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# Molecular Imaging: The State of the Science

**W**e may not yet have reached a watershed, but 2007 was a significant year for molecular imaging. The concept of molecular imaging is percolating throughout the medical imaging community. We are seeing recognition of nuclear medicine as the original molecular imaging modality as well as a groundswell of interest in the possibilities of targeted ultrasound contrast media and hyperpolarized <sup>13</sup>C spectroscopy, along with cutting-edge approaches, such as fluorescent and bioluminescent imaging, optical imaging with quantum dots, and nanoparticle probes, that are still in development.

PET has become the most widely used clinical molecular imaging modality while also becoming increasingly useful as a research tool in drug discovery, psychiatric research, and clinical trial monitoring. Clinical use could expand exponentially with approval of some of the many PET tracers under development. PET offers the possibility

of definitively diagnosing Alzheimer's disease in its earliest stages by directly imaging amyloid plaque (with <sup>11</sup>C-PIB and <sup>18</sup>F-FDDNP). Other research centers are looking at the chemical processes of addiction in the living brain using tracers such as <sup>18</sup>F-DOPA and <sup>11</sup>C-raclopride. SPECT and new single-photon probes, such as iodinated amyloid plaque agents, are emerging as tools for molecular imaging.

Nonnuclear molecular imaging continues to break new ground in the research lab. Multimodality imaging systems are in use in small animal imaging. Recent advances include simultaneous acquisition of MR spectroscopy and PET data. Optical tomography shows promise in bringing bioluminescent imaging into clinical practice—something that was considered impossible in the recent past. Tracers for tracking stem cells and lymphocytes in vivo are bringing the day closer when “personalized medicine” will be not only possible but accepted as standard practice. Imagine a pharmacologic

agent that can activate a latent gene. If the expression of that gene can be imaged in vivo, patients demonstrating the activation could be immediately identified as candidates for therapy.

One measure of the interest being generated by molecular imaging was the attention it drew at the Radiological Society of North America annual meeting in November. Elias A. Zerhouni, MD, director of the National Institutes of Health (NIH), delivered the Eugene P. Pendergrass New Horizons Lecture, focusing on the ways in which molecular imaging “has the potential to define itself as a core interdisciplinary science for extracting spatially and temporally resolved biological information at all physical scales from Ångströms to microns to centimeters in intact biological systems.” Zerhouni described molecular imaging as playing a major role in the transition to “P4 medicine”—the concept of predictive, personalized, preemptive, and participatory medicine—“where patients will be given clinical information from molecular imaging prior to symptoms being expressed and prior to loss of function.”

The Alzheimer’s Disease Neuroimaging Initiative, which is gathering and analyzing neuroimaging and neurocognitive data on more than 800 patients using both PET and functional MR imaging, was cited by Zerhouni as an example of a successful partnership, funded by the NIH, that is working toward P4 goals.

Translation of molecular imaging from research to clinical imaging and medical intervention is the next critical

step. NIH has established funding for translational medicine through the National Center for Research Resources. This national consortium will focus on translational research and the acceleration of clinical applications through Clinical and Translational Science Awards. Twenty-five institutions currently participate in this consortium, which has a budget of \$500 million and a goal of 60 participating institutions by 2012. The newest national institute of health, the National Institute of Biomedical Imaging and Bioengineering, is working under the directorship of Roderic Pettigrew, MD, PhD, to develop clinical aspects of molecular imaging as part of its mandate to develop technologies for early disease detection and assessment.

The stage is set to take molecular imaging to the next level. NIH is fully engaged and actively funding translational research; imaging societies such as SNM are committed to bringing all molecular imaging modalities into clinical practice; and the promise of molecular imaging’s role in improving medical care is becoming clear to clinicians and the general public. We at SNM look forward to working with all parties (the government, industry, academia, and other imaging societies) to advance the molecular imaging revolution and bring the benefits of personalized medicine to patients everywhere.

*Members of the SNM Molecular Imaging Center of Excellence Editorial Board*

## From the SNM Academic Council

**T**he SNM Academic Council’s mission includes helping residency directors fulfill Accreditation Council of Graduate Medical Education (ACGME) regulations, helping teachers teach more effectively, improving the educational experience of our residents, keeping program directors informed of changes in board and credentialing requirements, enhancing research output by residents and others, providing leadership training and maintenance of certification materials, and helping our young nuclear medicine professionals achieve their goals.

As the new year begins, I continue to be thankful to many people in the Academic Council. Bennett Greenspan, MD, is doing an excellent job of arranging conferences at the SNM Mid-Winter and Annual meetings and the Association of University Radiologists (AUR) meeting. He and Leonie Gordon, MD, serve as members of the SNM Board of Directors, and Dr. Gordon also works hard for us by serving on the Residency Review Committee in nuclear

medicine for the ACGME. I will be presenting 2 talks relevant to the activities of the Academic Council at the SNM Mid-Winter Meeting. Lorraine Fig, MD, is doing a wonderful job of improving communication with the membership. Heather Jacene, MD, continues to edit and produce our Academic Council newsletter. Amol Takalkar, MD, is working on organizing a mentorship program for members. Our past president, Darlene Metter, MD, is very active in the ACGME, American Board of Nuclear Medicine, and other organizations. Gary Smith, PhD, continues to be an able leader of the program directors and graciously attended the last Organization of Program Directors Associations meeting in Chicago, IL, at my request.



**Jay Harolds, MD**