Discussing the development of molecular, cardiac and neuroscience imaging, Dr Carolyn Meltzer of the Emory University School of Medicine, USA, explains why it really is on the inside that counts

The Emory Center for Systems Imaging (CSI) is an interdisciplinary and multimodal research facility focusing on biomarker development and advanced imaging for neuroscience, oncology and cardiac applications. In 2009, we installed one of the world’s only prototype magnetic resonance imaging (MRI)/position emission tomography (PET) scanners. This scanner allowed for simultaneously collecting both PET and MRI images of the brain. Its operation differed from a traditional PET/ computed tomography (CT) scanner where the CT scan is performed, the bed advances and then the PET data are subsequently collected.

The recent launch of our 2013-17 strategic plan builds on this foundation, focusing on the value of imaging in a changing nationwide academic healthcare environment. Our faculty collaborates with colleagues throughout Emory, and with our partner institution, the Georgia Institute of Technology, as well as with leading investigators across the globe.

Emory has received a US $7.5 million grant from the National Cancer Institute. Can you outline what your overall hopes are for this award?

This award, to create the Emory Molecular and Translational Imaging Center (EMTIC) was funded in 2008 and has allowed us to build upon a uniquely supportive Atlanta biomedical environment. It has facilitated a cross-disciplinary scientific, administrative and educational network that encompasses imaging and clinician scientists working in areas vital to cancer diagnosis and therapeutics. EMTIC is closely aligned with transforming investments in imaging technology, biomarker development, predictive and personalised medicine, and nanotechnology, based at Emory and the Georgia Institute of Technology.

How are researchers at Emory translating novel methods for neuroscience imaging into practice, and have there been any tangible impacts on patient treatment following these applications?

We have made substantial progress in the development and validation of molecular imaging of cancer biomarkers. In one translational study, we were able to apply 18F-FACBC, an amino acid transporter ligand developed at Emory, to demonstrate high tumour background signal in both prostate cancer and brain tumours. 18F-FACBC is a wonderful example of the bench-to-bedside capabilities of our investigative team (led by Drs David Schuster and Mark Goodman). Another project, led by Dr Hyunsuk Shin, developed and validated selective chemokine PET markers for CXCR4 in head and neck cancer.

EMTIC has provided an ideal platform to support an integrated Career Development Program and equip young imaging scientists with the technical and translational skills required to specialise in cellular and molecular imaging.

There is a major focus on the development of programmes such as your unique Adopt-a-Resident initiative. Why are such schemes important?

Imaging science and educational programmes require substantial resources. In order to sustain our top academic programmes we have fostered a philanthropic culture of giving back. Our Adopt-a-Resident Program is a highlight of this initiative, applying development funds to support innovative resident projects that will best prepare our trainees for distinguished academic careers. Funded mentored projects have included the development of novel web-based teaching tools, humanitarian global health initiatives and training in leadership and health policy.
Emerging medical imaging

The Emory Center for Systems Imaging in Atlanta, USA, is at the forefront of medical imaging techniques. Advancing diagnostics and therapeutics for a range of health conditions, the Center is integral to both the Emory University School of Medicine and the local health community.

FOR THE PAST 30 years, in line with computational and technological revolutions, medical imaging science has evolved a plethora of diagnostic tools. At the cutting-edge of medical imaging, the Emory Center for Systems Imaging has been busy developing and investing in new imaging resources, leading to a more holistic and systemic approach to imaging and basic research.

The ethos of the Center is to provide the local community in Atlanta with evidence-based medical imaging by utilising innovative approaches to research and its translation into clinical practice. From 2007-12, the Center strengthened existing resources, improved infrastructure, developed new programmes and facilities and expanded its research capabilities.

By building on the outstanding work and reputation the Center had already established through its visionary R&D progress, significant steps have already been achieved. Molecular imaging techniques for cancer research, diagnosis and treatment have been established; neuroimaging has been improved; and pioneering cardiac imaging services have been developed. These enormous achievements are a reflection of the dedicated team running the Center.

DEVELOPING MOLECULAR IMAGING TECHNIQUES

A five-year US $7.5 million research grant was awarded by the National Cancer Institute (NCI) to advance much-needed cancer imaging techniques. One of only eight NCI-funded centres, this support has enabled a variety of projects – both at the basic research and clinical diagnostic levels. Research activities have included the study of cancer-seeking magnetic iron nanoparticles or ‘biomarkers’ and the development of novel and accurate diagnostic techniques for the identification of prostate cancer. “Our unifying goal for this award was to develop, validate and apply unique molecular imaging biomarkers that clinicians may use to detect cancer earlier and more accurately,” explains Dr Carolyn Meltzer, William P Timmie Professor and Chair of Radiology and Associate Dean for Research at Emory University School of Medicine. “For patients with cancer, these important biomarkers will allow more precise monitoring of newer treatment approaches. Overall, this grant helps us build on our knowledge and expertise in an exciting new area of cancer imaging.”

Meltzer was joined as Principal Investigator by two colleagues: Professor of Radiology, Hematology and Oncology Mark Goodman, and Professor of Biomedical Engineering and Radiology Xiaoping Hu. Together, these three lead a highly skilled team, which includes Drs Baowei Fei, Hyunsuk Shim, James Provenzale, Ioannis Sechopoulos and Hui Mao. The group is working on projects financed through the NCI grant. Highlights include an amino acid positron emission tomography (PET) probing clinical study to identify aggressive tumours in prostate cancer; nano iron particle laboratory targeting breast cancer detection in magnetic resonance imaging (MRI); PET probe generation to detect head and neck cancers (squamous cell carcinomas); and fluorescent dye laboratory studies to investigate dyes that accumulate in cancerous cells for improved diagnostic and treatment capabilities.

IMPROVEMENTS IN NEUROSCIENCE IMAGING

The Emory Division of Neuroradiology is also advancing imaging techniques to improve diagnosis of neurological conditions at the frontline of neuroscience imaging. MRI techniques have benefited from advances in scanner hardware and coil technology, as well as new post-processing software updates. These technological breakthroughs – enabled by the Emory staff – have led to a range of improvements in the workflow and care of patients with both neurological disorders and cancers.

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INTELLIGENCE
EMORY DEPARTMENT OF RADIOLOGY & IMAGING SCIENCES

OBJECTIVES
The Emory Department of Radiology and Imaging Sciences serves the community through advanced innovation, translational research and clinical application of imaging sciences. The Department is committed to excellence in scholarship and to the training of the next generation of radiologists, technologists and imaging scientists. The Department's goal is to provide the highest quality patient care with predictive, diagnostic and therapeutic imaging-based approaches.

CLINICAL DIVISIONS
Abdominal Imaging • Breast Imaging • Cardiothoracic Imaging • Community Radiology • Emergency Radiology • Interventional Neuroradiology • Interventional Radiology & Image Guided Medicine • Musculoskeletal Imaging • Neuroradiology • Nuclear Medicine & Molecular Imaging • Pediatric Imaging

FUNDING
National Cancer Institute (NCI)
National Institutes of Health (NIH)

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DR CAROLYN MELTZER is board-certified in both Diagnostic Radiology and Nuclear Medicine, with CAQ certification in Neuroradiology and advanced training in PET imaging. In 2002, Dr Meltzer served as a fellow of the Hedwig van Ameringen Executive Leadership in Academic Medicine Program for Women (ELAM). She is a recent past president of the American Society of Neuroradiology and President-Elect of the Academy of Radiology Research.

EMORY CARDIAC TOOLBOX
The Emory Cardiac Toolbox is one of the world's most widely used software programs for nuclear cardiac imaging. The Toolbox was developed by Dr Ernest Garcia. Its tools help physicians and radiologists conduct cardiac imaging in thousands of hospitals worldwide – a testament to the innovative mind of the Toolkit's creator and his team.

Emory's physicians and scientists use functional MRI (fMRI) in the clinical setting to develop a detailed picture of the brain. fMRI relies on the principle of coupling blood flow with neuronal activation; when an area in the brain is active, more energy is used in this area, thus increasing blood flow. fMRI can detect the magnetism of blood dependent on how much oxygen it contains. The tool is particularly useful for mapping brain areas, detecting tumours and enhancing surgical strategy.

Emory is currently helping to improve the clinical treatment of epilepsy by using fMRI technology to assess lateralisation of language and memory before surgical intervention. Certain epilepsy treatments involve the removal of a portion of the temporal lobe to control seizures; fMRI can help to assess the risk of removing areas of the brain by identifying which are integral to language or memory functioning and thereby tailoring treatment to the individual.

CARDIAC IMAGING
The Center for Systems Imaging has also made significant improvements in the field of cardiac imaging, with multiple projects currently underway. One such project, led by Dr John Oshinski, Associate Professor of Radiology, has been developing contrast-enhanced magnetic resonance angiography (MRA). This is a technique, based on MRI, designed to image blood vessels. MRA offers advantages over computed tomographic angiography (CTA) as well as phase contrast magnetic resonance for aortic imaging, enabling rapid clinical assessment.

Meanwhile Dr Ji Chen, also Associate Professor of Radiology, has been conducting research to implement novel imaging analysis to quantify cardiac function, myocardial perfusion blood flow and metabolism; he is most noted for his innovative work in developing multi-harmonic phase analysis software which can assess ventricular dysynchrony – a factor indicating how well the heart is performing, and useful for the diagnosis of heart failure and determining prognosis. It was for this novel invention that Chen was awarded the American Society of Nuclear Cardiology/GE Healthcare Research Award for Basic and Applied Science.

A BRIGHT FUTURE
The tripartite mission of the Department to improve clinical service, research and teaching has not only led to improved facilities and research, but also to the initiation of new training programmes in the areas of combined molecular imaging, nuclear medicine, radiology residency and diagnostic radiology. These comprehensive training opportunities will ensure that the next generation of imaging experts have a thorough grounding in imaging science and will develop into highly skilled imaging professionals able to support local clinical practice.

With help from national funding bodies and private trust funds, the Emory Center for Systems Imaging has flourished into a comprehensive unit fitted with state-of-the-art biomarker development laboratories, MRI and PET scanning equipment, and computer facilities. By taking a holistic view on imaging science, Emory is leading the way in the development of both the tools and knowledge essential for professionals to be equipped to work within a new paradigm of imaging.