997 and receives patient referrals from a wide geographic area.

While the patient is under general anesthesia or deep conscious sedation, the radiologist uses fluoroscopy or computed tomography to locate the nidus. Then a small hole is made into the nidus so the tumor can be biopsied. Next, a radiofrequency is sent through a needle that is inserted into the center of the lesion. The radiofrequency generates heat—which is increased to 90 degrees Centigrade—that kills the tumor cells.

After allowing time for recovery from the anesthesia, most patients go home the same day. The pain is usually gone by the day following the RF ablation, and regular activities can be resumed. After the procedure, the nidus gradually fills in the bone, which usually is thicken around the lesion and is even stronger than normal; stress on the bone is not an issue. The exception, says Gilula, is for triathletes whose combination of activities puts undue stress on their joints. For these patients, Gilula recommends no training for six weeks.

Editor’s Note: Physicians who have questions about percutaneous RF ablation or want to refer a patient may call (314)362-2825.

TREATMENT ALTERNATIVES

- **Curettage**: Scraping the tumor from the bone, using a looped instrument called a curette. Donor bone tissue or other materials are used to pack the cavity resulting from the curettage.

- **En bloc resection**: Aggressive resection of the tumor, involving the surgical removal of a block of bone containing the tumor and allowing for wide margins of healthy tissue. This approach is typically unnecessary in osteoid osteomas but was the treatment of choice prior to RF ablation. More often, when pain interferes with daily activity, RF ablation of the tumor is the treatment of choice.

- **Internal fixation**: Following en bloc excision of the tumor, metal rods or pins are used to support the bone.

- **Surgery**: In some cases, surgery may be the best option for lesions close to the spinal cord or in very small bones close to the skin of the wrist bones.
Bringing ideas to life

by Amy Thomas, MD, FAAP

In a workday packed from start to finish with clinical duties, academic radiologists have limited time for medical research. Though many have the vision necessary to improve the future of health and medicine, the process of running a clinical research study can be a daunting task. Even the most industrious physician is challenged to find study participants, coordinate detailed research protocols, monitor patients, and engage in all of the additional tasks required to conduct a valid clinical trial.
But at Washington University in St. Louis, one of the world's largest academic research centers, physicians conducting clinical investigations that involve imaging can turn to a team skilled in the technical aspects of designing and executing a successful research protocol. Mallinckrodt Institute of Radiology’s Clinical Research Laboratory (CRL) is a full-service project coordination group whose mission is to assist in any step of the research process.

Led by Jeffrey Brown, MD; Shelly Meese; and Robin Haverman, the CRL has grown since 1997 from a small group of five to what is now a staff of 21 research specialists readily available to assist clinicians with imaging research. The CRL provides many services that are essential to running a clinical research trial such as participant recruitment, obtaining patients’ vital signs, laboratory tests and ECGs, image transfer and data entry. The CRL also helps principal investigators to identify appropriate funding opportunities for a project, prepare grant proposals, and prepare Institutional Review Board (IRB) applications. Research physicians are often pressed to find time for these duties, and guidance from highly qualified and experienced members of the CRL ensures that these processes run smoothly, without interrupting doctors’ busy clinical schedules and giving them more time to focus on the scientific aspects of research.

Getting projects off the ground

At the earliest stages of research, the CRL plays a critical role in development by finding financial sponsors and submitting grant proposals. Shelly Meese, MHA, CRA, assistant director of the CRL, is well-versed in locating potential funding opportunities for imaging research. Combining a scientific background with a thorough knowledge of how and where to obtain funding dollars, Meese is dedicated to making the best match between a clinician and a research sponsor.

The CRL staff also finds suitable principal investigators when approached by industry or agencies such as the National Institutes of Health. Once the match is made, members of the CRL are committed to smoothing the process of grant submission by preparing and reviewing biographical sketches, resource and environment information, letters of collaboration, IRB approvals, and budget justifications. They work closely with faculty on research design, editing and advising on the various sections throughout each step of the process and allowing more time for the clinician to concentrate on the medical science of the grant proposal.

The CRL provides many services that are essential to running a clinical research trial...
Bringing ideas to life

The CRL Staff
- Darlene Bird, RT(R) (M), clinical research specialist
- Jeffrey Brown, MD, director
- Angela Campbell, RT(R) (M), clinical research specialist
- Lora Gallagher, clinical research coordinator
- Ellen Haenni, research secretary
- Robin Haverman, manager
- Ruth Holdener, RT(R), clinical research coordinator
- Eileen Jacobs, RT(R) (M), clinical research coordinator
- Shelly Meese, MHA, CRA, assistant director
- Jill Neu, RT(R), clinical research coordinator
- JoAnn Nevelles, research assistant
- Patty Nieters, RN, BSN, clinical nurse coordinator
- Leslie Rickard, grant assistant
- Patty Rueweler, regulatory coordinator
- Linda Schimmoeller, RN, BSN, CCRC, clinical research specialist
- Mandie Street, RT(R), clinical research coordinator
- Kathy Taylor, clinical research coordinator
- Jeanine Wade, RT(R), clinical research coordinator
- Rochelle Williams, data assistant

Finding the right people
Once a project is approved, CRL staff identifies and screens potential research participants. Diligent and qualified CRL team members interact with potential study participants, educating them about the goals of the study and addressing any questions or concerns they might have. This educational process helps potential study subjects to make an informed decision about whether to participate.

Mastering a large-scale challenge
The NLST Services provided by the CRL have been particularly useful for Washington University School of Medicine’s participation in the National Lung Screening Trial (NLST), sponsored by the National Cancer Institute (NCI). The NLST is an ongoing multicenter study designed to compare lung cancer mortality rates in smokers screened for lung cancer by chest X ray or computed tomography. At the Washington University site, the CRL staff has carried out all aspects of the study, including patient recruitment and enrollment, preparation of images for viewing, computerized data entry, and tracking participant health status. Since the study’s launch in 2002, nearly 3,800 participants were recruited at the Washington University site.

CRL staff has carried out all aspects of the study...
David Gierada, MD, associate professor of radiology and co-principal investigator for the Washington University NLST site, finds the CRL staff to be an invaluable asset: "A trial of the size and complexity of the NLST requires considerable skill, organization, and coordination, so the performance of the CRL has been truly impressive. This has involved efforts of numerous study coordinators, nurses, as well as data entry and office support staff, working in conjunction with radiologists and designates of the NCI overseeing the trial. In the NLST and other clinical imaging studies, having study coordinators with a radiology background ensures the technical standards of imaging protocols are met and optimal image quality is maintained for scientific purposes."

The NLST is now closed to enrollment, but the CRL will continue to be involved in patient follow-up and retention until its expected completion in 2011.

IRAT

The CRL also works closely with the Imaging Response Assessment Team (IRAT) led by Barry Siegel, MD, professor of radiology and of medicine and chief of Mallinckrodt Institute's Division of Nuclear Medicine. IRAT, also funded by the NCI through the Siteman Cancer Center, is a shared resource designed to promote collaboration between radiologists and oncologists during early stages of clinical trials, when imaging could predict clinical outcome.

Marilyn Siegel, MD, professor of radiology and of pediatrics and the lead radiologist for conventional imaging studies, heads a team of six dedicated IRAT radiologists who perform all measurements of tumor response to the treatment under investigation, ensuring consistency within a study. The CRL coordinators monitor all incoming requests, schedule and prepare images for review, and track all images and results, so the IRAT radiologist can concentrate exclusively on interpreting exams.

Expanding their focus

The CRL, although still primarily focused on working with radiologists, is now assisting principal investigators in other departments with imaging-related research. In most cases, a recommendation is made to include a radiology co-investigator to provide technical and clinical support.

"One of our greatest advantages is that members of the CRL are intimately familiar with all imaging modalities..." from the CRL," adds Meese. "Our role is to do all we can to help radiology faculty succeed. If they succeed—then we do."

Patty Nieters, RN, is working with Suresh Vedantham, MD, the national principal investigator for a multicenter, NIH-funded study on the aggressive treatment of deep vein thrombosis (blood clots in the leg).
An estimated 70 percent of all women between the ages of 35 and 60 have uterine fibroids; one in four women in the United States has symptomatic fibroids severe enough to require treatment. Over 600,000 hysterectomies are done each year—many of them for fibroid symptoms—at a cost of $5 billion. But there is a cost-effective alternative to hysterectomy and its attendant complications: uterine fibroid embolization (UFE), sometimes called uterine artery embolization (UAE). Over 100,000 UFEs have been performed worldwide with an enviably low complication rate. UAE has been used since the 1990s for emergency embolization for postpartum hemorrhage or to stabilize bleeding of a tumor prior to surgery.

by Mary Jo Blackwood, RN, MPH, CHES
At Mallinckrodt Institute of Radiology (MIR), Michael Darcy, MD, leads a team of interventional radiologists who collectively have decades of experience with UFE. “We believe there is a large population of women who could be successfully treated with this procedure, but it is often overlooked as an option due to a general lack of awareness among the patients and their doctors,” he says. “We strive to provide our patients with information and education on the procedure and other alternatives so they can make an informed choice.

Lynn Hoese, a registered nurse on our team, excels in working with the patients and their families to provide procedure-related education and support.”

Nassir Siddiqi, MD, assistant professor of radiology, has been performing UFE for more than seven years with excellent results. For patients concerned about cutting off the blood supply to the uterus, he explains that the uterus is a resilient organ with the ability to withstand periods of blood flow deprivation: “During childbirth, for example, the uterus cuts off its own blood supply, while detaching the placenta, to keep the woman from bleeding to death. Nature designed it very well.”

“We believe there is a large population of women who could be successfully treated with this procedure, but it is often overlooked as an option due to a general lack of awareness among the patients and their doctors…”

How UFE Works
The patient must fast overnight. During the procedure—which takes about an hour and is done in the interventional radiology suite—the patient receives a local anesthetic. Then, a catheter (a thin tube) is passed into an artery in the groin and threaded into the uterine arteries where tiny embolic particles—about the size of grains of sand—are released. Riding along with the blood flow, these particles become lodged in the tiny arterioles feeding the fibroids and uterus, blocking the blood supply. If the uterus’ blood supply is removed, it draws on other vessels for a blood source and totally recovers within a couple of days. Fibroids, however, quickly starve to death when deprived of their blood supply, stop producing excessive bleeding, and become soft and spongy, taking the pressure off adjacent organs. Over time, the fibroids shrink to 50 percent or more in size.

Left: Selective injections into a uterine artery with a large hypervascular fibroid

SYMPTOMS

Uterine fibroid symptoms
• Heavy, prolonged menstrual flow
• Unusual monthly bleeding, sometimes with clotting
• Back and leg pain
• Pelvic pressure and pain
• Bloating and constipation caused by pressure on bowel
• Frequent urination caused by pressure on bladder
• Enlarged abdomen.
Regaining quality of life

“When I was having such heavy cramping and bleeding from my fibroids, I thought hysterectomy was my only option. I wouldn’t have thought of UFE, but my gynecologist brought it up, showed me a pamphlet on it, and gave me Doctor Darcy’s name, explaining that the procedure is done by an interventional radiologist.”

Karen Wehmeyer had a magnetic resonance scan prior to her appointment with Darcy, who showed her the films and mapped the route he would use to do the embolization. He also laid out her options, the pros and cons, so that she knew what to expect every step of the way. Wehmeyer gave Lynn Hoese, Darcy’s nurse, high marks for her explanation of the procedure and what to expect.

“I had IV [intravenous] sedation, and I went into the operating room awake but relaxed. The anesthesiologist, the nurse, and Doctor Darcy talked to me throughout the procedure, which took about an hour. They explained everything they were doing and included me in the conversation. I felt like I was in very competent hands.”

Wehmeyer stayed overnight in the hospital so her pain medication could be regulated. A pain pump was connected to an IV during the procedure and when the cramping started, she understood how to use it and was able to get relief from the pain. She went home the next morning, with a supply of oral pain medications. The pills managed the pain adequately and after two days, she didn’t need them.

“I took a week off from work to give my body time to recover, but after that, I was cleaning house and really wanted to get back to work. Two days after the procedure, I went to my daughter’s dance competition and climbed to the top of the bleachers in the gym with no problem,” she says.

Her real excitement, though, is the relief from her symptoms. “After the procedure, I had a very scant two-day period and then didn’t another one for three months. The periods I’ve had since then have been extremely light. I have recommended this procedure and Doctor Darcy’s team to all of my friends. There is really no recovery as compared to abdominal surgery, so I got my life back quickly.”

Says Siddiqi, “UFE has many advantages over hysterectomy: It is minimally invasive. The tiny nick in the groin leaves no scar, so it’s a good cosmetic result. We use thin catheters to access the arteries supplying the uterus. No general anesthesia is involved, and patients are ambulatory in six hours or less. They resume oral intake shortly after the procedure and generally stay one night in the hospital, so we can control any pain.”

“The fibroids start dying immediately after UFE is completed. The release of chemicals from the dying fibroids into the systemic circulation causes some cramping. The cramping may be initially severe but is easily controlled by pain medicines given intravenously in the hospital and then oral medications for a couple of days,” Siddiqi adds. “The procedure is more cost-effective than a hysterectomy, is need only once in the majority of patients, and most patients are back to work within a week or so versus six weeks with a hysterectomy. Most patients have satisfactory resolution of symptoms with this procedure.”

The success rate of UFE is impressive: 90 percent when the predominant symptom is heavy bleeding; 85 percent if the main symptom is pressure and bulk. For women who want to have children, UFE spares the uterus. “However, there is not enough data to claim that fertility is not affected. There is a small chance that UFE will affect the ovaries because of tiny connections between the ovaries and uterus and blocking the arteries that feed the ovaries. It can happen in up to ten percent of women, more often in patients over the age of forty five,” says Siddiqi. “If a woman wants to become pregnant,
she may want to consider hormonal therapy or myomectomy, an invasive surgical procedure that removes individual fibroids directly."

However, results of alternative therapies are mixed: The effects of hormonal therapy are temporary, and symptoms usually recur after hormonal withdrawal. There are 40,000 myomectomies done annually, but Siddiqi cautions that it's an aggressive, invasive procedure—and sometimes the fibroids removed might not be the ones causing the symptoms. The surgery also leaves areas of weakness and scarring in the uterus that potentially could cause complications during childbirth.

"The procedure is more cost-effective than a hysterectomy..."

FACTS

**Uterine Fibroid Facts**

- Every 10 minutes, 12 hysterectomies are performed in the United States.
- The majority of hysterectomies performed are due to the presence of uterine fibroids.
- 37 percent of all women undergo hysterectomy by age 60.
- African American women are 2 to 3 times more likely to have symptomatic uterine fibroids, typically at a younger age than other women with uterine fibroids.
- Average age range for fibroids to become symptomatic is 35 to 50 years.
- Obesity is associated with the presence of uterine fibroids.
- Recent research has shown some protective value (reduced incidence of uterine fibroids) to the consumption of green vegetables, fruit, and fish.
- Fibroids often grow rapidly during pregnancy when hormone levels are elevated and shrink after menopause when hormone levels decrease.

*Source: National Uterine Fibroids Foundation website: www.nuff.org/health.htm*
Appropriateness of UFE

“Not every woman with pelvic pain and excessive bleeding has fibroids. MIR interventional radiologists personally evaluate the patients during a clinic consult and obtain a magnetic resonance scan to make sure the fibroids are of the type and size that could be causing symptoms,” says Darcy, professor of radiology. “Contrary to some misconception, most IR [interventional radiology] practices follow a clinical model of patient care: obtaining a patient’s medical history; conducting a physical exam; arranging for required labs and procedures, admissions, and pre-certifications; and providing extensive patient education, including a discussion of the risks, benefits, and alternatives of the procedure.

In addition to the extensive history and physical exam, patients must have had a normal Pap smear [Papanicolaou screening test for cervical cancer] within the last year. Patients above a certain age who have irregular bleeding are referred to their gynecologists for an endometrial biopsy. This, together with the magnetic resonance imaging (MRI) of the pelvis, can identify other problems, if present. After undergoing UFE, the patient has a follow-up appointment after a few weeks and at six months, when they will have a repeat MRI to confirm all changes. All information is shared with the referring physician to ensure continuity of care.

As more information is publicized about the effectiveness of UFE, referrals continue to grow, and now Mallinckrodt Institute has the largest experience with UFE in the St. Louis Metro area.

Editor’s Note: To speak to a doctor or nurse about UFE, call (314)362-2375 or toll-free at 1-866-254-7237.

“We provide complete patient care, including follow-up care after the procedure in conjunction with the referring physician.”

The MIR Team

Michael Darcy, MD
Jennifer Gould, MD
Lynn Hoese, RN
Naganathan Mani, MD
Nael Saad, MD
Nassir Siddiqi, MD
Darryl Zuckerman, MD
PUSHING BACK BOUNDARIES
A St. Louis MRI scanner to be used in brain research in Argentina

by Steve Kohler

Out with the Old—the Siemens Vision MRI scanner was moved from the Imaging Center on Scott Avenue.
The indigenous Kolla people reside in the remote, mountainous plains of northwestern Argentina—more than 1,500 kilometers from Buenos Aires. They have no cars, few roads and, in many villages, only locally produced electricity. The train that once served the area stopped running 15 years ago. As a result, if the Kolla develop serious illnesses, they often go untreated. With only six psychiatrists for the entire region of 650,000 people, mental illnesses are particularly underdiagnosed.

But soon, a world-class diagnostic imaging device—a magnetic resonance imaging (MRI) scanner—will be delivered into their midst. Getting it there required every bit of the collaborative spirit and tenacious purpose that characterize the endeavors of Mallinckrodt Institute of Radiology (MIR) and Washington University.

THE SEED

Three years ago, when MIR faculty began to contemplate the need for a new research scanner, they wanted it to be an addition, not a replacement. The East Building’s existing scanner—a highly developed and well-tuned device—had been a “workhorse,” according to Marcus Raichle, MD, professor of radiology, of neurology, and of neurobiology. Many projects were being conducted with it as the data collection device.

So when space and budget constraints eventually made it clear that a new machine would have to replace the old one, sending the older scanner off for scrap seemed inappropriate and wasteful, Raichle says. Conversations soon began about how the machine might continue to be of service somewhere else. No one remembers the exact details, but during those discussions, Yvette Sheline, MD, professor of radiology and of psychiatry, mentioned a project being conducted in Argentina by a colleague, Gabriel de Erausquin, MD, PhD, associate professor of psychiatry and of neurology, that involved investigations into untreated schizophrenia.

Eventually, de Erausquin was invited to make a presentation to the Mallinckrodt Institute committee about how a scanner could benefit his research.

Thus began the saga of the first donation of such a device by a university to a drastically underserved region, a complex and layered puzzle that has called upon the talents of many people but especially Thomas Conturo, MD, PhD, associate professor of radiology,
of physics, and of biomedical engineering. Displaying his nature as a scientist, Conturo calls the experience, “one big experiment.” Instead of Petri dishes and DNA analysis, the tools in this experiment include U.S. Air Force C-17 Globemaster flights to Argentina, carrying 14 huge crates plus the scanner’s magnet—about 36,000 pounds of equipment, including the 23,000-pound magnet. Given all that the MIR team learned, Conturo is convinced that the experiment now could be replicated.

THE DELIVERY

The size of the payload was just one of the project’s complicating factors. “It was an ambitious undertaking,” Conturo says. Getting the magnet out of the scanner bay was the first challenge. Lots of help is available to install a newly purchased magnet, but the logistics and cost of disconnecting and removing this used one all fell to Washington University. Then it had to be trucked, boxed, and stored in such a way that it could be reassembled.

WASHINGTON UNIVERSITY

Above: Gabriel de Erausquin, MD, PhD
Right: Thomas Conturo, MD, PhD

Conturo says legal questions surrounding the donation—
What was the value of the scanner?
Who are the requirements for duty-free entry into Argentina?
—required nine months. Then came the move itself. Trucking it to Miami for loading onto a container ship was ruled out because the cargo wouldn’t fit under many highway overpasses. Departure via Chicago and the Great Lakes was no better, and a route via the Mississippi River was not possible. There was talk of giving up, Conturo and Raichle admit.

Then, a chance meeting between Conturo and scanner transportation specialists at the Radiological Society of North America’s annual meeting reinvigorated the project. “They were with the company that moved the Rolling Stones’ rock-and-roll stage show to Russia,” Conturo says. “They knew the legalities of getting through customs anywhere and regularly moved huge payloads.”

In with the New—the 3 Tesla Siemens Trio (a whole-body scanner) was hoisted onto metal tracks.

They also knew that no shipboard container was big enough. At 105 inches high (or even 95 inches if all possible parts were removed), the scanner’s magnet would need an open-topped container, and U.S. Homeland Security requires sealed containers. So they proposed air transport. But no commercial plane flying to Argentina could haul such cargo.

“They knew the legalities of getting through customs anywhere…”

Mississippi River was not possible. There was talk of giving up, Conturo and Raichle admit.

That left only the military. While he was participating in a conference in Buenos Aires, de Erausquin learned from his collaborators that the U.S. Air Force routinely flies supplies to South America (known as a channel flight). But whom to contact? Raichle says he jokingly suggested calling the Pentagon by looking under “P” in the phone book—which turned out to be exactly what de Erausquin had done, only to learn that the correct people were in MIR’s back yard at Scott Air Force Base in Illinois.
Fortuitously, the U.S. Air Force regularly runs a huge plane full of humanitarian supplies to South America. And "yes," they said, the scanner could go at no charge under the auspices of the U.S. Congressional Denton Amendment that allows donors to use space on U.S. military cargo aircraft to transport goods and equipment to countries in need. The Denton Program is run by the U.S. Agency for International Development (USAID); after application to the program, approval by the U.S. State Department, and months of coordination between USAID officers and FULTRA (the foundation responsible for the project in Argentina), the scanner shipment was authorized and a transportation solution was finally in place.

That breakthrough, Conturo says, revealed the next layer of complications. The magnet had to be restrained on the plane to resist g-forces of 3.0 to 4.5g, so a structural engineering analysis had to be performed—which a U.S. Air Force engineer had to approve—in order to certify the cargo for airlift. Because the scanner is a precision device, chains can’t simply be slung around it. Enter Washington University’s machine shop and facilities management. The restraint system—consisting of a steel frame, beams, wooden packing, and chains through steel rings—was designed (and is still evolving), in consultation with the Air Force, and a structural analysis is underway. Arrangements for getting components of the scanner from Buenos Aires, across the continent using military tank transports, into an appropriate location, and for obtaining installation and operation funding were facilitated by de Erausquin’s established contacts with health agencies and the military in Argentina.

THE REINCARNATION
In its new life in Salta, the scanner will be a wellspring of health benefits to the Kolla people and others of their region, where no other MRI scanner exists. Installed in the Hospital Militar de Salta (Hospital Bedoya), it could perform perhaps 10 scans per day for as many as the next five to 10 years, benefiting up to 36,000 patients who otherwise would never have a MRI scan, Conturo says. Because ownership of the scanner was transferred to a free-standing institute operated under an agreement between two healthcare foundations, all MRI imaging will be provided at cost to most users and free-of-charge to the Kolla population.

The scanner also adds an important layer to de Erausquin’s research. Until now, his investigations into untreated chronic schizophrenia in the region have progressed without a sophisticated imaging component.
“The lack of advanced imaging has been a limitation on the work,” de Erausquin says. It’s a “core need” in his attempt to get a handle on the cascade of events behind schizophrenia.

“Mission accomplished: The water cabinets are secured in the plane’s hold and are ready to be flown to South America.”

“The precise neurophysiological images the scanner produces will assist in separating the clinical manifestations of schizophrenia according to their potential causes—genetics, damage to particular neurons during development, and others. The comparison of specific changes in behavior and movement with changes in brain physiology that the scanner makes observable will be invaluable to the research, he says.

Because schizophrenia among the Kolla so frequently goes undiagnosed and untreated, the newly diagnosed, newly treated patients in these studies will be relatively unaffected by powerful pharmaceutical therapy usually prescribed for the disease. Through diagnosis, clinical care, and research involving this population, it may finally be possible, de Erausquin says, to ascertain whether any changes in the brain, detected by MRI imaging, are attributable to the disorder or to drug treatment. The research in the Andes ultimately may resolve long-running uncertainty and disagreement among researchers worldwide about whether certain observations in schizophrenia are truly a part of the disorder or are actually attributable to the side effects of pharmaceutical treatments.

Literally pushing back boundaries—from St. Louis to the Puna de Atacama range of the Andes—Mallinckrodt Institute faculty and their many colleagues kept at this project in the knowledge that their beloved old scanner could be of real benefit. With the device expected to be operational sometime in 2009, they will get to relish all of the ways in which that turns out to be true, from providing an accurate diagnosis of a single head injury that occurred 9,000 kilometers away to possibly putting to rest some of the most persistent questions in brain research.

THE UNSUNG

In addition to Raichle, Conturo, de Erausquin, Sheline, and Gilbert Jost, MD, director of Mallinckrodt Institute and head of the Department of Radiology, many people and organizations pitched in to make the donation of the scanner possible. Here are a few, with apologies to those overlooked.

Washington University
• John Kreitler, machine shop
• Gary Maus, purchasing
• Roy Van Hee, facilities management
• Marion Harris, Center for Clinical Imaging Research at Mallinckrodt Institute

Industry
• Lee Wyman, Ben-Hur Construction, St. Louis
• Grace Warner, Rock-It-Cargo transport service
• Jonathan Wood, Siemens Medical Solutions USA, Inc.
• David Purdy, PhD, Siemens Medical Solutions USA, Inc.
• Siemens Argentina
• Mario Gomez, PhD, structural engineering consultant, St. Louis

Military
• Technical Sergeant Charles Rager and colleagues, 375 Logistics Readiness Squadron air transportation specialists, Scott Air Force Base, Illinois
• Ken Hundemer and Mike McAvoy, Dental Program, Charleston Air Force Base, South Carolina
• Eric Treadwell, Wright-Patterson Air Force Base, Ohio
• Ejercito Argentino (the Argentinean Army)
• Eliana Korin, U.S. Air Mobility Command, Argentina

Foundations
• USAID Denton Program
• FULTRA Foundation, Argentina
• FUSEA, Argentina
By Steve Kohler

Lilliputian Particles

don't produce GIANT STRIDES in medicine

With cargo to deliver,
you need a truck of the right size and configuration. Too small, and the payload won’t fit. Too big, and overpasses, tight turns, and other obstacles restrict your destination.

The problem is essentially the same for researchers exploring the delivery of imaging agents and therapeutic radiation or pharmaceuticals using nanoparticles. It may be counterintuitive to think of a submicroscopic particle about the size of a single virus virion as a truck, but in many ways, the analogy holds, according to Michael Welch, PhD, professor of radiology, of chemistry, and of molecular biology and pharmacology.

Small animal projection positron emission tomography (PET) image at 4 hours: hind limb ischemia in mouse model using control-comb nanoparticle (NP), shown on right within red circle, and \( \alpha_{v} \beta_{3} \)-targeted-comb NP, shown on left. Uptake of \( \alpha_{v} \beta_{3} \)-targeted-comb was higher in the ischemic hind limb (shown on left) as compared to the control limb.
What are nanoparticles?

Though they are almost incomprehensibly tiny delivery devices, nanoparticles nonetheless are larger than the small molecules "...there are adverse effects and risks to everything, and we want to reduce them as much as possible while we maximize the benefit.”

commonly used to enhance imaging, known broadly as contrast agents. Those small molecules can be manufactured to have, “one, maybe two functions—a targeting element and something that can be detected to make an image,” Welch says. By contrast, nanoparticles can be “decorated with many small molecules” that enhance their functionality. And because they are only one-tenth to one one-hundredth the size of microparticles,
nanoparticles that are injected into the bloodstream can go to destinations that microparticles cannot. They also are not rapidly screened out of the system by the body's filters, such as the lung and the spleen.

Nanoparticles can be manufactured from many substances—inorganic particles are often forms of iron or gadolinium, a rare earth mineral with magnetic properties. Those that Welch, associate director of oncologic imaging for Siteman Cancer Center, develops are organically based. They originate in the laboratory of Karen Wooley, PhD, professor of chemistry and of radiology, who says that her nanoparticles are similar in composition to the Styrofoam™ in a throw-away coffee cup, which, believe it or not, is organically based. Others start as polyacrylic acid, akin to the absorptive filling in disposable diapers. Either way, their organic nature provides a measure of security against potential toxicity, Welch says. “Once they've done their work, they fall apart.”

Crafting Organic Nanostructures with Well-defined Sizes, Shapes, Structures, and Properties:
Robust nanoscale objects for fundamental studies and applications in nanomedicine

Cell transduction component
- permeation peptide

Targeting component for cell surface
- antibody, peptide or small molecule

Detection element
- radionuclide, MRI agent, or optical chromophore

Stealth character
- targeting component for intracellular mRNA – PNA

Therapeutic payload
- drug, protein or gene

Cardiac disease and cancer research

Welch and Wooley have been exploring the potential for nanoparticles in imaging for six years, funded by a major grant from the Heart, Lung and Blood Institute of the National Institutes of Health. Mallinckrodt Institute of Radiology at Washington University is one of only four centers in the nation named to develop nano agents for applications in cardiac disease. Lately, Welch and Wooley have been working to control the size, shape, flexibility, and composition of the particles so they can be tailored to do precisely the work that the researchers want done.
By manufacturing nanoparticles with surface chemistries that react to water at known rates, the researchers can dictate the length of the nanoparticles’ lives. That means, Welch says, that the life of a radioactive tag that’s attached to a nanoparticle is able to be controlled—functional long enough to generate an image but degraded and cleared from the body quickly thereafter. By using the available surface to attach many such radionuclides, the image produced is brighter than what was possible previously, and a lower dosage gives a better diagnostic image. Lower dosages are desirable because they produce fewer adverse effects.

Also instrumental in determining the lifetime of the nanoparticles, Wooley says, is the size. Small versions, what she calls “stealth” particles, take longer to be detected and don’t antagonize the body’s defenses as quickly, so they survive longer. That control is important, Wooley says, particularly because “there are adverse effects and risks to everything, and we want to reduce them as much as possible while we maximize the benefit.” Controversy exists, for example, over the safety of gadolinium nanoparticles, with some of the opinion that they can cause serious injury to the liver.

“If you can see the inflammation and assess its extent, you may be able to guide therapy more successfully.”

Wooley and Welch also attach targeting molecules to the surfaces of the nanoparticles to steer the complex precisely to a specified destination. Using antibodies, peptides, and ligands (molecules that recognize and bind to specific receptors), they have developed an array of clever systems for targeting particular locations. For example, certain peptides recognize and bind to enzymes of the immune system that are up-regulated as part of the body’s inflammatory response. Exploiting this activity provides the investigators with an effective way to make images of the inflammation that is characteristic of lung damage or acute vascular injury. “If you can see the inflammation and assess its extent, you may be able to guide therapy more successfully,” Welch says.

In their work on heart disease, the researchers have devised methods for targeting blood clots and atherosclerotic plaques, indicators of an impending heart attack that otherwise would be difficult to diagnose until the event has occurred. Welch believes nanoparticle imaging may make it possible to determine the extent of pre-heart attack cardiac disease so that clinicians can intervene before disaster strikes.

Cancer cells also express particular receptor proteins on their surfaces and inside cells. And by isolating the ligands that bind to those receptors and making them a part of the nanoparticle’s exposed cargo, Welch and Wooley can send the little payloads to tumors. The delivery also can include proteins called cell permeation peptides—proteins that drag themselves through the cell wall, along with

Nanoparticles

**HOW BIG?** Nanoparticles get their name from the prefix “nano,” meaning one-billionth. Strictly speaking, they should then be a billionth of a meter in diameter or long dimension. That’s 10⁻⁹ meters, if that helps. In fact, the group of particles classed as “nano” ranges from five to 100 nanometers in size, Wooley says.

That’s roughly the size of a virus particle, or virion, which is still not very instructive. So Wooley offers this image: In size, a nanoparticle is to an average human body as that human body is to the planet Earth.

Or, try this: If you have a full head of hair and, instead of being as big as they are today, the individual hairs were the thickness of a single nanoparticle, you’d appear completely bald to the human eye, the strands invisible.
Radiolabeled nanoparticles can be studied in mice, comparing three different particles with different stealth properties.

It works in visual imaging applications as optical probes to deliver fluorescent agents—the light from these agents can be detected by a new generation of scanners that will be able to "see" and then enhance what the eye cannot.

Nanoparticles also hold promise as a means to transport therapeutic agents of several types. If they can deliver small molecules for imaging purposes, and there is room on the truck, then they also might be used to haul pharmaceuticals to carefully targeted disease sites. By controlling distribution and dose, adverse effects might be mitigated. Welch says the same technique might be applied to delivering radiotherapy to tumor sites. By using nanoparticles that release their radiation only when they have accurately reached a tumor, for example, the need to treat cancer by passing beams of radiation through nearby, healthy tissue could be reduced. And the potential exists for using them in gene therapy to replace defective genes or restore failing gene activity.

It's this multifunctional aspect of nanoparticles and the precise control that researchers can exert over their behavior that make them especially promising for radiologists. Welch believes that nanoparticles have the potential to be the next big advance in imaging technology, a future in which fewer and smaller trucks will be guided precisely down the body's highways to do more work with reduced risks of adverse effects.

The RESEARCH TEAM

A grant from the Heart, Lung and Blood Institute/National Institutes of Health funds research for developing nanoagent applications in cardiac disease.

- **Samuel Achilefu**, PhD, professor of radiology and of biochemistry and molecular biophysics
- **Carolyn Anderson**, PhD, professor of radiology, of molecular biology and pharmacology, and of chemistry
- **Stephen Brody**, MD, associate professor of medicine
- **Robert Gropler**, MD, professor of radiology, of medicine, and of biomedical engineering
- **Michael Welch**, PhD, professor of radiology, of chemistry, and of molecular biology and pharmacology
- **Pamela Woodard**, MD, associate professor of radiology
- **Karen Wooley**, PhD, professor of chemistry and of radiology
Taking MIR expertise on the road.

The idea of sharing MIR expertise with radiologists and radiology residents in India was conceived at a noon conference in Scarpellino Auditorium. As I heard the lectures given by MIR faculty, I wished that residents in my native India could be exposed to this high quality of training and education. I was actively involved in education and training programs in India and was involved in the management of an ultrasound training school for technologists and doctors in Coimbatore.

On a CME trip to Thailand, I travelled with Sanjeev Bhalla, MD, associate professor of radiology, and Christine Menias, MD, associate professor of radiology. During the trip, I proposed to them the idea of a CME course in India. Their enthusiasm to participate was the catalyst I had been waiting for.

For the course to be truly effective, the Indian Radiology and Imaging Association (IRIA) had to be involved in the planning. Dr. N. Kulasekaran, president of IRIA, was very encouraging and supportive. After much deliberation, we chose Agra as the CME course site. Agra is easily accessible from Delhi for international faculty, and it is the home of the Taj Mahal—a world renowned monument and a big attraction for delegates. Dr. Bhupendra Ahuja took on the responsibility of all local organization on behalf of the Uttar Pradesh state branch of IRIA. A team was assembled to coordinate the entire conference, and their efforts toward the success of the initiative cannot be overemphasized.

Bhalla, Menias, and I were the final Mallinckrodt Institute faculty for this maiden attempt. The success of this CME would be the basis for an annual or a biannual event focusing on different areas of radiology. Thus, it was imperative to actively participate in the formations of this course curriculum and selection of the faculty.

We decided to focus on “Body Imaging” and a “Musculoskeletal Ultrasound Workshop” for this first course, which required multiple late night telephone calls and teleconferences with the organizers in India. Flexibility was critical in multiple areas. We asked nationally known speakers from India to

In Coimbatore, Dr. Murugan, the CME organizer, introduces doctors Nirvikar Dahiya, Menias, and Bhalla. Murugan, who runs a state-of-the-art diagnostic facility in the region, visited Mallinckrodt Institute in 2007.
cover magnetic resonance imaging and added faculty for the workshop related to musculoskeletal ultrasound.

The CME in Agra was two days (August 2 and 3) of intense work—the faculty lectured to and answered questions from more than 150 residents and junior radiologists attending the CME. The workshop received rave reviews. Everyone appreciated the quality of teaching. Positive feedback was put forth on how to conduct an even better CME and workshop in the future.

We did get to see the Taj Mahal in Agra. The multiple pictures seen in brochures and travelogues do not do justice to the mausoleum’s majestic appeal in real time. After a brief stopover in Jaipur, we proceeded to Coimbatore, an industrial city in South India. On August 10, we conducted a one-day CME course, which focused on multidetector CT technology and its role in changing radiology management, for the local radiologists and other physicians. We were pleasantly surprised by the enthusiasm shown by the local students and physicians.

Our basic idea for the CME course in India was to achieve “knowledge transfer” in a way that would contribute to the future of radiology on an international scale. While international conferences routinely achieve this goal, our concerted effort at the CME in India was to present the content in a manner that resonates with the excellence of the residency and fellowship training programs at Mallinckrodt Institute. To that effect, I think we succeeded and hope that our effort will motivate other distinguished faculty from Mallinckrodt Institute to participate in similar CME programs in India in the future.

—Nirvikar Dahiya, MD

Below: (Left to right) Bhalla, Menias, and Dahiya at the Taj Mahal in Agra—an internationally known mausoleum built during the reign of Mughal Emperor Shah Jahan in memory of his wife Mumtaz Mahal.
In this section, the names of employees who are full-time faculty or staff or who have an appointment in the Department of Radiology are highlighted in boldface type.

**NEW FACULTY**

Catherine Appleton, MD, instructor in radiology, Division of Diagnostic Radiology.

Xiang He, PhD, instructor in radiology, Division of Radiological Sciences.

Cheryl Herman, MD, instructor in radiology, Division of Diagnostic Radiology.

Jack Jennings, MD, PhD, instructor in radiology, Division of Diagnostic Radiology.

Geetika Khanna, MD, assistant professor of radiology, Division of Diagnostic Radiology.

Seung Kwon Kim, MD, assistant professor of radiology, Division of Diagnostic Radiology.

Robert Pallow, MD, instructor in radiology, Division of Diagnostic Radiology.

Nasir Siddiqi, MD, assistant professor of radiology, Division of Diagnostic Radiology.

**FIRST-YEAR FELLOWS**

Tara Anthes, MD, breast imaging clinical fellow, received an undergraduate degree from Brown University and a medical degree from the University of Washington. She completed additional training at Virginia Mason Medical Center and a diagnostic radiology residency at the Mallinckrodt Institute of Radiology.

Truitt Balart, MD, abdominal imaging clinical fellow, received an undergraduate degree from the University of Georgia and a medical degree from Louisiana State University. He completed additional training and a radiology residency at Louisiana State University Health Sciences Center.

Samuel Chang, MD, body magnetic resonance imaging clinical fellow, received an undergraduate degree from the University of Utah and a medical degree from the Mallinckrodt Institute of Radiology.

Monica Kessi, MD, diagnostic neuroradiology clinical fellow, received an undergraduate degree from Northwestern College and a medical degree from the University of Iowa. He completed additional training at the Mallinckrodt Institute of Radiology.

Catherine Glynn, MD, breast imaging clinical fellow, received an undergraduate degree from the National University of Ireland.

Jennifer Demertzis, MD, musculoskeletal radiology clinical fellow, received an undergraduate degree from Emory University and a medical degree from the University of Notre Dame. She completed additional training at Emory University and four years (chief resident, 2007-2008) of diagnostic radiology training at the Mallinckrodt Institute of Radiology.

Tejaswini Deshmukh, MD, pediatric radiology clinical fellow, received an undergraduate degree from Johns Hopkins University and a medical degree from the University of Missouri. She completed additional training at the Mallinckrodt Institute of Radiology.

Alexandra Georges, MD, musculoskeletal radiology clinical fellow, received an undergraduate degree from Johns Hopkins University and a medical degree from the University of Missouri. She completed additional training and a radiology residency at the Mallinckrodt Institute of Radiology.

Samuel Gibson, MD, abdominal imaging clinical fellow, received an undergraduate degree from Johns Hopkins University and a medical degree from the University of Missouri. He completed additional training and a radiology residency at the Mallinckrodt Institute of Radiology.

Cheryl Herman, MD, breast imaging clinical fellow, received an undergraduate degree from Brown University and a medical degree from the University of Washington. She completed additional training at Virginia Mason Medical Center and a diagnostic radiology residency at the Mallinckrodt Institute of Radiology.

Eric Hatfield, MD, body magnetic resonance imaging clinical fellow, received an undergraduate degree from the University of Notre Dame and a medical degree from Washington University in St. Louis. He completed additional training at St. Mary's Health Center and four years of diagnostic radiology training at the Mallinckrodt Institute of Radiology.

Alok Jaju, MD, pediatric radiology clinical fellow, received an MBBS degree from Government Medical College and Hospital. He completed additional training at Government Medical College and Hospital and at Lokmanya Tilak Municipal Medical College.

Kartikeya Kantawala, MD, abdominal imaging clinical fellow, received an MBBS degree and a diploma in Medical Radio-diagnosis from Lokmanya Tilak Municipal Medical College and Hospital and a medical degree from the University of Seychelles. He completed additional training and a radiology residency at Lokmanya Tilak Medical College and Hospital.

Shahid Sattar, MD, abdominal imaging clinical fellow, received an MBBS degree and a diploma in Medical Radio-diagnosis from Lokmanya Tilak Municipal Medical College and Hospital and a medical degree from the University of Seychelles. He completed additional training and a radiology residency at Lokmanya Tilak Medical College and Hospital.

John Demertzis, MD, diagnostic neuroradiology clinical fellow, received an undergraduate degree from the University of Oregon and a medical degree from the University of Utah. He completed additional training at Legacy Emanuel Hospital and a radiology residency at Saint Louis University.
Jonathan Kraus, MD, musculoskeletal radiology clinical fellow, received an undergraduate degree from the University of Notre Dame and a medical degree from Wake Forest University. He completed additional training at the University of Alabama.

Alan Lobo, MD, diagnostic neuroradiology clinical fellow, received an undergraduate degree from Texas A&M University and a medical degree from Louisiana State University. He completed additional training and a radiology residency at Henry Ford Hospital.

David Loy, MD, PhD, diagnostic neuroradiology clinical fellow, received an undergraduate degree, a medical degree, and a doctoral degree from the University of Louisville. He completed additional training at the University of Louisville and four years of diagnostic radiology training at Mallinckrodt Institute of Radiology.

Jose Maldonado, MD, cardiothoracic imaging clinical fellow, received an undergraduate degree from Tulane University and a medical degree from the University of Puerto Rico. He completed additional training and a radiology residency at the University Hospital, University of Puerto Rico.

Paolo Marciano, MD, PhD, interventional radiology clinical fellow, received an undergraduate degree, a medical degree, and a doctoral degree from the University of Pennsylvania. He completed additional training at the University of Pennsylvania and four years of diagnostic radiology training at Mallinckrodt Institute of Radiology.

Christopher Murdock, DO, body magnetic resonance imaging clinical fellow, received an undergraduate degree from the University of Utah and a medical degree from Kansas City University of Medicine and Biosciences. He completed additional training at Forest Park Hospital and a radiology residency at Saint Louis University.

Amy Oberhelman, MD, diagnostic neuroradiology clinical fellow, received an undergraduate degree from Stanford University and a medical degree from Washington University in St. Louis. She completed additional training at St. John’s Mercy Medical Center and four years of diagnostic radiology training at Mallinckrodt Institute of Radiology.

Rosana Ponisio, MD, diagnostic neuroradiology clinical fellow, received a medical degree from the National University of La Plata.

Monika Prost, MD, breast imaging clinical fellow, received a medical degree from Charles University. She completed additional training at the University of Missouri, Columbia Health Science Center.

Steven Repka, MD, abdominal clinical fellow, received an undergraduate degree from Pennsylvania State University and a medical degree from Temple University. He completed additional training and a radiology residency at Western Pennsylvania Hospital.

Patricia Richmond, MD, breast imaging clinical fellow, received an undergraduate degree from the University of California, Berkeley, and a medical degree from the University of California, San Francisco. She completed a transitional year at Forest Park Hospital and four years of diagnostic radiology training at Mallinckrodt Institute of Radiology.

Sara Rohr, MD, musculoskeletal radiology clinical fellow, received an undergraduate degree from Gustavus Adolphus College and a medical degree from the University of Iowa. She completed additional training at Forest Park Hospital and four years (chief resident, 2007-2008) of diagnostic radiology training at Mallinckrodt Institute of Radiology.

Jonathan Sehy, MD, diagnostic neuroradiology clinical fellow, received an undergraduate degree from the University of Illinois at Chicago Medical Center.

Jennifer Sharp, MD, abdominal imaging clinical fellow, received an undergraduate degree from the University of Illinois.

Rakesh Varma, MBBS, interventional radiology clinical fellow, received an undergraduate degree from Seth Gordhandas Sunderas Medical College/Edward Memorial Hospital. He completed additional training at Seth Gordhandas Sunderas Medical College/King Edward Memorial Hospital and at LTMMC & LTM General Hospital.

Quan Vu, MD, musculoskeletal radiology clinical fellow, received an undergraduate degree from the University of Virginia and a medical degree from Emory University. He completed additional training at Carilion Health System and four years of diagnostic radiology training at Mallinckrodt Institute of Radiology.

Ramana Yedavalli, MD, interventional radiology clinical fellow, received an undergraduate degree from Northwestern University and a medical degree from the University of Illinois. He completed additional training at Northwestern Memorial Hospital and a residency at the University of Illinois at Chicago Medical Center.
FIRST-YEAR DIAGNOSTIC RADIOLOGY RESIDENTS

Jared Allen, MD, PhD, received an undergraduate degree from Brigham Young University, a medical degree from the University of California, Los Angeles, and a doctoral degree from the University of California, San Diego. He completed additional training at LDS Hospital.

Russell Allman, MD, received an undergraduate degree from Auburn University and a medical degree from the University of Alabama. He completed additional training at Baptist Health System.

Desi Dennis, MD, received an undergraduate degree from Southern Illinois University Edwardsville and a medical degree from Vanderbilt University. He completed additional training at St. Louis University.

Jay Desai, MD, received an undergraduate degree from the University of Mississippi and a medical degree from Emory University. He completed additional training at Brigham and Women’s Hospital.

Sara Dyrstad, MD, received an undergraduate degree from Augustana College and a medical degree from Southern Illinois University. She completed additional training at Southern Illinois School of Medicine and its affiliated hospitals.

Amy Fowler, MD, PhD, received an undergraduate degree from South Dakota State University and a medical/doctoral degree from the University of Wisconsin. She completed additional training at Gundersen Lutheran Medical Center.

Michael Friedman, MD, received an undergraduate degree from Washington University in St. Louis and a medical degree from the University of Iowa. He completed additional training at St. Luke’s Hospital.

Amer Haque, MD, received an undergraduate degree from the University of Kentucky and a medical degree from the University of Louisville. He completed additional training at West Suburban Medical Center.

Joseph Ippolito, MD, PhD, received an undergraduate degree from Cornell University and a medical/doctoral degree from Washington University in St. Louis. He completed additional training at St. John’s Mercy Medical Center.

Clinton Jokerst, MD, received an undergraduate degree and a medical degree from Saint Louis University. He completed additional training at St. John’s Mercy Medical Center.

Lauren Kim, MD, received an undergraduate degree from Harvard College and a medical degree from Washington University in St. Louis. She completed additional training at St. Mary’s Health Center.

Douglas Kitchin, MD, received an undergraduate degree from the University of Notre Dame and a medical degree from Indiana University. He completed additional training at St. Luke’s Medical Center.

Jessica Lee, MD, received an undergraduate degree from Stanford University and a medical degree from Washington University in St. Louis. She completed additional training at MacNeal Memorial Hospital.

Luke Linscott, MD, received an undergraduate degree and a medical degree from the University of Utah. He completed additional training at Sacred Heart Medical Center.

Nicholas Rhodes, MD, received an undergraduate degree from the University of Wisconsin and a medical degree from Washington University in St. Louis. He completed additional training at Barnes-Jewish Hospital.

Gretchen Smith, MD, received an undergraduate degree and a medical degree from the University of Washington. She completed additional training at Virginia Mason Medical Center.

Robert Stachek, MD, received an undergraduate degree and a medical degree from the University of Pittsburgh. He completed additional training at Children’s Hospital of Pittsburgh and a residency at Seth Goldhandus Sunders Medical College/King Edward Memorial Hospital.

Marcus Kessler, MD, completed premedical studies at and received a medical degree from the University of Pittsburgh. He completed an internship at the Clinics of the City of Cologne; a diagnostic radiology residency at Hospital Holweide; a pediatric radiology residency at Pediatric Hospital Amsterdam; an academic fellowship at Mallinckrodt Institute of Radiology.

Collins Liu, MD, received a medical degree from the University of California, Berkeley and a medical degree from New York Medical College. He completed an internship and a neurology residency at the University of Pittsburgh and a fellowship at Mallinckrodt Institute of Radiology.

FIRST-YEAR NUCLEAR MEDICINE RESIDENTS

Joanna Fair, MD, PhD, received an undergraduate degree from Rice University, a doctoral degree from the University of Colorado, and a medical degree from Washington University in St. Louis. She completed a radiology residency at the University of New Mexico.

Archana Kantawala, MD, completed premedical studies at Kirti M. Doongerse College and received a medical degree from Pravara Institute of Medical Sciences. She completed an internship and a residency at Seth Goldhandus Sunders Medical College/King Edward Memorial Hospital.

Gordhandas Sunderas, MD, completed premedical studies at and received a medical degree from the University of Notre Dame. He completed an internship at Children’s Hospital Amsterdamer and a pediatric radiology clinical fellowship at Mallinckrodt Institute of Radiology.
Jonathan Weiss, MD, received an undergraduate degree from Northwestern University and a medical degree from Indiana University. He completed an internship at St. Vincent Hospital and a diagnostic radiology residency at the Medical College of Wisconsin.

GRANTS

Kevin Black, MD, associate professor of psychiatry, of neurology, of radiology, and of anatomy and neurobiology, as site principal investigator, received a grant from Boehringer Ingelheim Pharmaceuticals, Inc. for “A randomized, double-blind, placebo-controlled, flexible dose study to evaluate efficacy and safety of pramipexole IR (0.125-0.5mg/day) versus placebo for 6 weeks in children and adolescents (age 6-17 inclusive) diagnosed with Tourette’s Disorder according to DSM-IV criteria.” Bradley Schlaggar, MD, PhD, assistant professor of neurology, of radiology, of pediatrics, and of neurobiology, is co-investigator of the grant.

Thomas Conturo, MD, PhD, associate professor of radiology, of physics, and of biomedical engineering, as principal investigator, received a two-year grant in the amount of $119,963 from Autism Speaks to study “Analysis of brain microstructure in autism using diffusion MRI.” Collaborators are Erbil Akbudak, PhD, research assistant professor of radiology; Charles Smith, PhD, University of Kentucky; and Nancy Minshew, MD, and Diane Williams, PhD, University of Pittsburgh.

Tamara Hershey, PhD, assistant professor of psychiatry and of radiology, as principal investigator, received a $1.3 million grant from the National Institute of Mental Health, for “Mapping mood in the subthalamic nucleus in PD.” Coinvestigators for the five-year grant are Kevin Black, MD, associate professor of psychiatry, of neurology, of radiology, and of anatomy and neurobiology; Tom Videen, PhD, research professor of neurology and of radiology; and Joel Perlmutter, MD, professor of neurology, of radiology, and of physical therapy. Hershey also is principal investigator for a $1.1 million grant from the National Institute of Diabetes and Digestive and Kidney Diseases to study “Glycemic control, brain structure and cognition in youth with T1DM.” Coinvestigators for the five-year grant are Kevin Black, MD; Neil White, MD, Department of Pediatrics; and Joshua Shimony, MD, PhD, assistant professor of radiology.

Linda Larson-Prior, PhD, research associate professor of radiology, as imaging principal investigator, received a $76,660 grant from Cephalon, Inc. for a Phase IV Clinical Trial—“A randomized, double-blind, placebo-controlled, functional neuroimaging study of the effects of Armodafinil (200 mg/day) treatment on prefrontal cortical activation in patients with residual excessive sleepiness associated with obstructive sleep apnea/hypopnea syndrome.” Principal investigator for the one-year grant is Stephen Dunley, MD, Department of Neurology; coinvestigators are Beth Ward, MD, Department of Neurology; Ravi Aysola, MD, Department of Medicine; G. Warmouth, MD; Tonya Russell, MD, Department of Medicine; Amy Bertelson, PhD, Department of Psychology; Mehmet Dokucu, MD, Department of Psychiatry PhD; and Milan Anadkat, MD, Department of Medicine.

Robert McKinstry, MD, PhD, associate professor of radiology, as principal investigator of imaging core, received a four-year grant in the amount of $9,126 from the Medical College of Wisconsin, National Marrow Donor Program® to “determine event-free survival at one year after unrelated donor hematopoietic stem cell transplantation using bone marrow or umbilical cord blood in patients with sickle cell disease.” Joel Perlmutter, MD, professor of neurology, of radiology, and of physical therapy, as principal investigator, received a $3.2 million grant from the National Institute of Neurological Disorders and Stroke for “Validation of neuroimaging biomarkers for nigrostriatal neurons.” Coinvestigators for the five-year grant are Stephen Moerlein, PhD, associate professor of radiology and of biological chemistry; Tom Videen, PhD, research professor of neurology and of radiology; Morvarid Karimi, MD, Department of Neurology; and Joanne Markham, MS, research associate professor of radiology.

David Reichert, PhD, assistant professor of radiology, received a two-year grant in the amount of $800,000 from the Department of Energy for “Microfluidic radiometal labeling systems for biomolecules.” Co-investigator for the grant is Paul Kenis, PhD, University of Illinois, Urbana-Champaign.

Yoram Rudy, PhD, professor of biomedical engineering, cell biology, and physiology, of medicine, and of pediatrics and research professor of radiology, as principal investigator, received a four-year grant in the amount of $1.3 million from the National Heart, Lung and Blood Institute, for “Inverse and forward problems in electrocardiography.”

Jeffrey Zacks, MD, associate professor of psychology and of radiology, as principal investigator, received a five-year grant in the amount of $1.5 million from the National Institutes of Health for “Encoding and remembering events across the lifespan.”
APPOINTMENTS/ELECTIONS

Colin Derdeyn, MD, professor of radiology and of neurology and neurological surgery, was appointed by the American Heart Association to a two-year term on the Research Committee and to a two-year term as chair of the Membership, Marketing, and Communications Committee.

Bennett Greenspan, MD, instructor in radiology, was appointed to a three-year term as a member of the Practice Standards Committee of the American College of Radiology, a two-year term on the Program Planning Committee of the Association of University Radiologists, and a one-year term on the Membership Committee of the Society of Nuclear Medicine. He was reappointed to a one-year term on the Nuclear Medicine Program Directors Committee of the Association of Program Directors in Radiology and to a three-year term on the Commission on Accreditation of Medical Physics Educational Programs.

Tamara Hershey, PhD, assistant professor of psychiatry and of radiology, was appointed to a one-year term as secretary of the Washington University School of Medicine Academic Women’s Network Board.

Linda Larson-Prior, PhD, research associate professor of radiology, was elected to a one-year term as pre-clinical counselor of the Washington University School of Medicine Academic Women’s Network Board.

Robert McKinstry, MD, PhD, associate professor of radiology, was elected as a representative of the Washington University School of Medicine Faculty Practice Plan to the Executive Committee of the Faculty Council.

HONORS/AWARDS

Louis Gilula, MD, professor of radiology, of orthopaedic surgery, and of plastic and reconstructive surgery, served as an examiner for the Radiology Boards, Louisville, Kentucky, May 31-June 3.

Bennett Greenspan, MD, instructor in radiology, received the Academic Council of the Society of Nuclear Medicine’s Distinguished Service Award.

LECTURES

Tammie Benzinger, MD, PhD, assistant professor of radiology, spoke on “Clinical applications of diffusion tensor imaging” at the 6th MAGNETOM World Summit, Munich, Germany, May 29-June 1. She presented “Advanced neuromagnetic resonance imaging: 3 Tesla in clinical practice” to the Central Illinois Radiological Society, Peoria, August 8.

Kevin Black, MD, associate professor of psychiatry, of neurology, of radiology, and of anatomy and neurobiology, presented “Diagnosis and treatment of Tourette syndrome, 2008” at Neurology Grand Rounds, Louisiana State University Health Science Center, Shreveport, June 13. He spoke on “Quantitative pharmacodynamic imaging by a novel method” at the Organization for Human Brain Mapping 2008, Melbourne, Australia, June 15-19.


Louis Gilula, MD, professor of radiology, of orthopaedic surgery, and of plastic and reconstructive surgery, as visiting professor, presented “Radiology Board review” at the Oregon Health and Science University, Portland, June 23.

Tammara Hulett-Bowling, MD, assistant professor of radiology, presented “Interestesting cases and unusual pediatric tumors” at the Pacific Coast Pediatric Radiology Association Annual Meeting, Napa, California, July 29-August 3.

Linda Larson-Prior, PhD, research associate professor of radiology, spoke on “Neuroimaging of human sleep” at the Sleep Research Society 15th Annual Trainee Symposium, Baltimore, Maryland, June 8. She presented “Phase synchrony analysis of network dynamics during task performance links EEG and BOLD” at the Organization for Human Brain Mapping Annual Meeting, Melbourne, Australia, June 15-19.

Mark Mintun, MD, professor of radiology, presented “FDG & amyloid PET: What information do these provide?” at The Alzheimer’s Disease Summit, sponsored by Mount Sinai School of Medicine and MBL Communications, Washington, DC, May 3. He spoke on “Metabolic domains and neuronal activation” at the Gordon Research Conference on Brain Energy Metabolism and Blood Flow, Andover, New Hampshire, August 17-22.

Joel Perlmutter, MD, professor of neurology, of radiology, and of physical therapy, presented “Monitoring the mentors” and chaired the Biomarkers for PD Progression session at the Parkinson Study Group Annual Meeting, San Diego, California, May 8.

James Quirk, PhD, research instructor in radiology, presented “Optimal sample parameter estimates from phased array coil data utilizing joint Bayesian analysis” at the 16th Scientific Meeting of the International Society for Magnetic Resonance in Medicine, Toronto, Ontario, May 3-8. He spoke on “Models and applications...” at the ISMRM 2008 World Congress, Melbourne, Australia, June 15-19.

YOUTH OUTREACH/EDUCATION

The Department of Radiology participated in the International Society for Magnetic Resonance in Medicine (ISMRM) 2008 World Congress, Melbourne, Australia, June 15-19.
Nasir Siddiqi, MD, assistant professor of radiology, spoke on "Arterial hepatic brachytherapy: VIR perspective" at the New England Chapter of the Association of Physicists in Medicine Annual Meeting, Norwood, Massachusetts, June 18.

Yvette Sheline, MD, professor of psychiatry, spoke on "The molecular basis for the clinical electrocardiogram—electrocardiographic imaging (ECGI): solving the electrographic inverse problem" and "Why do T-waves change?—Fundamental basis of the T-wave" at the Heart Rhythm Society, 29th Annual Scientific Sessions, San Francisco, California, May 16. He presented "Computation of cardiac arrhythmia," for the Department of Biomedical Engineering’s Professor Samuel Sideman In Memoriam Lecture, and "Noninvasive electrocardiographic imaging (ECGI) of cardiac electrophysiology and arrhythmia" for the Cardiovascular Science Grand Rounds, Israel Institute of Technology School of Medicine, Haifa. He spoke on "Noninvasive ECG imaging" at the World Congress in Cardiac Electrophysiology and Cardiac Techniques, Nice, France, June 19.

Yvette Sheline, MD, professor of psychiatry, of radiology, and of neurology, presented "Support for the vascular depression hypothesis: neuropsychological and neuroimaging findings from a prospective treatment trial in LLD" at the American Psychiatric Association Annual Meeting, Washington, DC, May 3-8.

SYMPOSIA

In this section of FYI, only those faculty and staff who have Department of Radiology appointments are listed.

SOCIETY OF NUCLEAR MEDICINE

55th Annual Meeting
New Orleans, Louisiana
June 14-18, 2008

Carolyn Anderson, PhD, "The importance of chelator for radiometal-based radiopharmaceuticals in PET imaging"; "What is molecular imaging?"

Bennett Greenspan, MD, "Radiotherapy response evaluation: When is the optimal time for PET imaging?"; "Ethics in research—responsibilities of the investigator."

Robert Gropler, MD, "Where is cardiovascular molecular imaging going and when are we going to get there?"

Aviv Hagooly; Raffaella Rossin; Monica Shokeen; Carolyn Anderson, PhD; Michael Welch, PhD, "Evaluation of a RGD-dendrimer labeled with 18F in hindlimb ischemia mouse model."

Zulfia Kisrieva-Ware, MD, PhD; Terry Sharp; Carmen Dence, MS; Andrew Cogan; Robert Gropler, MD; Pilar Herrero, MS, "Assessment of myocardial triglyceride turnover with PET and 1-18C-palmitate."

Hyeran Lee, PhD; Delphine Chen, MD; Michael Welch, PhD; Robert Mach, PhD, "Fluorine-18 labeled PPARy antagonists for PET imaging studies."

Yongjian Liu; Aviv Hagooly; Raffaella Rossin; Jibin Xu; Karen Wooley, PhD; Michael Welch, PhD, "In vivo evaluation of 64Cu labeled PEGylated shell crosslinked nanoparticles (SCNs) as candidates for imaging and drug delivery."

Jonathan McConathy, MD, PhD; Dong Zhou, PhD; Lynne Jones; Elizabeth Griffin; Robert Mach, PhD, "Click synthesis and murine biodistribution of the radiolabeled amino acid [18F]PATP."

Mark Mintun, MD, "Emerging CSF and blood biomarkers for AD and their likely impact on the role of imaging."

Joel Perlmutter, MD, "DAT imaging does not provide unique and clinically useful information."

Raffaella Rossin; Aviv Hagooly; Michael Welch, PhD, "Characterization of 18F-labeled AMG 655 as a PET tracer for imaging Death Receptor 5 (DR5) in tumor."

Henry Royal, MD, "Leadership success in academic nuclear medicine; "ABN perspective on MOC."

Kooresh Shoghi, PhD; Robert Gropler, MD; Terry Sharp; Pilar Herrero, MS; Nicole Fettig; Michael Welch, PhD, "Assessing the efficacy of anti-diabetic therapies on myocardial glucose utilization in an animal model of type 2 diabetes (T2D) with PET."

Yi Su; Kooresh Shoghi, PhD, "Spatial constrained voxel-based kinetic analysis of small animal dynamic PET images with wavelet denoising."
SYMPOSIA
Continued from page 31

Yuan-Chuan Tai, PhD; Heyu Wu; Tae Song; Joseph O'Sullivan, PhD; Sergey Komarov, "A high-resolution head insert device for a clinical PET/CT scanner."

Zhude Tu, PhD; Robert Mach, PhD, "Evaluation of the putative dopamine D₃ PET tracer [¹¹C]WC-10 in non-human primates."

Zhude Tu, PhD; Jinbin Xu; Lynne Jones; Shihong Li; Robert Mach, PhD, "Radiosynthesis and in vivo evaluation of [¹¹C]papaverine as PDE10A PET tracer."

Jerold Wallis, MD, "IHE: What is it and what is new?"

Michael Welch, PhD, "Imaging tumor hypoxia with Cu-ATSM PET."

Dong Zhou, PhD; Hyeran Lee, PhD; Justin Rothfuss; Delphine Chen, MD; Michael Welch, PhD; Robert Mach, PhD, "Synthesis, "F radiola-belling and in vivo biodistribution of 6-(2-fluoropropyl)-4-methylpyridin-2-amine as a potential PET tracer."

SAMUEL ACHILEFU, PhD; Yunpeng Ye, PhD; Zongren Zhang, PhD; Hyeran Lee, PhD; Jinda Fan, PhD; Kexian Liang; Mikhail Berezin, PhD; Philip Cheney; Barry Edwards, PhD, "Chemical and biochemical contrast strategies for optical imaging of molecular processes in vivo."

Carolyn Anderson, PhD, "Graduate and undergraduate training in imaging sciences at Washington University."

Ashley Flamengo; Yunpeng Ye, PhD; Samuel Achilefu, PhD; Carolyn Anderson, PhD, "Binding affinity and cellular internalization of avb₅ targeting ligands for molecular imaging of cancer and cardiovascular disease."

Raffaella Rossin; Michael Welch, PhD; Karen Woolley, PhD, "Cell uptake and the dependency on surface moieties of differently-shaped nanoparticles."

ALUMNI NEWS

Yvonne Taylor, PhD, a former assistant professor in radiology, received Colgate University’s Alumni Corporation Humanitarian Award for her efforts to help improve education and living conditions in the African country of Kenya. Taylor joined the faculty of the Division of Radiation Oncology’s Cancer Biology lab in 1986 and left in 1995 for a two-year stint as a science teacher in the Peace Corps. And she quickly fell in love with the Akamba people, who call her Mwende (or Loved One). She is the founder and CEO of One Heart with Africa Inc—an outgrowth of her dream to provide the Akamba with a clean and adequate resource for water (by spearheading the construction of 17 community-built, subsurface dams and water tanks along the Syuuni River) and to provide job training for the Akamba children who cannot go to college (by offering computer training and establishing a technical institute that offers tailoring, dressmaking, carpentry, and masonry classes). One Heart with Africa (online at http://oneheartwithafrica.org) also provides student sponsorships and promotes cultural exchange.

Above, Left: Taylor (in white hat) is shown with the children of Kyamathenge Primary School, where she is the administrator and principal and “chief cook and bottle washer.”

Above, Right: Taylor (right) and her adopted daughter Kanini Mutie, a Kenyan orphan who is now a student at the University of Nairobi.
Diagnostic Radiology and Nuclear Medicine

FELLOWS AND RESIDENTS FOR 2008-2009

(SEATED, LEFT TO RIGHT) Doctors Jeffrey Lin; Jonathan Sehy; Travis Hillen; Jonathan Baker; Jennifer Gould, diagnostic radiology residency program director; Gilbert Jost, director, Mallinckrodt Institute; Sara Rehr, diagnostic radiology chief resident; Meghan Lehner, diagnostic radiology chief resident; Jennifer Demertzis, diagnostic radiology chief resident; Robert McKinstry, research residency program director; Sanjiv Bajaj; Paul Holcombe; Alexander Ho.

(SECOND ROW) Doctors Cyien Javidan-Nejad, cardiothoracic imaging fellowship program director; Amy Oberhelman; Rex Parker; Carlos Uma; Constantine Kupitis; Tabassum Ahmed; Gilbert Cheung; Vincent Mellnick; Kevin Johnson; Calvin Barnes; Celine Buckley; Nicole Bolton; Robin Yang; Danielle Weems; Stanley Chan; Marcus Kessler; Michelle Miller-Thomas; Caitlin Lopez; Sall Patel; Susan Holley; Joseph Matonberg; Patricia Richmond; Jennifer Salcman; Kristy Wolske; Norna Ludeman; Heather Tauscheck; Jakob Schutz.

(THIRD ROW) Doctors Yasha Kadkhodayan; Carl Aschkenas; Edward Hwang; Joseph Azok; Kelsey Morgan; Sushil Sonavane; Paul Fehnert; Alok Jajj; Prakash Musand; John Burkett; William Grande; Travis Henry; Lance Reinsmith; Kyle Shipley; Robert Cardile; Brandon Liu; Aaron Hendon; Omar Agosto; Ariel Kruger; Quan Yu; Yihua Zhou; Martin Reis; Thomas Watson; Ferenc Czeide-Pommersheim; Sril Padd; Alexander Sevrucok; Benjamin Pettus; Paolo Marciano; Jonathan McConathy; Vilass Shetty.