

## Research Weighs Benefits of DW-MRI

**N**orthwestern Radiology has entered a new age of diffusion-weighted (DW) magnetic resonance imaging (MRI). Refining this technique to differentiate lesion types and ultimately improve treatment planning, clinical investigators are evaluating the use of DW-MRI in previously unexplored abdominal applications.

“Most places use diffusion-weighted MR imaging in the brain,” says Frank Miller, MD, director of body imaging. “We are now evaluating the abdominal organs, such as the liver. With DW-MRI, we hope to detect functional post-therapy tissue changes to better assess response to treatment and improve patient survival.

“In particular, we are using this technique and applying for grants with Drs. Riad Salem and Reed Omary to evaluate liver cancer patients treated with yttrium-90 microspheres. In this patient population, diffusion has been especially promising,” he continues. “Lesions of the liver often appear to increase in size after therapy due to hemorrhage or necrosis, incorrectly indicating a lack of response. DW-MRI may permit improved differentiation of malignant and healthy tissues.”

Anatomic changes in tumor size, therefore, don't necessarily provide clinicians with clear cut answers, according to Andrew Larson, PhD, an assistant professor of radiology, who is developing diffusion-weighted and other MRI strategies for functional tumor imaging. DW-MRI, providing metrics of tumor necrosis and tissue water mobility characteristics, may improve diagnosis and treatment. And it can also help separate benign lesions such as hemangiomas or focal nodular hyperplasias from malignant ones—not

always an easy task and one that sometimes results in misdiagnosis.

DW-MRI works by measuring the motion of water molecules in biological tissues. Since benign and malignant lesions of the liver have different diffusion properties, DW-imaging can offer a microscopic and discriminating look at tumor tissues. Primarily performed in neuroimaging applications, DW-MRI until recently had faced some stumbling blocks when used on the body. The requisite larger field of view and respiratory motion has led to poor image quality. Faster imaging times and the development of new sequences to decrease sensitivity to motion, for example, have helped overcome some of these challenges.

“We are just scratching the surface as far as characterizing disease,” says Dr. Larson. “However, as we advance in our studies, body DW-MRI will provide us with some flexibility in interpreting exams and may even produce PET-like whole-body projection images for the detection of metastasis.” Similar to the use of positron emission tomography (PET) scans, diffusion has the potential to become an effective screening tool for cancer. Yet, unlike PET, diffusion doesn't require ionizing radiation.

“Diffusion testing only adds an extra 20 seconds to MR scans that patients would already be undergoing,” remarks Dr. Miller, “With the help of Andy Larson and others, the image quality should improve to the point that DW-imaging becomes more routinely used across the country.”

# IMAGES

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## A Few Words from Eric J. Russell, MD . . .

### Translational Research and Radiology

**O**ur specialty is undergoing a relatively rapid transformation, and we are participating in this fully at Northwestern Radiology. Radiologists are incorporating functional evaluations along with anatomical analysis as we move toward a comprehensive evaluation of health and disease. The recent addition of the first clinical Siemens Miyabi system, a combined Interventional and Magnetic Resonance Imaging suite, allows us to investigate and apply real-time analysis of organ physiology during

minimally invasive interventions. The goal is to improve the effectiveness and safety of these procedures, for the benefit of our patients, and work to translate research into routine clinical practice.

In this sense, we are fully aligned with the direction our medical school and the NIH have taken to promote such activity. Infrastructure at the school is now in place to compete for the recently developed NIH Clinical and Translational Science Awards (CTSA). These sizable awards promote the more efficient ap-

plication of basic science research to the development of new medical therapies.

At the Feinberg School of Medicine, the CTSA program, led by Dr. Phillip Greenland, creates a centralized home to “encourage the development of novel methods and approaches to clinical and translational research, enhance informatics and technology resources, and improve training and mentoring for new investigators.” We will be active participants in this effort.



## Interventional Oncology Expands Sphere of Influence

**S**mall but potent, radioactive microspheres delivering high doses of radiation (yttrium-90) to malignant and inoperable tumors of the liver continue to demonstrate their value in extending the lives of cancer patients. Since introducing this innovative, minimally-invasive technique to the state of Illinois and the Chicago area in 2003, Northwestern Radiology has expanded its section of interventional oncology to accommodate the demand for this procedure and other clinical services.

“In the past two years, our annual patient volume has grown by 200 percent,” says Riad Salem, MD, MBA, director of interventional oncology. “The medical and surgical oncology community has adopted our treatment paradigms. They like our results and see that this therapy has provided some measure of hope in a group of patients for whom standard therapy has failed.”

More than 18,000 individuals will re-

ceive a diagnosis of primary liver cancer this year. About 16,200 people will die of this disease in the United States, according to the American Cancer Society. Surgical removal of liver cancer offers the best option for a cure. Unfortunately, fewer than 15 percent of patients are suitable surgical candidates due to the advanced stage of their cancer upon detection or other medical considerations.

Radiation treatment with the microspheres involves injecting millions of tiny (15 to 35 microns in diameter) beads into the artery supplying blood to the liver. The interventional radiologist guides a small catheter into the liver’s hepatic artery and then delivers the microspheres that carry the radioactive yttrium to malignant cells in liver tumors. The procedure kills tumor cells without the possible radiation side effects such as hair loss, weakness, burns, or nausea. The beads irradiate the liver for approximately 12 days before losing their radioactive properties.

Performed on an outpatient basis, the therapy can as much as double the time some liver cancer patients have left to live—from four to five months to almost a year. The treatment has even allowed a small number of patients to significantly improve their conditions to undergo more curative therapy.

“We have been able to downstage nine patients—from non-transplantable to transplantable—in the last two years who became good candidates for liver transplants,” says Dr. Salem. “Turning around what amounts to an incurable disease for these patients has been a huge success.” The interventional oncology team now includes Dr. Salem and four other interventional radiologists: Reed Omary, MD; Albert Nemcek, MD; Robert Ryu, MD; and Kent Sato, MD. A physician’s assistant, two clinical nurses, a research nurse,

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## What's New with MRI-based Quantitative Cerebral Perfusion

Research Update ■ Research Update ■ Research Update ■ Research Update ■ Research Update



By Timothy J. Carroll, PhD

The pathophysiology of many debilitating diseases of the central nervous system, including cancer, cerebrovascular occlusive disease, and ischemic stroke, is related to changes in capillary-level cerebral blood flow (CBF) and cerebral blood volume (CBV). There is currently no widely available method to quantify physiologic parameters related to perfusion over the entire brain.

During the past decade, several research groups have attempted to quantify CBF using MRI. To date, the only successful attempts were based on the assumption that normal appearing white matter is regulated to be within “average population” values. This assumption breaks down for patients in which knowledge of CBF is most critical, such as cases of ischemic stroke. The poor performance of existing cerebral perfusion imaging has prompted the American Heart and Stroke Association to recommend that “more research must be conducted to make these techniques, especially the MR-based methods, quantifiable.”

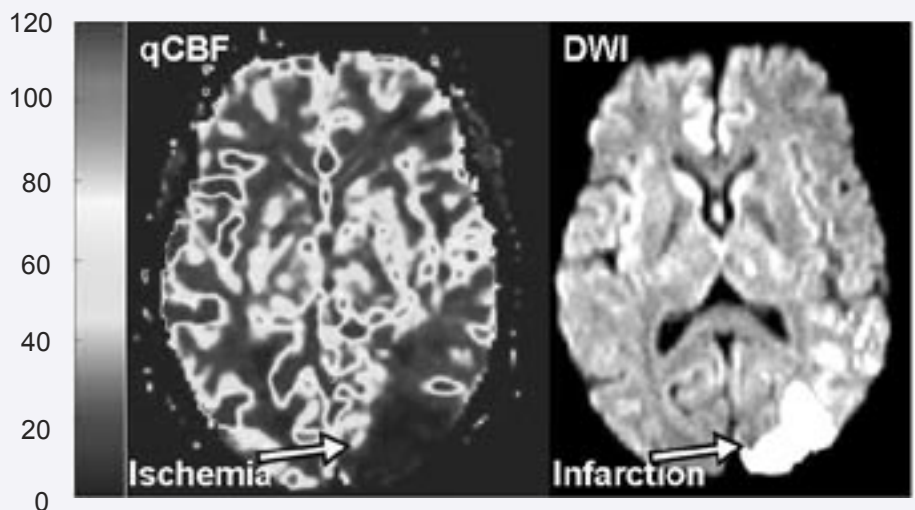
At Northwestern we have developed a means of quantifying CBF by using information normally ignored in traditional dynamic susceptibility MRI contrast perfusion measurements. Traditional MRI perfusion images provide relative CBF by performing a deconvolution analysis on the passage of a bolus of contrast agent. Long after the passage of the contrast bolus, the contrast agent alters the longitudinal relaxation time (T1) of brain parenchyma in proportion to its fractional blood volume. This change in T1, an

effect that is normally ignored in MR perfusion scans, is the missing piece of information that allows us to quantify CBF. By making a precise calculation of the T1 changes in white matter, we can calculate quantitative CBV (qCBV) and CBF (qCBF) over the entire brain. These so-called “steady-state” CBV measurements are subject to large variability due to the exchange of water molecules across the capillary wall. Biomedical engineering doctoral degree candidate Wanyong Shin has recently authored a manuscript in which he outlines a method of calculating the water exchange effects to improve the accuracy of our perfusion quantification.

The National Institutes of Health recently awarded us extramural funding for our quantitative perfusion work. A major aim of our qCBF research is to compare MRI-derived qCBF perfusion with the “gold standard,” H2[15O] PET, in collaboration with investigators at Washing-

ton University in St. Louis. Through this collaboration, we will perform a direct comparison of MRI and PET quantitative CBF measurements in patients enrolled in the Carotid Occlusion Surgery Study (COSS). These studies will begin early next year and will continue for 24 months. In the meantime, Northwestern Radiology faculty members Matthew Walker, MD, and Ali Shaibani, MD, have been looking at qCBF changes associated with stroke. They are using qCBF in both acute and chronic stroke patients to determine the degree of hypoperfusion and relating the perfusion deficit to the size of the associated diffusion abnormality. Their goal is to extend the three-hour time limit for thrombolytic therapy. Two large phase II clinical I.V. thrombolysis trials (DIAS and DEDAS), using perfusion-diffusion mismatch as selection criteria, have shown positive clinical outcomes for

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A single slice axial cut through an ischemic region (left, arrow) as imaged with the quantitative cerebral blood flow (qCBF) “Bookend” scans which were developed through a collaboration of the Departments of Radiology and Biomedical Engineering. The severe hypoperfusion (qCBF < 10 ml/100g-min) resulted in a diffusion positive region (right, arrow) indicating the presence of an infarct.

# Northwestern Radiology Participates at SIR Annual Meeting

The 31st Annual Scientific Meeting of the Society of Interventional Radiology (SIR), to be held March 31 to April 4, in Toronto, Canada, will feature significant work in the field as well as the valuable contributions of several Northwestern faculty members. In addition to symposia, courses, workshops, and presentations, members of the department volunteer their time to the society and annual meeting in many ways.

Albert Nemcek, Jr., MD, serves on the group's Executive Committee and as editor-in-chief of the *Journal of Vascular and Interventional Radiology*; Howard Chrisman, MD, MBA, is incoming treasurer of the Executive Committee; and Robert Ryu, MD, is chair of the Resident Education and Training Committee and director of Resident-in-Training Scholarship activities.

## MEDIA TRAINING SEMINAR

Friday, March 31

12:00 p.m.–1:30 p.m.

Sunday, April 2

12:00 p.m.–1:30 p.m.

Robert Vogelzang, MD, and Fleishman Hillard Public Relations.

## FEATURED SYMPOSIA

Thursday, March 30

**Cardiac CT and MR:**

**The Heart Comes Back**

12:00 p.m.–12:15 p.m.

Current Challenges in the Workup of Ischemic and Non-ischemic Heart Disease, James Carr, MD.

3:15 p.m.–3:40 p.m.

Technical Principles of Cardiac MRI, James Carr, MD.

4:00 p.m.–4:20 p.m.

Cardiac MRI: Non-ischemic Applications, James Carr, MD.

Tuesday, April 4

**Building an IR Oncologic Practice**

7:30 a.m.–7:45 a.m.

From Caring to Cure: Initiating a Practice/Uniqueness of the Oncology Patient, Riad Salem, MD.

8:20 a.m.–8:35 a.m.

Marketing an Interventional Radiology Oncology Practice, Francis Facchini, MD.

9:40 a.m.–10:00 a.m.

The Importance of Pre- and Post-imaging, Reed Omary, MD, MS.

11:20 a.m.–11:35 a.m.

Maximizing the Palliative Benefit, Albert Nemcek, Jr., MD.

## CATEGORICAL COURSES

Friday, March 31

**GI Bleeding**

3:20 p.m.–3:35 p.m.

New Approaches to Diagnostic Imaging of GI Bleeding, Albert Nemcek, Jr., MD.

Saturday, April 1

**Lessons Learned: Fibroids**

8:20 a.m.–8:40 a.m.

Technical Considerations: Instruments, Embolics, and the Current Opinion on Embolization Endpoint, Howard Chrisman, MD, MBA.

**Case-based Review: Vascular Diagnosis**

8:00 a.m.–9:30 a.m.

Coordinator/moderator and panelist, Albert Nemcek, Jr., MD, and panelist, Robert Ryu, MD.

**Case-based Review: Vascular Interventions**

12:30 p.m.–2:00 p.m.

Coordinator/moderator, Albert Nemcek, Jr., MD.

**Case-based Review: Non-vascular Interventions**

2:15 p.m.–3:45 p.m.

Coordinator/moderator and panelist, Albert Nemcek, Jr., MD.

**Saphenous Vein Ablation: Lessons Learned, Complications, and Controversies**

2:15 p.m.–3:45 p.m.

Coordinator/moderator, Howard Chrisman, MD, MBA.

Sunday, April 2

**IR of the Future: Really New Stuff**

5:15 p.m.–5:30 p.m.

MR-guided Interventions, Reed Omary, MD, MS.

Monday, April 3

**Complex Drainage**

5:00 p.m.–5:20 p.m.

Use of Thrombolytics Agents for Complex Fluid Drainage, Albert Nemcek, Jr., MD.

## PLENARY SESSIONS

Saturday, April 1

**Cardiac/Vascular Imaging**

10:25 a.m.–10:40 a.m.

Cardiac MRMRA: "One-Stop"

Imaging and Testing, James Carr, MD.

Monday, April 3

**Evidence-based Decision Making in Interventional Oncology: Assessing the Moving Target**

10:30 a.m.–10:45 a.m.

Y90 Microspheres: Do the Results Justify the Costs and Logistics? Riad Salem, MD, MBA.

## WORKSHOP SESSIONS

Friday, March 31, 12:30 p.m.–2:30 p.m.

Sunday, April 2, 4:30 p.m.–6:30 p.m.

Monday, April 3, 1:30 p.m.–3:00 p.m.

**IR Management of Portal Hypertension (TIPS).**

Workshop faculty: Robert Ryu, MD.

Saturday, April 1, 12:30 p.m.–2:00 p.m.

Monday, April 3, 3:15 p.m.–4:45 p.m.

**Practice Development: Lessons Learned in Developing an Oncology Practice.**

Coordinator: Riad Salem, MD, MBA.

Saturday, April 1, 12:30 p.m.–2:00 p.m.

**Basics Series: Angiography Tools and Techniques.**

Workshop faculty: Albert Nemcek, Jr., MD.

Saturday, April 1, 2:15 p.m.–3:45 p.m.

Sunday, April 2, 4:30 p.m.–6:30 p.m.

Monday, April 3, 1:30 p.m.–3:00 p.m.

**Atrial Embolotherapy.**

Workshop faculty: Howard Chrisman, MD, MBA.

## ORAL PRESENTATIONS

Friday, March 31

**Oncology: Liver**

Session Time: 10:30 a.m.–12:00 p.m.

Diffusion-weighted MRI for Determination of Hepatocellular Carcinoma Response to Yttrium-90 Radioembolization, Deng J, Miller F, Barrett K, Omary RA, Salem R, Larson AC, *et al.*

Treatment of Unresectable Hepatocellular Carcinoma Using Intra-arterial

Y90 (TheraSphere): Long-term Follow Up, Atassi B, Lewandowski RJ, Kulik L, Mulchay MF, Omary RA, Salem R.

## Belgian Contingent Tours Department during U.S. Visit

Prime Minister of Belgium, Guy Verhofstadt, toured Northwestern Radiology January 20 as part of a three-day state visit to the United States that included meetings with President George W. Bush, Chicago Mayor Richard M. Daley, and members of our very own department!

On an economic and trade-related mission, the prime minister made a 45-minute stop at Northwestern Memorial Hospital to learn more about the successful partnership and strategic corporate alliance between Northwestern Radiology, GE, and Barco, a Belgium technology firm. The department features 120 Barco high resolution monitors, used at more than 80 dedicated PACS workstations at the hospital.



Photograph courtesy of Maria Corely

Belgium's prime minister, Guy Verhofstadt (third from left) saw Belgian technology in action with the help of (from left) Timothy Zoph, chief information officer, NMH; Dr. Eric Russell; and Jean Przybylek, VP, operations, NMH.

The prime minister's whirlwind tour included visits to Northwestern Radiology's reading room on the fourth

floor of the Galter Pavilion as well as the Lynn Sage Comprehensive Breast Center.

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## SIR Meeting (continued)

Yttrium-90 (TheraSphere) Treatment for Metastatic Cancer to the Liver: Midterm Results, Yu M, Lewandowski RJ, Wong CO, Gates VL, Omary RA, Salem R.

Friday, March 31

### **PAD/Renal**

Session Time: 10:30 a.m.–12:00 p.m.

A Comparison of Static and Dynamic 3D MRA for Diagnosis of Infrapopliteal Disease Using TREAT and iPAT, Dill K, Carr JC, Carroll TJ, Diniz LO, Morasch M, Pereles S.

Saturday, April 1

### **Oncology: Colon Renal/Other**

Session Time: 2:15 p.m.–3:45 p.m.

Efficacy and Safety of the Pleurx Catheter When Used to Treat Recurrent Malignant Ascites, Courtney A, Nemcek Jr. AA.

### **Fibroid Embolization**

Session Time: 2:15 p.m.–3:45 p.m.

Feasibility of a Rabbit Animal Model for Uterine Fibroid Embolization: A Preliminary Investigation, Ryu R.

Sunday, April 2

### **Oncology: Liver**

Session Time: 9:00 a.m.

Effect of Transcatheter Arterial Embolization on Hypoxia Inducible Factor-1 Alpha Levels in

Rabbit VX2 Liver Tumors, Rhee, TK, Young, JY, Larson AC, Hofmann LV, Salem R, Omary RA, *et al.*

### **Fibroid Embolization**

Session Time: 4 p.m.

Efficacy of UFE in the Post-menopausal Patient. Accepted as featured abstract of 13 total. Chrisman H.

Monday, April 3

### **PAD/Renal**

Session Time: 1:30 p.m.–3:00 p.m.

3.0T MRI Assessment of Renal Function During Angioplasty of Renal Artery Stenosis in Swine, Park J, Cashen TA, Shin W, Rhee TK, Carroll TJ, Omary RA, *et al.*

### **Vascular Disease**

Session Time: 1:30 p.m.–3:00 p.m.

The Perclose Run: Is It Necessary? Lewandowski RJ, Atassi B, Alli A, Omary RA, Salem, R.

### **POSTERS**

The Development of an Interventional Oncology Practice: Two-year Follow Up, Courtney AL, Nemcek Jr. AA, Barrett K, Sajdak K, Gilbertsen P, Salem R.  
Diagnosis of Subclavian Steal Syndrome Using

a Novel Time-resolved Magnetic Resonance Angiographic Technique, Virmani R, Dill K, Carroll TJ, Omary R, Carr JC.

Quantitative Analysis of ECG-gated High-resolution Contrast-enhanced MR Angiography of the Thoracic Aorta, Groves E, Bireley W, Carr JC, Carroll TJ.

Retraction of Portal Vein Thrombus following Treatment with Y90 TheraSphere: A Secondary Sign of Tumor Response, Lewandowski RJ, Alli A, Atassi B, Kulik L, Mulchay MF, Salem R.

Medical student Jonathan Park received a SIR research award and a trip to the meeting. Last summer he worked with Reed Omary, MD. Park will present his abstract, "3.0T MRI Assessment of Renal Function during Angioplasty of Renal Artery Stenosis in Swine."

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## Russell Receives Endowed Professorship

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Eric Russell, MD, was named the Drs. Frederick J. Bradd and William Kennedy Professor of Radiology at Northwestern University's Feinberg School of Medicine at a special investiture ceremony held in January.

The first interventional radiologist in Illinois, Dr. Russell joined Northwestern in 1986 as director of neuroradiology. Colleagues, friends, and mentors spoke at the investiture, which concluded with some words from Dr. Russell. The professorship honors the father and father-in-law of Eva Kennedy, a longtime benefactor of Northwestern. In 1983, Kennedy left her entire estate to the medical school.



Celebrants at the investiture ceremony included (from left) Drs. Lee F. Rogers, Michael Hackman, Robert Vogelzang, Eric Russell, Robert Zimmerman, and Lewis Landsberg, dean and vice president for medical affairs, Feinberg School of Medicine.

## What's New with MRI-based Quantitative Cerebral Perfusion

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patients treated as late as nine hours after symptom onset. These results give us great confidence that qCBF will play an integral part in extending the three-hour time limit for thrombolysis that denies treatment to 95 percent of stroke patients.

Our quantitative perfusion work is not limited to ischemic stroke. Tumor vascularity has long been used as an indicator of aggressiveness. Sandy Horowitz, MD, in collaboration with James Chandler, MD, (Neurological Surgery) and Jeffrey Raizer, MD, (Neurology) will be studying whether our qCBV images can, for the first time, quantify vascular proliferation for tumor grading. Initial results are encouraging and will be presented

at upcoming meetings of the ASNR and ISMRM.

qCBF imaging also has the potential to provide feedback on the staged embolization of cerebral arteriovenous malformations (AVMs). The embolization of cerebral AVMs is associated with transient local changes in CBF resulting from the redistribution of previously shunted blood. Dr. Shaibani and Bernard Bendok, MD, (Neurological Surgery) are using qCBF images to track these changes throughout the staged embolization. Perfusion changes are only part of the story; a detailed 3D mapping of the vascular architecture is also needed. Ty Cashen, an MSTP student, has developed

an MR angiographic technique for mapping the vascular architecture of cerebral AVMs. We have recently submitted the combined qCBF/MRA project to the American Heart and Stroke Association and are currently awaiting scores.

This exciting new imaging technology—developed at Northwestern—has the potential to add to our understanding of a variety of diseases. In future studies, we hope to explore the link between perfusion deficits and both Alzheimer's dementia and pediatric cerebrovascular disease.

*Timothy J. Carroll, PhD, is an assistant professor of radiology and biomedical engineering at Northwestern University.*

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## Northwestern Radiology Faculty & Staff Notes

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### Top Docs Gain Spotlight

Several Northwestern radiologists have garnered “best of the best” honors from peers and readers of two publications: *Chicago Magazine* and *Medical Imaging*. The January issues of the periodicals featured the names of the chosen few.

Chicago Magazine’s “Top Doctors” included: **Ellen Mendelson, MD**, women’s imaging; **Albert Nemcek, Jr., MD**, uterine fibroid embolization; **Riad Salem, MD, MBA**, cancer radiotherapy, cancer chemoembolization, and liver cancer; and **Robert Vogelzang, MD**, uterine fibroid embolization, varicocele embolization, and vascular malformations.

*Medical Imaging* readers voted **Dr. Mendelson** among the top radiologists in the category of “Women’s Imaging Specialist.” She ranked number four out of 10 possible spots.

### Antiquities Scanned for Content

Field Museum researchers looked toward technology (and Northwestern Radiology) to help them uncover the secret contents of some ancient urns.

In late December the museum’s scientists brought the artifacts to Northwestern Memorial. **David Channin, MD**, put the centuries-old containers through the CT scanner to help determine what they might have held at one point. Local news outlets, ABC-7 and Fox-32, featured the story.

### The “SUR’s” Up

Several Northwestern faculty members presented at the Society of Uroradiology’s (SUR) Abdominal Radiology Meeting 2006 held late February and early March in Kauai, Hawaii. **Frank Miller, MD**, lectured on liver MR as well as on adrenal and kidney MR and on film panel. **Paul Nikolaidis, MD**, gave talks on MRI of the pelvis, extrauterine and extraovarian pathology, and uterine artery embolization—indications and outcomes with emphasis on imaging. **Suresh Patel, MD**, discussed hysterosalpingography. SUR and the Society of Gastrointestinal Radiologist co-sponsored the program.

### Awards and Grants

The National Institutes of Health (NIH)

awarded **Tim Carroll, PhD**, a \$1.3 million grant to support his research “Improved Measurement of Cerebral Perfusion with MRI.”

**David Channin, MD**, received a \$330,000 grant from Planar Systems Inc. for a “Planar Dome Radiology Workstation Collaboration.” He also was awarded an NIH grant for \$37,125 for his research project “caBIG In Vivo Imaging Work-space.”

Terumo Medical Corporation awarded **Howard Chrisman, MD, MBA**, a \$231,942 grant for his research on the “Evaluation of the Embolic Agent Bead-Block™ in the Treatment of Uterine Fibroids with Uterine Artery Embolization.”

**Gayle Woloschak, PhD**, received a \$108,410 grant from the Department of Energy for her study “Adaptive Response Mechanisms after Chronic Whole-body Exposure to Low LET Radiation.”

The American Cancer Society’s Illinois Chapter awarded **Reed Omary, MD, Andy Larson, PhD, and Riad Salem, MD, MBA**, a \$100,000 grant for their investigation of MR diffusion-weighted imaging of tumor response in VX2 rabbits.

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## Interventional Oncology Expands Sphere of Influence

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and a research fellow round out the interventional oncology section. Beyond the microspheres procedure, the section has expanded its clinical offerings and now provides a range of services such as hepatic artery chemoem-

bolization, bland embolization, ethanol, chemical (ethanol, acetic acid) and RF ablation, and portal vein embolization. RF ablation is also being performed for the treatment of kidney and lung cancers.

The interventional oncology team has

also done well in academic productivity, publishing some 20 papers, book chapters and presentations at international and national meetings

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## Welcome New Northwestern Radiology Faculty

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### **Karin Dill, MD**

#### **Instructor, Cardiovascular Imaging and Body Imaging**

Dr. Dill received her MD degree from Loyola University Stritch School of Medicine in 1996. She trained for one year in obstetrics and gynecology and one year in psychiatry before switching to radiology. Completing a residency in diagnostic radiology at St. Francis Hospital in 2002, Dr. Dill subsequently joined Northwestern for fellowship training in pediatric radiology, interventional radiology, and cardiovascular imaging. She completed her fellowship last November.



### **Arnold Strimling, MD**

#### **Instructor, General Imaging and Nuclear Medicine**

Dr. Strimling earned his medical degree from the University of Illinois at Chicago (UIC) in 1965. He served as an intern at St. Paul Ramsey Hospital in St. Paul, Minnesota, and returned to UIC where he completed his radiology residency training in 1969. He then served in the military as a Lieutenant Commander at the San Diego Naval Hospital from 1969 to 1971. He practiced at St. Joseph Hospital in Joliet, Illinois, from 1971 to 1978, and at St. Mary's Medical Center in Racine, Wisconsin, from 1978 until his retirement in February 2005.



### **Allison Summers, MD**

#### **Instructor, Body Imaging**

Dr. Summers is a medical school graduate of the University of Nebraska and earned her MD degree in 1999. She completed a radiology residency at the Maine Medical Center in Portland, Maine, in 2004. Since finishing her training, Dr. Summers has provided *locum tenens* services for private radiology groups.

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**RADIOLOGY**

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