Scientific studies reported at the 2022 SNMMI Annual Meeting in Vancouver, Canada, June 11–14, covered a broad range of topics in molecular imaging, therapy, instrumentation, research, and clinical practice. A number of these studies were reported in national and international media. Following is a selection and brief overview of some of these presentations.

Self-Collimating Cardiac SPECT

Researchers from Tsinghua University (Beijing, China) and the University of Buffalo (East Amherst, NY) reported on a "Feasibility study of a self-collimating SPECT for fast dynamic cardiac imaging." The authors described development and validation of a system in which active detectors in a multilayer architecture carry out the dual functionality of detection and collimation, improving on documented limitations of mechanical collimators. The results hold promise for "expanding clinical applications of dynamic cardiac SPECT imaging by eliminating the impact of respiratory motion, increasing patient throughput, enabling ultra-low-dose imaging, and precisely quantifying myocardial blood flow and coronary flow reserve."

"SPECT is an important noninvasive imaging tool for the diagnosis and risk stratification of patients with coronary heart disease," said Debin Zhang, a doctoral student at Tsinghua University. "However, conventional SPECT suffers from long scan time and poor image quality as a result of relying on a mechanical collimator. The new SPECT system is capable of performing fast-framed dynamic scans with high quality."

"The technology proposed in this work may drive a paradigm shift in all single-photon-emission–based molecular imaging and nuclear medicine technologies," said Tianyu Ma, PhD, associate professor at Tsinghua University and senior author of the study. "The new detector design opens up a broad range of possibilities for development of new imaging systems with better image quality, higher speed, and better diagnostic accuracy in molecular imaging."

PSMA PET Mapping and Salvage Radiation Therapy

Multiple presentations at this year's SNMMI meeting covered studies on prostate-specific membrane antigen (PSMA) targeting. "PSMA PET mapping of postoperative local recurrence and impact on prostate fossa contouring guidelines for salvage radiation therapy [SRT]," was the focus of a report from researchers at the University of California, Los Angeles (UCLA), the University of Miami Miller School of Medicine (FL), and the VA Greater Los Angeles Healthcare System (CA). The authors used ^{68}Ga-PSMA-11 PET/CT data to analyze typical patterns of disease in patients experiencing biochemical recurrence of prostate cancer in the prostate fossa after radical prostatectomy. They evaluated correlations between clinical target volumes (CTVs) delineated using the Radiation Therapy Oncology Group (RTOG) contouring guidelines and patterns of PSMA PET–identified recurrence in the prostate fossa. A total of 230 patients with such recurrence on PSMA PET were included in the analysis (127 patients with PSMA-detected recurrence limited to the prostate fossa, 30 with PSMA-detected disease spread to pelvic nodes only, 34 to distant organs and/or extrapelvic nodes only, and 39 to both pelvic nodes and distant organs/extrapelvic nodes).

The authors found that in patients experiencing biochemical recurrence with disease limited to the posterior fossa, the RTOG contouring guidelines for salvage radiation therapy covered the full extent of the disease in 41% of patients. In 46%, the recurrence was only partly covered, and in 13% recurrence was located fully outside the CTV. They concluded that this study suggested that PSMA PET should be incorporated into updated radiation treatment contouring guidelines. "This study has the potential to redefine prostate bed contouring guidelines to improve the therapeutic ratio for patients receiving postoperative radiotherapy," said Ida Sonni, MD, lead author from UCLA. "Nuclear medicine and molecular imaging advances, such as PSMA PET, have the ability to guide individualized, tailored treatments that will ultimately benefit all our patients."

Melanoma-Targeting Radiopharmaceutical Pair

Researchers from the National Institute of Radiological Sciences/National Institutes for Quantum and Radiological Science and Technology (Chiba, Japan) reported on "Theranostics of melanoma-targeting metabotropic glutamate receptor 1 [GRM1] with a novel small-molecular radiopharmaceutical pair." They described the design, synthesis, and development of a novel small-molecular radiopharmaceutical theranostic duo, 1 intended for PET imaging and labeled with ^{11}C (^{11}C-1) and the other intended for therapy and labeled with ^{211}At (^{211}At-1). The theranostic potentials of the radiolabeled pair were explored in GRM1-positive B16F10 melanoma-bearing mice. ^{11}C-1 PET imaging was performed to visualize the melanoma, and mice were treated with ^{211}At-1 and monitored for tumor growth and adverse effects. Serial ex vivo biodistribution studies were conducted after imaging in subgroups of mice.

PET clearly visualized targeted melanomas with good tumor-to-background contrast. Ex vivo biodistribution studies verified the consistent increase of ^{11}C-1, which reached 12.29 ± 2.44 %ID/g tissue in the targeted melanomas at 90 min after injection and rapidly cleared from nontarget organs. Treatment with ^{211}At-1 showed "unequivocal and durable" antitumor efficacy with only a single treatment (2.96 MBq). No decreases in body weight and no liver or kidney damage were observed during the study period in the mice injected with ^{211}At-1.

"The results of this study highlight the strong potential of using ^{11}C-1 and ^{211}At-1 as theranostic agents for the management of GRM1-positive tumors," said Lin Xie, MD, PhD, first author of the presentation and a senior researcher at the National Institutes for Quantum and Radiological Science and Technology. "This radiopharmaceutical pair may have broad application and help to bring us 1

step closer to winning the fight against solid cancers."

AI-Generated Virtual CT for PSMA PET

Investigators from the National Cancer Institute (NCI; Bethesda and College Park, MD) reported on "Artificial intelligence [AI]–generated PET images for prostate-specific membrane antigen [PSMA] PET/CT studies: Quantitative and qualitative assessment." The group's novel method used AI techniques to reduce or eliminate the need for CT-based attenuation correction, creating a virtual attenuation correction model for PET.

Data for AI model development were generated from >300 clinical ^{18}F-DCFPyL PSMA PET/CT studies, each including a non-attenuation-corrected PET, attenuation-corrected PET, and low-dose CT. Studies were then assigned to 3 sets for training (n = 185), validation (n = 60), and testing (n = 60). A 2D Pix2Pix generator was then used to create synthetic attenuation-corrected PET scans from the original non-attenuation-corrected PET. For qualitative evaluation, 2 nuclear medicine physicians reviewed 20 of the 60 testing PET/CT studies in a randomized order, blinded to whether images were attenuation corrected by CT or with the virtual process. Readers were able to successfully detect lesions on the AI-generated PET images with reasonable sensitivity values, although they reported poor image quality, a result of downscaling and loss of uptake values during pre- and postprocessing of AI-generated images.

"High-quality artificial intelligence-generated images preserve vital information from raw PET images without the additional radiation exposure from CT scans," said Kevin Ma, PhD, first author of the study and a postdoctoral researcher at NCI. "This opens opportunities for increasing the frequency and number of PET scans per patient per year, which could provide more accurate assessment for lesion detection, treatment efficacy, radiotracer effectivity, and other measures in research and patient care."

Novel PET Agent for Meningioma Imaging

Authors from University Hospital/Ludwig Maximilians Universität (LMU) Munich (Germany), the Technische Universität Dortmund (Germany), Heidelberg University (Mannheim, Germany), and the University of Alberta (Edmonton, Canada) reported on "Next-generation PET/CT imaging in meningioma: First clinical experiences using the novel somatostatin-receptor [SSTR]–targeting peptide ^{18}F-SiTATE." ^{18}F-SiTATE has previously shown superior imaging properties in neuroendocrine tumors. This study included 86 patients with known or suspected meningiomas who underwent ^{18}F-SiTATE PET/CT. Among factors assessed were SUV_{mean} and SUV_{max} in tumors, healthy organs, and nonmeningioma lesions. Transosseous extension of meningiomas was assessed on PET and compared to morphologic imaging on CT or MR. A total of 177 lesions were classified by ^{18}F-SiTATE PET as meningioma and 41 as nonmeningioma lesions (including post-therapeutic changes, schwannomas, etc.). Ninety-one (51.1%) meningiomas showed partial transosseous extension, and 24 (13.6%) showed predominantly intraosseous extension. Forty-eight (27.1%) of the meningioma lesions were not clinically suspected and/or not detected on previous conventional imaging. SUV_{mean} was lowest in healthy brain tissue, followed by bone marrow, parotid gland, and pituitary gland. SUV_{max} was significantly higher in meningiomas than in nonmeningioma lesions; however, high uptake was found in some nonmeningioma lesions (malignant pituitary adenoma, schwannoma, sinusitis). No adverse events were associated with the study.

Researchers noted that the ^{18}F-SiTATE agent's longer half-life than ^{68}Ga-DOTATATE and ^{68}Ga-DOTATOC and independence from ^{68}Ge/^{68}Ga generators confer significant logistic advantages that could enable widespread use of SSTR-targeted imaging in neurooncology. "This study shows that ^{18}F-SiTATE PET/CT has a high feasibility for the detection of meningiomas, including bone involvement. This is especially important since bone involvement has major impact on surgery and radiotherapy planning for meningioma patients yet cannot be properly assessed using standard morphological imaging," said Marcus Unterrainer, MD, PhD, MSc, first author and a radiologist and nuclear medicine physician at LMU.

PET Links Obstructive Sleep Apnea Cardiovascular Disease

Investigators from the Yale University School of Medicine (New Haven, CT) and Ocean University Medical Center/Hackensack Meridian Health (Brick, NJ) reported that "Obstructive sleep apnea [OSA] severity is associated with abnormal ^{82}Rb myocardial PET blood flow reserve [MFR]." They assessed correlations between markers of OSA severity (frequency of upper airway obstruction, hypoxia severity, and clinical symptoms of sleepiness) with coronary microvascular disease.

The cross-sectional analysis included 346 patients who underwent diagnostic overnight polysomnography and ^{82}Rb cardiac PET perfusion imaging. Obstructive features were categorized using the apnea–hypopnea index (AHI) as mild or no, moderate, or severe OSA. Abnormal MFR was defined as a ratio of stress to rest myocardial blood flow <1.5 after rate-pressure product correction. Odds ratios of abnormal MFR for each of the OSA severity categories were calculated, with resulting models adjusted for multiple comorbidities, demographics, and lifestyle factors. Although patients with abnormal MFR were generally older on average than those with normal MFR (62 and 59 y, respectively), no associations were noted between abnormal MFR and sex, race, body mass index, hypertension, or hyperlipidemia. The frequency of abnormal MFR increased with worsening AHI. Individuals with severe OSA were more than twice as likely to have abnormal MFR than those with mild or no OSA or those with nonsevere OSA.

"Interestingly, the significant relationship between OSA severity and MFR persisted among those with normal heart PET perfusion scans and no prior history of coronary artery disease," said Ehimen Aneni, MD, MPH, first author and an instructor at the Yale University School of Medicine. "The findings of this study may begin to explain why people with obstructive sleep apnea develop heart disease, including heart failure. Future studies should focus on the role of MFR in risk stratification and prognosis of OSA, as well as on the impact of OSA-specific therapy on MFR."