FOCAL SPOT

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SUMMER 2021 Navigating a Pandemic: When Virtual Becomes a Reality
MALLINCKRODT INSTITUTE OF RADIOLOGY // WASHINGTON UNIVERSITY // ST. LOUIS

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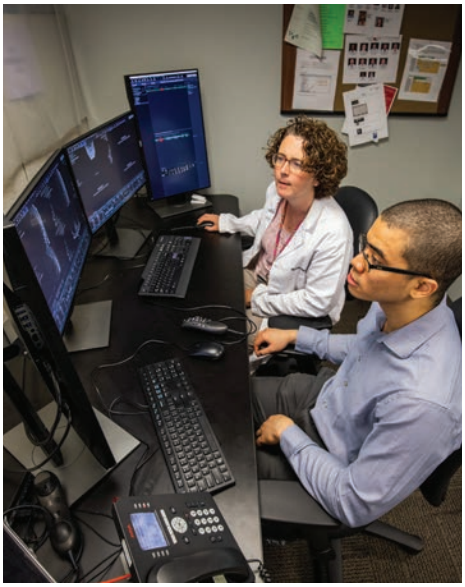

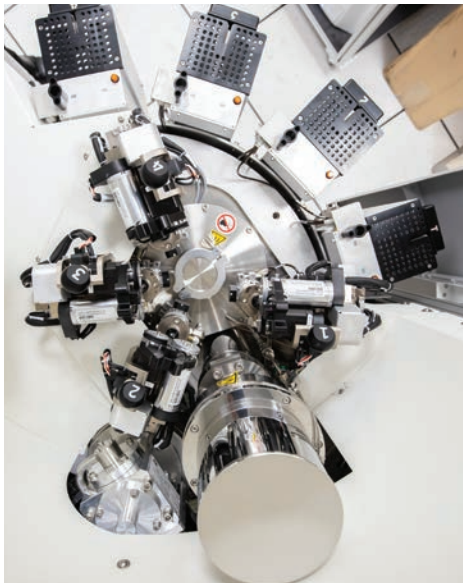

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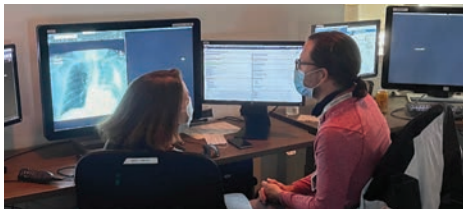
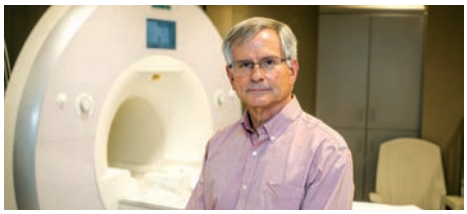
Cover Photo: Robert C. McKinstry, MD, PhD, senior vice chair and division director of diagnostic imaging, at home with his 5-year-old "Swissie" Kepler.

Left: MIR faculty, staff and trainees adjusted to a more virtual work environment during the COVID-19 pandemic, with teleconferencing becoming a mainstay of the experience.





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Editor: Marie Spadoni
Associate Editor: Kristi Luther
Photography: Glennon Williams, MIR Archives
Design: Kim Kania

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Michelle M. Miller-Thomas, MD, aims to showcase radiology as a "desirable, fulfilling career" playing a central role in modern medical care.

Educating the Next Generation

by Marie Spadoni

The last major medical curriculum reform at Washington University was over two decades ago, and it's been more than 10 years since any significant changes were made in how radiology was taught. In July 2019, Michelle M. Miller-Thomas, MD, associate professor of radiology, was selected as a member of the School of Medicine's curriculum planning committee. "As radiology has grown in importance and now touches all areas of medicine, the school recognized the need to incorporate it into all medical curriculum," says Miller-Thomas, who also co-directs the advanced imaging service in neuroradiology.

The university's development of a new curriculum — named the Gateway Curriculum — is comprised of three phases: preclinical (16 months), clinical clerkship (12 months) and advanced clinical rotations (16 months). As Radiology Thread Leader, Miller-Thomas is responsible for supervising the incorporation of radiology education in all phases. According to her, there are two objectives to consider when integrating radiology into today's medical school curriculum. First, training students to understand the appropriate use of medical imaging and image-guided intervention in the care of patients. Second, imparting some key fundamental interpretive skills. Because radiology is so pervasive in medicine, understanding appropriate use of medical imaging is a foundational skill for every clinician.

Phase I: Preclinical

For Phase I, Miller-Thomas was named Design Team Lead for Procedural Clinical Immersions, working to create a new educational approach rooted in experiential education in the preclinical phase. "We take preclinical students and place them in the clinical environment so they can learn the social aspects of medicine as well as hone their skills in physical examination and clinical history taking," she says. Radiology hosts up to seven immersion students three times a year. Students navigate a curriculum that integrates radiology into every foundational organ system-based module. For example, in the cardiopulmonary module, Miller-Thomas collaborated with the design team leaders to create a series of lectures as well as innovative self-study modules to teach the students how to interpret a chest X-ray as well as how to appropriately apply medical imaging to the care of their patients.

Phase II: Clinical Clerkships

Miller-Thomas also serves as one of four members of the design team for the neurology clerkship, where they are teaching neurology using a signs-and-symptoms approach with application to inpatient and outpatient settings. "I'm working with all clerkships in Phase II to incorporate medical imaging and image-guided intervention into their programs," she says. "The emphasis is on appropriate utilization, the role of medical imaging in clinical diagnostic reasoning, and basic image interpretation for all medical graduates."

Phase III: Advanced Rotations

For the final phase of the curriculum renewal, Miller-Thomas is creating a neuro-oncology Keystone Integrated Science Course (KISC). "The KISC will take post-clerkship advanced clinical students back to the classroom to expand upon a foundational science topic at the leading edge of medicine and explore the application of those concepts to patient care at Washington University School of Medicine."

The course, co-developed with the departments of Pathology and Neurosurgery, will focus on the molecular and genetic

foundations of adult primary central nervous system tumors, applying those concepts to the care of patients with brain tumors through the lenses of neuroradiology, neurosurgery, neuropathology, neuro-oncology and radiation oncology.

In September 2020, the university implemented Phase I of the Gateway Curriculum, with Phases II and III expected to rollout in January 2022 and 2023, respectively. The curriculum renewal process gave MIR radiologists and educators an opportunity to consider how they want students to practice medicine and radiology after they graduate.

"The fundamental change is that now radiology is integrated from the ground up," says Miller-Thomas. "I think this was, and continues to be, a way for us to showcase the field of radiology to the students as a desirable, fulfilling career that plays a central role in medical care in the 21st century."

A New Era for Inclusion Efforts at MIR

by Kristi Luther

As MIR's first director of the Office of Diversity, Equity and Justice (DEJ), Gloria J. Guzmán Pérez-Carrillo, MD, hopes to usher in an elevated level of cultural consciousness.

During a year of unremitting trials — from the national response to racial injustice to the deep health disparities presented by the COVID-19 pandemic — MIR's focus on equity echoes the strong commitments from Washington University School of Medicine leadership. "I think it is fundamental to engage underrepresented minorities from an early stage and use the substantial WashU resources to lift our local community," says Guzmán, assistant professor of radiology and an alumna of MIR's neuroradiology fellowship.

With a faculty and staff of more than 600, Guzmán's efforts have the chance to make endless ripples of impact both inside and outside MIR's walls, including in patient care. "I have found that there are doctors, and then there are healers," says Guzmán, who is also co-director of MIR's advanced neuroimaging service. "The healers are those physicians who can identify with their patients in a way that creates trust."

The Office of DEJ promotes equity for all members of MIR by fostering a community that embraces and reflects diversity of backgrounds, experiences and perspectives as a stimulus for innovation and problem solving, local community outreach, excellence in education, research and scholarship, and equity and justice in patient care.

Gloria J. Guzmán Pérez-Carrillo, MD, works to position MIR as a model for diversity and inclusive excellence.

"We serve a very diverse population of patients," says MIR Director Richard L. Wahl, MD, "so we want our workforce to be broadly representative of the patients we serve."

The initiative's aim is for MIR to become a model for diversity and inclusive excellence through progressive hiring practices, policies and cutting-edge research on health disparities relating to radiological health care. The Office of DEJ also houses an Executive Diversity Committee comprised of faculty, trainee and staff volunteers dedicated to diversity, equity and inclusion (DEI). "I want to emphasize that inclusion is not just being part of the group but being actively engaged in discussion and decision-making," says Wahl, the Elizabeth E. Mallinckrodt Professor of Radiology.

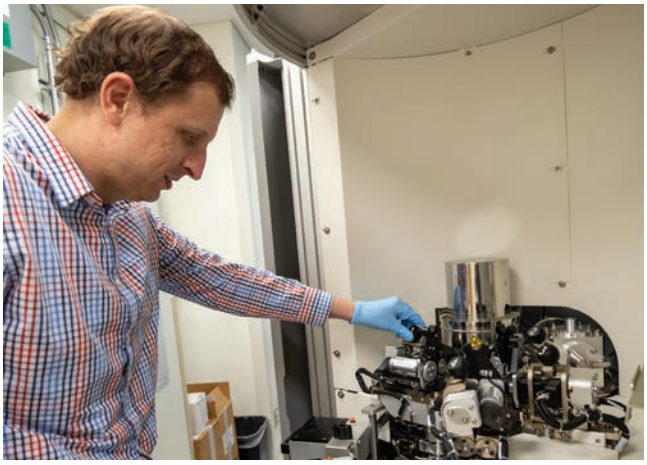
Guzmán strives for MIR's inclusivity efforts to be just that — truly inclusive. "Diversity is not Black and Brown," she says. "It is the first-generation university student, somebody with low socioeconomic background, somebody who has a non-visible or apparent disease, immigrants, refugees, different sexual orientations, different religions. Diversity represents many things."

Despite the setbacks of a global pandemic, programming out of the Office of DEJ is off to a running start. So far, the office has launched Brown Bag discussions covering inclusion topics, virtual happy hours for underrepresented identities, deeper dives into faculty recruitment and retention data, regular DEI-focused internal communications, community outreach, scholarships, and listening tours for the MIR team to voice any concerns or experiences with senior leadership.

"I've been told by some that they think this work isn't necessary, and I believe that's because it doesn't affect them," Guzmán says. "One has to understand that cultural incompetency leads to true health disparities and suffering in people's lives."

Hyperpolarized MRI: The Future of Molecular Imaging

by Kristi Luther



Having studied hyperpolarized MRI for 10 years, Cornelius J. von Morze, PhD, sees a bright future for the technology, which offers an amplified view of metabolic processes.

Hyperpolarized MRI presents a wealth of possibilities previously untapped with conventional MRI. With conventional MRI, the signal is generated from a few out of every million atoms. With hyperpolarized MRI? Up to 500,000 out of every million atoms.

"There is nothing else like that in MRI," says Cornelius J. von Morze, PhD, assistant professor of radiology. "We're able to investigate metabolic pathways on a highly localized basis for the first time on an MRI scanner."

MIR's venture into hyperpolarized MRI embraces the promise of expanding beyond imaging organs as static lumps of tissue. "You think of these organs and tissues as pictures on the screen that are frozen in time, when they are really these dynamic entities that are going through profound shifts all the time," says von Morze, who is leading MIR's preclinical efforts in hyperpolarized MRI. The centerpiece of the efforts is the GE SPINlab™, a dynamic nuclear polarizer that enables this visualization of cell activity in real time.

With hyperpolarized MRI's transformative amplification abilities also comes some logistical challenges. von Morze says the technology is in an evaluation phase — one of determining whether the tech will only be functional at select sites or whether it is able to be translated more broadly.

The hyperpolarized imaging exam (see right) — from dissolving the materials to injecting a subject — is only a couple of minutes long, making it essential for a research facility to have a uniquely efficient layout and skillset. "It's no coincidence that the SPINlab was sited right next to two 3T Siemens scanners on the first floor of East Imaging. That was done with an eye on clinical translation," says von Morze. "The sheer number of MR or MRI scanners accessible within a 10- to 15-second run might be more than anywhere else in the world."

The biggest success story in hyperpolarized carbon-13 MRI thus far has been pyruvate, an intermediate in sugar metabolism that is being used to explore potential applications in brain tumors, prostate cancer, traumatic brain injury, liver disease and beyond. For example, if hyperpolarized pyruvate could be used to distinguish between benign prostate cancers and more aggressive forms, then countless people could be spared invasive treatments.

There's also research on the liver, an area of particular interest to von Morze. Almost 30% of the U.S. population is believed to have fatty liver disease. While conventional MRI is the gold standard for precisely measuring fat content, it lacks a method of staging the severity of the disease. Currently, this can only be done through biopsy, which is expensive and cannot be performed regularly to study patients over time.

"I do see this as the latest chapter in the development of molecular imaging, a field in which MIR has a rich, pioneering history," says von Morze.

Hyperpolarized MRI: Step-by-Step

1. Load contrast material and seal with dental filling glue. The latter cures rapidly when exposed to UV light, making it the perfect fit for sealing the fluid path.
2. Pre-polarize materials in SPINlab using a combination of ultra-low temperature, high magnetic field and microwave irradiation.
3. Allow polarization to build up for a couple of hours.
4. Rapidly dissolve sample and bring to room temperature quickly using super-heated temperatures.
5. Transfer the sample to an MRI scanner. The half-life of the agent is about 45 seconds, so close proximity is crucial. Luckily, the SPINlab is near six MRI scanners, including access through a drop chute leading to the scanners one floor below in MIR's Small Animal Magnetic Resonance Facility.
6. Catch the sample and inject into the subject.

$6.5 Million Grant to Study Immune Therapies for Heart Disease

by Tamara Bhandari

An international group of researchers has teamed up to study the biological processes that drive injurious inflammation after heart attacks, with a goal of finding therapies to help people recover more completely and reduce the risk of permanent heart damage. With a $6.5 million grant from the Leducq Foundation, they have established a network called "The Inflammatory-Fibrosis Axis in Ischemic Heart Failure: translating mechanisms into new diagnostics and therapeutics network (IMMUNO-FIB HF)" to study the intertwined roles of inflammation and fibrosis, or scarring, in driving long-term heart damage.

IMMUNO-FIB-HF is part of the foundation's Transatlantic Networks of Excellence, an effort that aims to foster innovative scientific research in cardiovascular and neurovascular disease by bringing together European and North American scientists with complementary expertise. Robert J. Gropler, MD, professor of radiology and MIR's senior vice chair and division director of radiological sciences, leads the North American effort.

"Heart failure progression is one of the leading causes of death in the world," says Gropler. "Inflammation and fibrosis are the twin drivers of heart failure progression, but we don't really understand how these processes occur. The idea was to bring together experts in inflammation and experts in fibrosis to unravel the mechanisms and design specific therapies to ameliorate the process."

A heart attack triggers an inflammatory response and sets off a cascade of biological events that can end in structural changes to the heart that impair the organ's ability to pump blood, a process called cardiac remodeling. Researchers have tried to find drugs to interrupt this process, but a lack of detailed information on how the process unfolds has stymied efforts to come up with good therapeutic targets.

"We know that inflammation is important, but the problem is that the immune system is very complex," says co-principal investigator Kory J. Lavine, MD, PhD, associate professor of medicine in cardiology at Washington University School of Medicine. Also an associate professor of developmental biology and of pathology & immunology, Lavine leads the team's effort to identify the immune cell types and molecules that mediate harmful inflammatory responses.

"There may be multiple pathways that lead to detrimental cardiac remodeling, and different patients may benefit from different therapies," Lavine says. "The challenge is: Can we identify the right immune cells to target, can we figure out how to target them, and can we deliver these therapeutics to the patients most likely to benefit from them?"

To better understand the processes at work, the researchers need to be able to see what is going on inside the heart in the aftermath of a heart attack. Co-principal investigator Yongjian Liu, PhD, an associate professor of radiology at MIR, has developed a PET imaging agent that detects inflammatory white blood cells known as CCR2+ monocytes and macrophages. Another co-investigator has developed an imaging agent for fibroblasts, cells that produce scar tissue. Both imaging agents have proven useful in animal studies. Liu leads the team's effort translating them for use in people, so they can track inflammation and fibrosis in heart attack patients in the days, weeks and months after such events.

By combining these imaging agents with other measures of heart damage and abnormal function, the researchers expect to be able to see how such cells contribute to cardiac remodeling and whether investigational therapies have an effect on these cells. Two experimental therapies are being developed by other groups in the network.

"We don't really have treatments available to reduce inflammation and fibrosis in people who have suffered heart injuries," says Lavine. "The goal of IMMUNO-FIB-HF is to find novel therapies that block or attenuate these pathways and give people the best chance for their hearts to heal."

Robert J. Gropler, MD, leads the North American research team probing inflammation after heart attack.

COVID-19

MIR Responds to a Worldwide Pandemic

by Pam McGrath

On March 4, 2020, during a senior leadership meeting, MIR Director Richard L. Wahl addressed the alarming reality of the novel coronavirus first identified in Wuhan, China, in December 2019. The first case in the United States already had been confirmed on January 21, 2020, in Washington state.

"Once coronavirus disease 2019, or COVID-19, reached the states, we knew it was inevitable that we would see it in the St. Louis metropolitan area," says Wahl, the Elizabeth E. Mallinckrodt Professor of Radiology. "Although there was a lot we didn't know yet, it was clear this new virus spread easily and quickly and was, for a disturbing number of patients, deadly."

During the meeting, the decision was made to suspend faculty travel to national and international professional meetings and conferences. Wahl, however, had a more ambitious goal in mind. He charged senior leadership with the task of not only developing but, in fact, implementing new COVID-19-specific standard operating procedures (SOPs) focused on the safety of faculty, trainees, staff and patients. In addition, steps needed to be taken to guarantee technology was available to keep radiology services functioning, ensure research was uncompromised and sustain MIR's educational mission.

The timing of these decisions was prescient. On March 7, the first case of COVID-19 in St. Louis County was diagnosed. On March 11, the World Health Organization declared COVID-19 a worldwide pandemic.

Opposite: MIR faculty, staff and trainees like Chief of Breast Imaging Debbie L. Bennett, MD (front), navigated the new normal — from virtual meetings and social distancing, to masks and satellite reading rooms.

Reconfiguring Technology-Driven Patient Care

In a specialty that requires imaging and complex viewing systems as the prerequisite for quality care, Vamsi R. Narra, MD, had the unique challenge of reimagining the reading room environment.

"If we don't have the use of this equipment, it is equivalent to our patients being unable to access health care," says Narra, professor of radiology and senior vice chair for informatics and new business development.

Under normal circumstances, MIR's reading picture archival and communication systems (PACS) workstations are located in reading rooms with multiple stations at which residents and attending radiologists work, with attendings teaching and providing guidance. "Our method of teaching is 'at the elbow,' side-by-side with our trainees at their workstations," says Robert C. McKinstry, MD, PhD, the Orthwein Professor of Radiology and Pediatrics as well as senior vice chair and division director of diagnostic imaging. "We also gather at weekly clinical case conferences at which residents, fellows and attendings review interesting imaging studies. Lively discussions are a hallmark of these meetings."

With the advent of COVID-19, however, "social distancing" entered the world's lexicon. "We realized we needed to protect faculty, trainees and staff, and our current method of working and teaching was not viable," says Narra. "Our main concern, however, was ensuring we would be able to take care of patients no matter the circumstances brought about by COVID-19."

The solution was establishing additional, satellite reading rooms. Working in concert with BJC HealthCare IT leadership, within two weeks locations were identified in two of the hospital's conference rooms as well as in office space in buildings both on campus and offsite. "We knew there were instances of whole hospitals becoming contaminated with the virus, which meant we needed the flexibility of having reading rooms outside Barnes-Jewish's physical space as insurance against our not being able to work within the hospital," says Narra.

Flexibility also influenced changes in faculty and resident work schedules. "We established three groups. When group A was working from the hospital, group B worked remotely and group C had the week off. The next week, group C was at the hospital, group A was remote and group B was off," says McKinstry.

"The rotation ensured that if one person contracted the virus or was exposed, resulting in the whole group going into quarantine, there were two other groups that could keep working."

Another distancing solution was installing home PACS workstations for faculty responsible for reading critical studies, such as emergency room or inpatient cases. It proved to have both advantages and disadvantages. "These remote readouts allow me to share with trainees pertinent lectures I have on my computer or search the Internet more readily for radiology resources from which I can teach."

"If we don't have the use of this equipment, it is equivalent to our patients being unable to access health care."

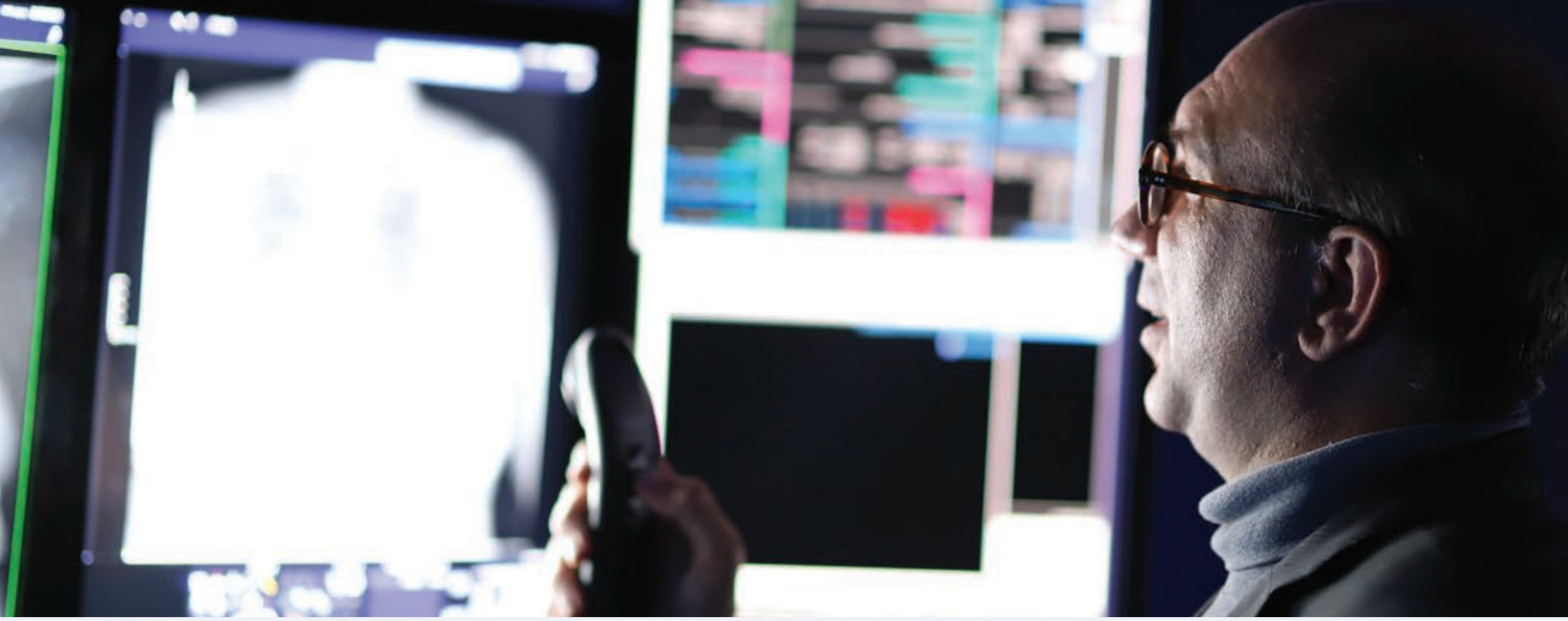
The disadvantage is that the readouts are done via Zoom, with residents connected by their iPads and earphones. Rather than the focus being centered on a resident's view of a study, as is the case with in-person teaching, the focus shifts to the attending's view. There is also the problem of what McKinstry refers to as the "Zoom barrier" to free discussion. "If there are three or four people in a Zoom meeting, a discussion is possible. Beyond six or eight people, a barrier develops and some participants don't say anything. At 25 people, only the speaker talks, and people revert to typing questions into the chat instead of asking them," he adds.

When COVID-19 first arrived in St. Louis, hospitals within the BJC HealthCare system stopped scheduling elective procedures, which significantly reduced the number of patients undergoing imaging studies. By June, those restrictions were reduced and, although sometimes hesitant, patients began to return to the hospitals. Guaranteeing their safety became the top priority. "After the initial COVID-19 surge and subsequent lockdown in March, by June our patient volume was reaching normal levels," says McKinstry. "And it stayed that way even during the second surge in November because we kept our COVID-19 standard operating procedures in place — we never reverted to our pre-virus practices."

For years Narra had encouraged MIR faculty and staff to use teleconferencing for meetings that did not require in-person interaction. Resistance to the concept was high until the COVID-19 pandemic

(continued on page 10)

Vamsi R. Narra, MD, had the unique challenge of reconfiguring MIR's reading rooms — normally filled with faculty, staff and trainees working side-by-side — into socially distant spaces by establishing satellite reading rooms.



MIR Quality and Safety: Keeping Order During a Pandemic

In the first months of the COVID-19 pandemic reaching the United States, almost-daily conflicting reports from trusted government sources about how the virus spread and the best means of preventing infection resulted in a confusing array of safety recommendations. Andrew J. Bierhals, MD, associate professor of radiology and vice chair for quality and safety at MIR, served as the point person for sifting through the muddle.

"Particularly from March through May, information was very fluid, with new recommendations from the Centers for Disease Control and Prevention coming out regularly," says Bierhals, pictured above. "We were keeping abreast of the CDC guidelines and following closely what was happening in hard-hit areas like Seattle and New York City, while making sure we remained in compliance with mandates being developed by Washington University."

According to Robert C. McKinstry, MD, PhD, the Orthwein Professor of Radiology and Pediatrics, Bierhals drove the agenda for daily Zoom meetings among primary decision makers from MIR and BJC HealthCare.

"We were just ticking off to-do items, writing policies and developing strategies pretty much around the clock. It was really an intense time," says McKinstry, also senior vice chair and division director of diagnostic imaging. "It was a joint effort across our department and with hospital leadership to develop an entirely new way to deliver care."

Bierhals also participated in ad hoc Zoom meetings with his radiology quality and safety colleagues across the country. "We were sharing ideas about PPE policies, safety for residents and how we continue teaching them, how techs should interact with patients, what are appropriate cleaning procedures and air filtration," he says. "Yale, Harvard, Washington University — we were all facing the same situations."

He adds, "We also were communicating with frontline physicians in Italy and Spain to get an understanding of what we could expect and how to approach those challenges."

The unknowns surrounding COVID-19 inevitably led to an undertone of stress developing within MIR. Bierhals says communicating to faculty, trainees and staff became another important priority.

"Conversations at sectional levels helped us understand people's concerns. As much as possible we communicated in real time what was happening and how changes would affect everyone involved," he says.

As new policies and procedures became the norm, leadership meetings were cut back in frequency to weekly and then monthly. By summer 2020, patients were beginning to return for services like mammography screenings and oncology scans. When a second COVID-19 surge occurred in November, MIR was well-prepared because of the effective processes already in place.

"Calling how MIR's people responded to COVID-19 a 'team effort' really doesn't convey how everyone worked to meet what was — and continues to be — a serious health threat to our community," says Bierhals. "In the process, we developed at a higher level an ability to share information between our department and BJC HealthCare that going forward will continue strengthening our organizations and the services we provide to our patients."

necessitated a new way of interacting. "Within a couple of days people were figuring out Zoom and sharing tips with each other on how to schedule meetings," he says. "We all have reached a level of competency with teleconferencing that I'm sure will carry on post-COVID."

McKinstry sees teleconferencing and home workstations carrying forward, but the one-on-one interaction with trainees will remain a vital means of teaching. "There is no substitute for the in-person exchange of ideas, and the relationship that develops between teacher and student as a result," he says.

Research Redefined: Finding a Balance Moving Forward

Adhering to a campus-wide directive issued by the university, in mid-March MIR shut down all laboratory activity except for that deemed essential: COVID-19 research, ongoing experiments in which data would be lost if not completed, and therapeutic trials that if stopped would put patients' health at risk. The cyclotron facility also remained in operation. In total, approximately 90% of MIR's labs went dark in response to the university's red-level assessment of risk.

"For researchers conducting computational studies, it was easier for them to begin working remotely from home. For those conducting bench or clinical research, their work was severely curtailed," says Robert J. Gropler, MD, professor of radiology and senior vice chair and division director of radiological sciences.

The challenge became guiding this second group of investigators to projects that allowed them to advance their research from a different perspective. They were encouraged to use the time to develop research papers by analyzing data already collected, which could serve as a basis for grant writing. There also was an opportunity to develop SOPs unrelated to COVID-19 that improved the general operation of the labs.

As a better understanding of the virus developed, the university downgraded to an orange level of risk, which meant most labs could begin operations again but with only 30% of laboratory personnel on site at any one time. "Our lab chiefs were responsible for developing SOPs that best met the university's strict standards in light of the research being conducted by their individual groups," says Gropler.

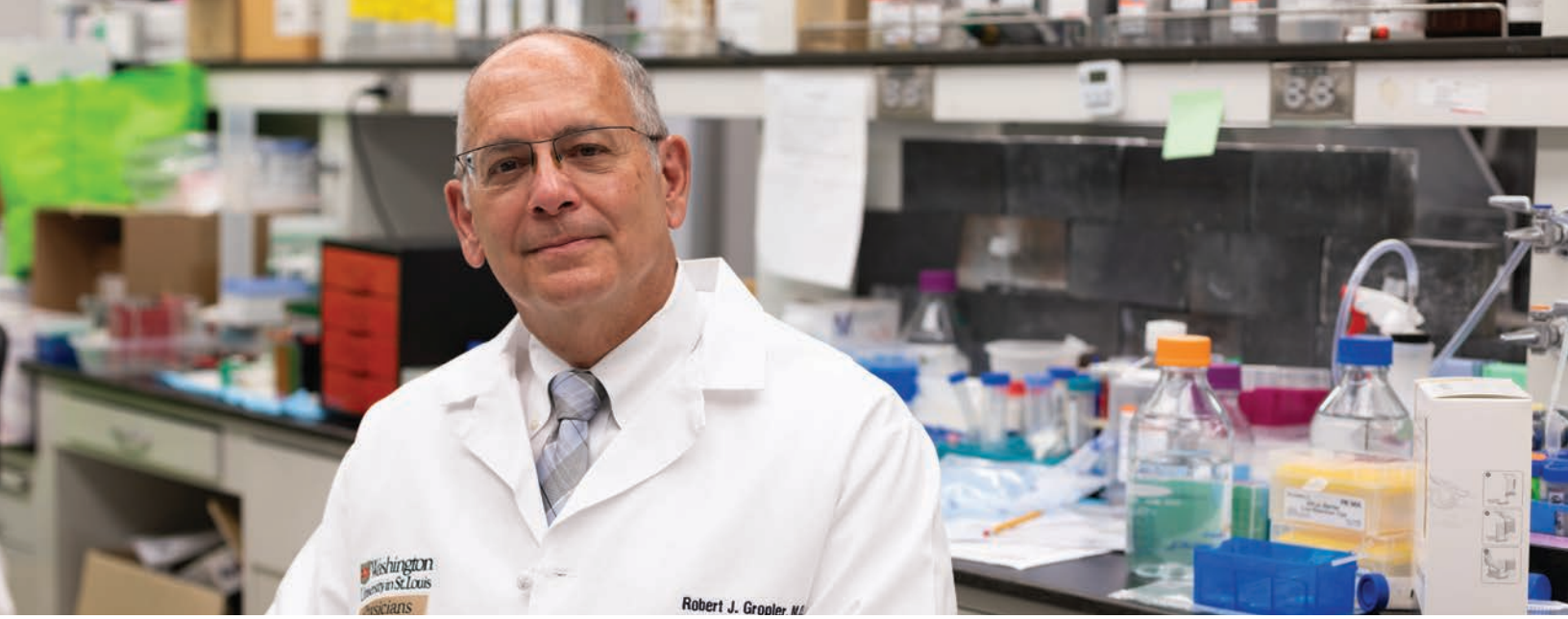
Research personnel began working in shifts, with teams configured to ensure that if one group went into quarantine, other groups could continue advancing research. Individuals recorded their arrival and departure and remained socially distanced and masked while working.

"This was a phenomenal team effort, with great leadership from the university, department and particularly the lab chiefs. All of the researchers and staff understood the gravity of our situation and were vigilant in making sure they followed the established guidelines," says Gropler.

As the number of COVID-19 cases multiplied in St. Louis and throughout the country, concern escalated regarding the availability of personal protective equipment (PPE) and other materials involved in caring for patients. A diverse team — those involved in developing new products and equipment — came together from the university's Danforth and Medical campuses, Barnes-Jewish Hospital and BJC HealthCare to form a Maker Task Force to address possible shortages. Projects ranged from isolation gowns, face shields and N95 respirators, to emergency ventilators and ventilator replacement parts. David H. Ballard, MD, assistant professor of radiology and former chief resident, was one of a number of researchers who began developing 3D-printed PPE alternatives.

> **"All of the researchers and staff understood the gravity of our situation and were vigilant in making sure they followed the established guidelines."**

"My group's focus was an N95-equivalent, 3D-printed respirator that could be used in a hospital



setting," says Ballard. "At the time we began developing the respirator, a survey conducted by the Association for Professionals in Infection Control and Epidemiology indicated that nearly half of all reporting U.S. health care facilities were nearly or completely out of N95 respirators. We were concerned that this would be the case at our institution as well."

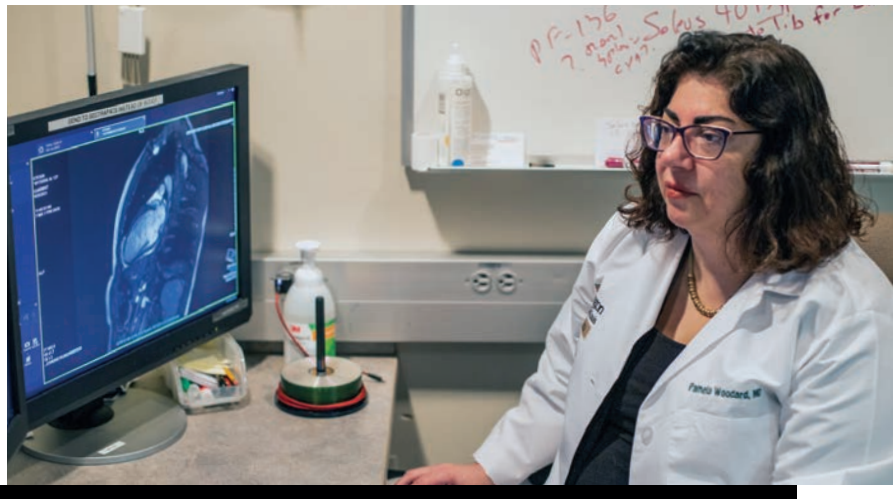
Using rapid prototyping and topographical facial CT, Ballard and his colleagues developed a flexible polymer, 3D-printed N95 alternative mask that passed Occupational Safety and Health Administration testing.

"Fortunately, we never reached a point where we were required to use the masks we generated," says Ballard. "However, we suspect this process of rapid prototype/iteration facilitated by 3D printing is translatable to future urgent needs in health care." He adds, "The Maker Task Force was an incredible response of physicians, researchers, engineers and others who shifted their attention to working toward a common goal of helping in a crisis situation."

Ballard's group and others involved in the task force published papers outlining their methodology and outcomes regarding the PPE they developed. For two newly developed products, MIR's Radiology Clinical Research Core was instrumental in assisting with submission of Emergency Use Authorization (EUA) requests to the Food and Drug Administration.

These products were the COVID-19 saliva test developed by the School of Medicine's Department of Genetics and McDonnell Genome Institute, and a PAPR — powered and supplied air respirator — currently undergoing clinical trials in internal medicine. "We've gained valuable experience in submitting EUAs that will aid us in advancing approval for products developed for other crisis situations," says Pamela K. Woodard, MD, the Hugh Monroe Wilson Professor of Radiology and senior vice chair and division director of radiology research facilities.

With research projects either curtailed or suspended, MIR and research facilities across the country needed to address the billing structures inherent in grants from the National Institutes of Health (NIH) and other funding sources. "Fortunately, the NIH had the foresight to adjust the billing requirements for its grants, giving us permission to continue supporting our researchers even though the experimental work was for the most part on hold," says Gropler. "As our research labs open up again, we'll see a rapid increase in the amount of grant money spent on experiments that were not begun or put on hold during the COVID-19 shutdown."



Opposite: The Maker Task Force spearheaded several projects to address possible PPE shortages, including 3D printing N95-equivalent respirators for hospital employees.

Above: New standard operating procedures were developed to ensure lab personnel could continue working while following the university's strict safety standards. "This was a phenomenal team effort," says Robert J. Gropler, MD.

Right: "We've gained valuable experience in submitting EUAs that will aid us in advancing approval for products developed for other crisis situations," says Pamela K. Woodard, MD.

Once a greater understanding of COVID-19 developed, the university declared a yellow level of risk, meaning the laboratories could conduct 80% of their research with 50% of research personnel onsite at one time. Clinical research also began opening up, with patient safety-focused modifications. In addition to masks, staff were required to wear goggles or face shields when interacting with research subjects where they couldn't maintain social distance. The WashU Institutional Review Board developed an electronic method of consent that could be used instead of pens and paper. "We provided patients with specific routes to our facility so that they wouldn't get lost and inadvertently enter a COVID-19 unit," says Woodard.

"I'm extremely hopeful that the availability of COVID-19 vaccines will facilitate the continuation of the critical investigational work being done in areas such as Alzheimer's disease and chemotherapeutic agents," Woodard adds.

Woodard cites remote and electronic patient consent as an example of the time-saving and safety-focused changes that will remain active post-COVID-19. Gropler agrees. "This experience has shown us that the entire way we structure our laboratories in terms of member composition, communication strategies and physical design needs to be thoroughly reevaluated," he says. "Simply said, how do we take the best of what we did before COVID-19 and combine it with the best of what we learned from it to be an even greater research enterprise?"

Resident Recruitment: Selling MIR and St. Louis Virtually

During a normal resident recruitment cycle at MIR, medical students begin submitting their applications on Sept. 15 for the 16 diagnostic and two interventional radiology openings available. On Oct. 1, the resident selection committee receives Medical Student Performance Evaluations. The applicants then come to St. Louis to interview with faculty and residents, attend luncheons and dinners, tour the Washington University Medical Center, and take a bus tour of St. Louis's Central West End neighborhood and Forest Park, one of the largest urban parks in the U.S. Once all the interviews are completed, the MIR selection committee ranks the applicants in order of preference, and the applicants do the same for their choice of residency programs. A computer algorithm matches programs and residents, and on the third Friday of March, the results are announced.

"MIR is consistently ranked among the top radiology training programs in the country, but our location in St. Louis has us competing with what is perceived as more desirable locations on the coasts," says Jennifer E. Gould, MD, associate professor of radiology and for more than a decade director of MIR's diagnostic radiology residency program. "We have always dispelled that perception by having residency candidates visit St. Louis to see how impressive our medical campus is and learn firsthand how appealing our city can be. By spring 2020, we knew this recruitment strategy would need to be totally revamped."

Work began on developing a strong virtual presence that reflected the caliber of MIR's training program, faculty and residents, as well as why trainees enjoyed living in St. Louis. A "Welcome MIR Candidates" website was developed to explain the residency programs, outline the curriculum and provide insight into why MIR is a top-ranked radiology program. It also featured a section titled "Living in 'The Lou'" that featured video selfies of residents talking about the diverse dining, sports and cultural activities in the city.

"Our goal was to capture a more intimate look at MIR, with people speaking candidly about their experiences in the program and the city," says Jimmy L. Xu, MD, IR chief resident. "We also increased our presence on social media. Although feedback from current residents indicated that this form of social media wouldn't influence their decision to submit an application, they felt it was an important indicator of a program's understanding of current cultural influences."

Another popular recruitment tool was an interactive virtual tour conducted by an MIR resident. A collage of videos, photos and 3D pictures provided a sense of the medical campus's impressive space and scale.

Equally challenging to selling the residency program and St. Louis virtually was conducting candidate interviews via Zoom. Approximately 225 candidates were interviewed over 18 days. "No one at MIR had extensive experience conducting applicant interviews over Zoom, and certainly not as many as we had scheduled," says Janice W. Semenkovich, MD, associate professor of radiology and chair of the resident selection committee. "Although we had multiple meetings about how to organize a Zoom interview season, it came down to our conducting multiple practice interviews with administrative staff to work out kinks. Once we were comfortable with the technology, we tried to anticipate the snafus we might encounter — bandwidth issues, disconnected sessions — and planned how to manage them."

She adds, "Once the season started it ran smoothly, but the first few practice sessions were like very bad Star Trek episodes, with people appearing and dematerializing as if they were characters on a holodeck."

> **"By spring 2020, we knew this recruitment strategy would need to be totally revamped."**

The reward for the hard work, says Gould, was a 2021 match to an exceptionally strong group of residents. "At this point, we don't know whether our 2022 recruitment season will be in-person or virtual," she says. "We will plan for either possibility, or we may end up with a totally new hybrid of both options."

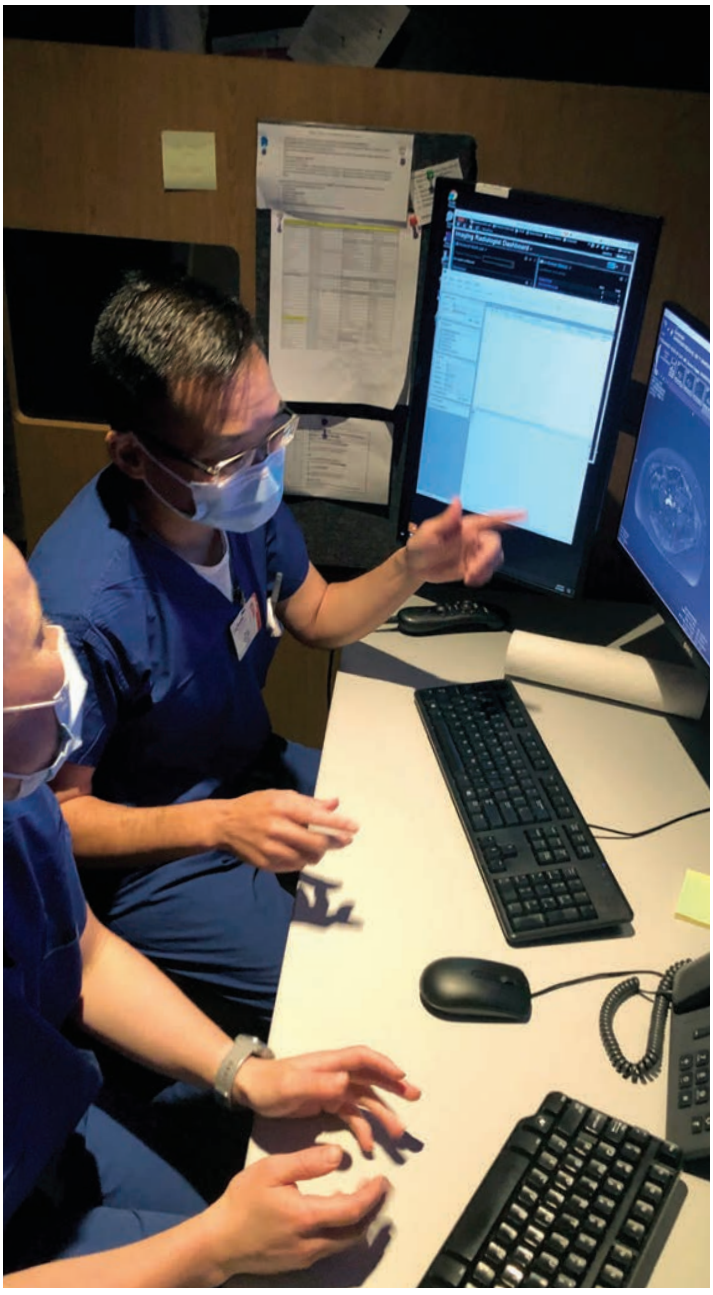
"We knew 2020 would be an unusual and challenging recruitment season, and I think we learned that by being flexible and thinking outside the box we could develop effective recruitment tools that reflected MIR's culture and commitment to excellence," says Gould. "We also learned how to conduct virtual interviews that hopefully brought out the best in each applicant and highlighted their strengths as candidates for our residency positions."

Opposite: After a year of virtual education, many faculty and trainees are thrilled to be vaccinated and resume in-person training.

Right: "At this point, we don't know whether our 2022 recruitment season will be in-person or virtual," says Jennifer E. Gould, MD, shown here at MIR's 2021 residency graduation that was held on campus.

Alumni Spotlight

Navigating COVID-19 has presented countless challenges, changes and teachable moments for MIR's vast alumni network. We caught up with the following alumni to discuss their experiences in their part of the country: Travis S. Henry, MD, who was at the University of California, San Francisco for much of the pandemic (now chief of cardiothoracic imaging at Duke University); David H. Kim, MD, professor of radiology and vice chair of education at the University of Wisconsin School of Medicine and Public Health; and Yulia Lakhman, MD, a radiologist specializing in body imaging at Memorial Sloan Kettering Cancer Center in New York City.



Tell us a little about how COVID changed your day-to-day life as a radiologist.

Henry: COVID accelerated technologic advancements in academic radiology departments and allowed for flexible work hours and remote work, which many large academic departments were reluctant to do in the past. This is both a plus and a minus; we can be more efficient and creative in the ways we handle increasing workloads, but at the same time risk limiting our in-person interactions.

Kim: During COVID, the most dramatic change in my day was the loss of the reading room as a central hub as we socially distanced into separate areas. Although we were able to read cases efficiently and successfully transitioned to remote readouts and teaching, I now realize how much was lost as we return to a pre-pandemic environment with side-by-side readouts. Much more teaching and learning occurs, and the small talk in the reading room is a wonderful change from our year-long period of social isolation.

Lakhman: Our schedule changed and we would work every other week because there were no patients. There were no people on the streets; it was abandoned. Everybody who could, moved out. I wasn't juggling work with homeschooling my kids because my husband took them to our house in the Poconos, and they attended remote school. But I was by myself for months because they worried about me visiting. I think I was, if anything, lucky.

Left: Kim says the pandemic taught him to be more flexible and embrace change, particularly with digital technology.

Opposite Left: While Lakhman (second from left) was grateful her family could get out of the city, this left her — like many other physicians — alone for months.

Opposite Right: Henry (right) says his MIR training emphasized the value of in-person education, and he cautions other radiologists not to get too comfortable with remote work.

In what way did your training at MIR play a role in how you handled the unprecedented situation?

Henry: COVID brought me closer to a lot of alumni from MIR. Many of us got together early in the pandemic to discuss our experiences and were able to publish our perspectives and approaches to imaging during the pandemic. MIR taught me the value of in-person resident education and consultations with clinical teams. Radiologists cannot get too comfortable with remote work as we risk devaluing our role in patient care.

Kim: I can't believe that it has been well over 20 years since I finished my residency. MIR shaped me as a radiologist and my approach to work. I remember the energizing, busy environment which made me feel I could handle anything. MIR set the foundation for me to succeed. This year has been terrible, but it has also brought out a spirit of innovation and flexibility to solve numerous problems ranging from patient care to education to conducting research.

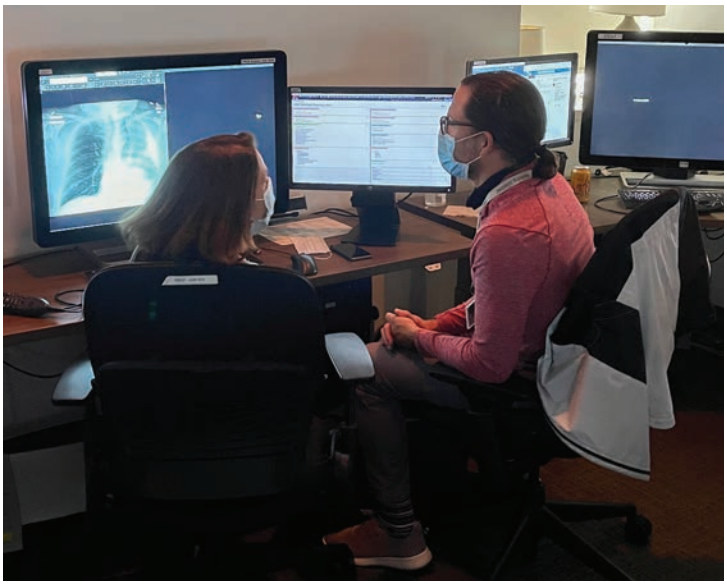
Lakhman: Don't get frazzled. As residents, we were by ourselves at night, so I think that really taught us independence and taking responsibility for your actions. I think that builds confidence, not cockiness, because you're the one who has to make the decision. I think it's the desire to do your best and really think about how things fit together like puzzle pieces as opposed to a random collection of findings in trying to tell the story.

What is one takeaway from the pandemic you think will stay with you as a radiologist long after it's over?

Henry: As telehealth and remote visits become increasingly popular, clinicians will continue to rely on imaging as a replacement for the physical exam. Radiology has a bright future if we continue to work hard to prove our value as consultants for our clinical colleagues.

Kim: The main takeaway for me is to be flexible and embrace change. Prior to COVID, I admit I was becoming set in my ways. I was determined not to learn Twitter or fully embrace electronic changes. Post-COVID, I feel younger and willing to change! This is something that I will hold on to dearly, hopefully all the way to retirement (in the distant future).

Lakhman: I forged better, more personal relationships with my colleagues. Normally, you have so many distractions during your day: traveling, preparing talks, shuttling kids between activities, etc. This time was almost like a pause button. It brought me closer to many of my friends from before. We supported each other.



Bhalla Receives Three Honors for Excellence in Education

Sanjeev Bhalla, MD, professor of radiology and vice chair for education, received three major honors from top radiological professional organizations.

The American Alliance of Academic Chief Residents in Radiology recognized Bhalla's exemplary dedication to educating the next generation of radiologists by presenting him with the prestigious Outstanding Teacher Award. MIR alumna and Bhalla's co-resident, Christine "Cooky" Menias, presented him with the honor.

In December, he was named liaison for education by the Radiological Society of North America (RSNA), joining the society's board of directors. Bhalla, MIR's chief of cardiothoracic imaging, and a residency and fellowship alumnus, was also named the 2021 Distinguished Educator by the American Roentgen Ray Society (ARRS).

"I am beyond excited to serve the RSNA in this new role," Bhalla told RSNA. "I look forward to helping to build on our sense of community as we explore the novel ways we learn and grow in the post-COVID world." He has served RSNA in various capacities, including as associate editor for Radiology: Cardiothoracic Imaging, and has been honored with the RSNA Honored Educator Award four times since 2014.

The ARRS Distinguished Educator Award "celebrates truly inspirational teachers, like Dr. Bhalla, dedicated to education that results in improved participant performance, which ultimately leads to enhanced patient outcomes."

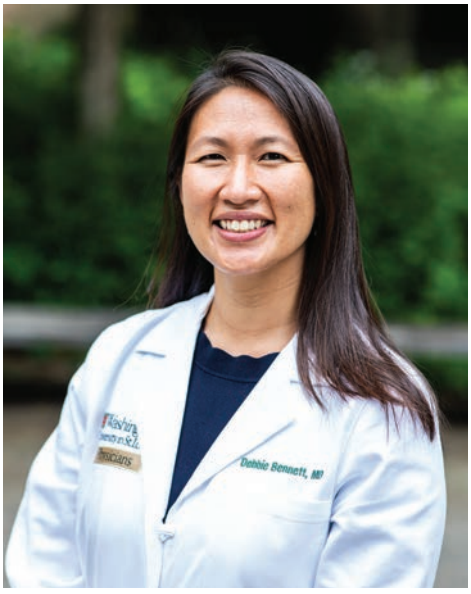
Bennett Named Chief of Breast Imaging

After a national search, noted radiologist Debbie L. Bennett, MD, has been named chief of breast imaging at Mallinckrodt Institute of Radiology. Bennett will oversee screening and diagnostic mammography services offered through Siteman Cancer Center at Barnes-Jewish Hospital and Washington University School of Medicine, including at the Joanne Knight Breast Health Center.

Bennett comes to MIR from Saint Louis University School of Medicine, where she had served on the faculty since 2014, most recently as an associate professor. There, she established the breast imaging section and began serving as its chief in 2015. "We are very excited that someone with Dr. Bennett's proven leadership and experience is joining our breast imaging faculty," said Richard L. Wahl, MD, Elizabeth E. Mallinckrodt Professor of Radiology and director of MIR.

Bennett serves on several committees of professional and academic organizations, including the American College of Radiology, Society of Breast Imaging, American Board of Radiology and Radiological Society of North America. She also is engaged in outreach and education, and has mentored many residents who have gone on to pursue careers in breast imaging

After an internship in internal medicine at Vanderbilt University Medical Center, she completed a residency in diagnostic radiology and a fellowship in breast imaging, both at Massachusetts General Hospital. She earned her medical degree from Harvard Medical School and bachelor's degree from Princeton University, graduating magna cum laude from both institutions.



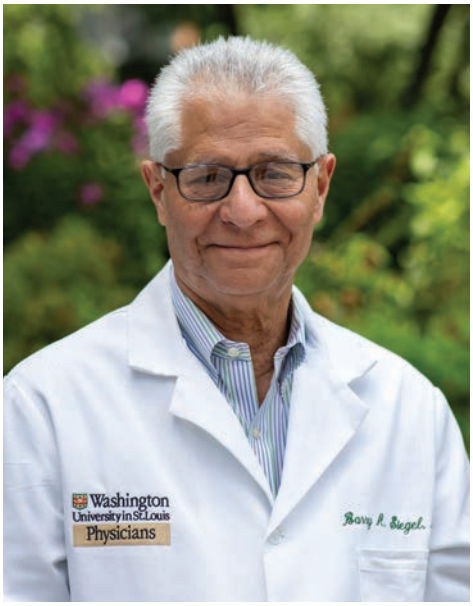
Wahl Elected President of SNMMI

Richard L. Wahl, MD, the Elizabeth E. Mallinckrodt Professor and director of MIR, has been elected 2021-22 president of the Society of Nuclear Medicine and Molecular Imaging (SNMMI). He stepped into the presidency in July 2021. Wahl, also a professor of radiation oncology, has been at the forefront of efforts to combine quantitative data from multiple kinds of scans to form so-called fusion images that can help physicians more precisely diagnose and characterize cancers. He was also among the first to harness the power of the immune system to precisely target radiation therapy to cancers, a technique that has become known as radioimmunotherapy.

Wahl is an elected member of the American Society for Clinical Investigation, the American Association of Physicians and the National Academy of Medicine. He also serves as the chair of the Research and Discovery domain for the SNMMI's Value Initiative. His clinical and research interests include radiopharmaceutical therapies, radioimmunotherapies, quantitative imaging and imaging of the immune system.

Siegel Awarded Gold Medal from American College of Radiology

Barry A. Siegel, MD, professor of radiology and of medicine, has received the Gold Medal Award from the American College of Radiology (ACR)



for his more than 40 years of leadership in the nuclear medicine community. The honor recognizes his accomplishments in helping develop PET into a major clinical and research tool and elevating the quality of imaging clinical trials.

Siegel helped develop PET methods for imaging hypoxia, and for assessing the utility of both conventional and novel agents in studying breast, prostate, cervical and other cancers. Much of this research, including the first human studies with radiolabeled estrogen, has been focused on approaches for predicting and monitoring response to cancer treatment. As associate principal investigator of the ACR Imaging Network, now known as the ECOG-ACRIN Cancer Research Group, he helped guide a wide range of clinical trials of PET imaging, bridging the gap between clinicians and imaging specialists and elevating the quality of clinical trial conduct in imaging.

Siegel served as senior vice chair and division director of nuclear medicine at MIR for over four decades before stepping down in 2017. During his tenure, he introduced clinical PET services to the portfolio of activities offered in nuclear medicine. The success of moving PET into clinical care at the university paved the way for many other medical centers. Consistent with his commitment to evidence-based nuclear medicine, Siegel and colleagues developed the National Oncologic PET Registry to study how F-18 fluorodeoxyglucose PET (FDG-PET) scanning could be applied to improve clinical care for a wide variety of cancers and indications. Their work, in collaboration with the Centers for Medicare & Medicaid Services, resulted in near-universal coverage of FDG-PET imaging in oncology.

Darcy Receives SIR Gold Medal

Michael D. Darcy, MD, professor of radiology and associate professor of surgery, was recognized by the Society of Interventional Radiology (SIR) with a Gold Medal, the society's highest honor. The award was given in recognition of his distinguished and extraordinary service to the society as well as his achievements in advancing the quality of medicine and patient care through interventional radiology.

Darcy, MIR's former chief of interventional radiology, is known for his expertise in managing gastrointestinal bleeding and portal vein interventions. He served as SIR's president from 2002 to 2003, and as chair of the SIR Foundation from 2007 to 2009. His contributions to the field were recognized previously when he delivered the Dr. Charles T. Dotter Lecture at the society's 2016 meeting.

Bruker Scanner in the House

Thanks to a $2 million National Institutes of Health Instrumentation grant, MIR's East Imaging Building is now home to a new Bruker BioSpec 9.4 Tesla preclinical MRI scanner.

The scanner, installed in August 2020, has a high-performance system that delivers unmatched flexibility and offers new potential for advancing preclinical research and molecular imaging.

Appointments/ Promotions

Diane S. Abou, PhD
Assistant Professor of Radiology

Hongyu An, PhD
Professor of Radiology and Professor of Neurology

Jennie E. Brodsky, MD
Assistant Professor of Radiology

Steven Don, MD
Professor of Radiology and Professor of Pediatrics

Saul N. Friedman, MD, PhD
Assistant Professor of Radiology

Evan M. Gordon, PhD
Assistant Professor of Radiology

Akash P. Kansagra, MD
Associate Professor of Radiology

Kooresh I. Shoghi, PhD
Professor of Radiology

Kushaljit Sodhi, MD, PhD
Professor of Radiology

Daniel L.J. Thorek, PhD
Associate Professor of Radiology

Malcolm Tobias, PhD
Assistant Professor of Radiology

Andrew B. Wallace, MD
Assistant Professor of Radiology and Assistant Professor of Pediatrics

Dean F. Wong, MD, PhD
Professor of Radiology, Professor of Neuroscience, Professor of Psychiatry and Professor of Neurology

Jonathan R. Wood, MD
Assistant Professor of Radiology

Grants

Samuel I. Achilefu, PhD, the Michel M. Ter-Pogossian Professor of Radiology, was awarded a three-year, $2.2 million grant from the National Institute of Biomedical Imaging and Bioengineering to optimize imaging goggles for fluorescence-guided surgery.

Gloria J. Guzmán Pérez-Carrillo, MD, assistant professor of radiology, received a one-year, $40,000 RSNA Research & Education Foundation Research Seed Grant for "Precision Diffusion Weighted Imaging of Head and Neck Squamous Cell Carcinoma."

Richard Laforest, PhD, professor of radiology, received a $571,251 grant to acquire a preclinical PET/CT scanner for Biological Safety Level-3 imaging research.

Christopher D. Malone, MD, assistant professor of radiology, received a one-year Research Seed grant of up to $40,000 from the RSNA Research & Education Foundation for "Harnessing Cerenkov Emission From Yttrium-90 (Y-90) as a Source of Photodynamic Therapy to Enhance Radioembolization for Liver Tumors."

Daniel S. Marcus, PhD, professor of radiology, was awarded a $4.1 million grant from the National Cancer Institute to sustain the Integrative Imaging Informatics for Cancer Research Center. He also received a $1.9 million NIH grant to build a high-performance research image repository.

Cyrus A. Raji, MD, PhD, assistant professor of radiology, was awarded a three-year, $2.3 million National Institutes of Health (NIH) grant for "Neuroinflammation and Alzheimer's Disease Imaging Biomarkers in Midlife Obesity."

Kooresh I. Shoghi, PhD, professor of radiology, received a $928,767 grant to acquire a high-resolution PET/CT preclinical imaging instrument.

Muriah D. Wheelock, PhD, instructor in radiology, was named a 2020 K99/R00 BRAIN Initiative Advanced Postdoctoral Career Transition Award to Promote Diversity recipient, a program that supports mentored research for postdoctoral fellows and bolsters diversity in the biomedical research workforce.

Honors/Awards

Gloria J. Guzmán Pérez-Carrillo, MD, assistant professor of radiology, was accepted into the RSNA Value of Imaging through Comparative Effectiveness Program, a nine-month curriculum aimed to teach key comparative effectiveness research methodologies.

Ali Y. Mian, MD, assistant professor of radiology, and **Michelle M. Miller-Thomas, MD**, associate professor of radiology, have been named 2020-22 Carol B. and Jerome T. Loeb Teaching Fellows. The two-year program aims to advance medical education by providing fellows dedicated time to implement innovative ideas into their teaching and training.

Christopher J. Moran, MD, professor of radiology and of neurological surgery, was inducted as a Society of NeuroInterventional Surgery Fellow. One of the society's most prestigious honors, fellowship recognizes members for their achievements and contributions to the field of neurointervention.

Cyrus A. Raji, MD, PhD, assistant professor of radiology, received the Society for Pediatric Radiology's 2020 Jack O. Haller-Thomas L. Slovis Award for Excellence in Pediatric Radiology Education. The award recognizes the best basic scientific paper submitted to the journal that year.

Demetrios "Jim" A. Raptis, MD, assistant professor of radiology, received the Outstanding Reviewer Award from the Canadian Association of Radiologists Journal. This award recognizes dedicated volunteer service and high-quality reviews completed on behalf of the journal.

Xavier Robinson, MD, a diagnostic radiology resident, was elected president of the Washington University Minority Medical Association. Run by residents and fellows, this inter-departmental organization fosters an inclusive medical community and supports the development and retention of underrepresented medical trainees.

Monica Shokeen, PhD, assistant professor of radiology, was appointed to the NIH Imaging Probes and Contrasts Agents Study Section for a four-year term. The study section reviews proposals to develop novel contrast agents.

Facilitating State-of-the-Art Research

by Marie Spadoni

In 2007, then-MIR director R. Gilbert Jost, MD, was looking for a new head of planning and Rick Schaefer, director of design and construction for the School of Medicine, was tapped to lead the search. Schaefer whittled the list down to two finalists but just days before an offer was to be extended, he came to a decision that surprised even him.

"Gil thought both candidates were good and asked me what I thought," recalls Schaefer. "I said, 'I think I'd like the job.'" Jost was shocked but also delighted. After eight years with the School of Medicine, Schaefer took the reins at MIR, where he stayed until his retirement in June.

Over the past 14 years, Schaefer has been at the forefront of a facilities renaissance. "The evolution in facilities at MIR has been pretty incredible," he says. "When I came on board, the CCIR (Center for Clinical Imaging) had only been open a year." He recalls the installation of a PET/MR scanner, one of the first in the country at that time.

"You're craning up this 28,000-pound machine to the 10th floor, then trying to fit it through an 8 feet by 8 feet opening in the wall," Schaefer says. No small undertaking, considering the machine itself measures slightly more than 7 feet by 7 feet.

Pamela K. Woodard, MD, senior vice chair and division director of radiology research facilities, agrees. "I think one of the most complex projects Rick has undertaken is the installation of the Siemens Biograph mMR PET/MRI," says Woodard, who is also director of the CCIR. "The scanner required both ionizing radiation and radiofrequency shielding and extensive shoring of the floor for increased weight-bearing capacity." She cites Schaefer's unique knowledge of radiology equipment room planning and design as key to the successful expansions and renovations of the CCIR, East Building MR Facility, and Small Animal MR/Preclinical PET Facilities. "He has a thorough understanding of the electric, chiller and weight-bearing requirements so vital to equipment delivery and installation."

Though Schaefer oversaw several major projects over the years, he considers the 2014 installation of the TR-19 cyclotron the most challenging. "The walls of the vault it sits in are 6-foot-thick concrete, as is the lid that sits on top of it," he says. "It was craned into a hole in that lid, which was then sealed back up with about four layers of concrete panels, each about 1 foot, 6 inches thick." The project was part of the $12 million Cyclotron Facility expansion that significantly broadened the development and translation opportunities available in PET radioisotope production at MIR.

In addition to maintaining all of MIR's owned facilities, Schaefer's in-house team is responsible for planning and design. This includes overseeing space for everything from staff offices and conference rooms to wet-and-dry research labs.

"Rick was an invaluable asset to our research enterprise," says Robert J. Gropler, MD, senior vice chair and division director of radiological sciences for MIR. "His ingenuity in designing and redesigning research space and ensuring the timely delivery of a high-quality product that met our researchers' needs was truly remarkable."

As MIR continued to grow, managing space became akin to a high-level game of "Tetris." Then came COVID. Prior to the pandemic, Schaefer had a strategic plan to move non-research employees out of the East Building. Now that plan has changed.

"For the next six months to a year, it will be super challenging to figure out what we're going to do with space," he says. Whatever happens, it will be under the direction of Tim Rogan, who stepped into the director role on July 1. In an interesting twist of fate, Rogan was one of the final candidates for the position back in 2007.

While Schaefer is happy with some of the changes he made over the years, such as implementing new standards for furniture, office and work station sizes, there are a few things left on his to-do list. For example, he would love to update all conference rooms with standardized, state-of-the-art A/V equipment. He also hopes for a 7 Tesla MRI scanner in the East Building. If and when that happens, he has a design ready.

"I just want to know that things are in place for the department to carry on," says Schaefer. "When I walk out the door I want to know that everything is going to function as well as or better than it has been."

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a: The East Building cyclotron installment in 2014 was Schaefer's most challenging project. **b:** Prisma scanner installment in the East Imaging building in 2017. **c:** Schaefer on a work site during a scanner installation at the CCIR. **d:** Schaefer oversees the install of the Bruker BioSpec 9.4 Tesla preclinical MRI scanner in 2020. **e:** Job site for the MIR Tower's fourth-floor renovation, which houses interventional radiology. **f:** Research faculty members consider Schaefer's planning expertise key to MIR's successful facilities expansion. **g:** A 2017 scanner installation on the 10th floor of the CCIR.

FOCAL SPOT

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