FDA Approves $^{18}$F-DCFPyL PET Agent in Prostate Cancer

The U.S. Food and Drug Administration (FDA) announced on May 27 its approval of Pylarify ($^{18}$F-DCFPyL) for PET imaging of prostate-specific membrane antigen (PSMA)-positive lesions in men with prostate cancer. In a press release, FDA announced approval for Pylarify in patients with suspected prostate cancer metastasis who are potentially curable by surgery or other therapy. Imaging with the agent is also indicated for patients with suspected prostate cancer recurrence based on elevated serum prostate-specific antigen (PSA) levels.

The FDA approved the first PSMA-targeted PET imaging drug, $^{68}$Ga-PSMA-11, on December 1, 2020, for the same prostate cancer imaging indications as Pylarify. Marketed $^{68}$Ga-PSMA-11, however, is currently available locally at only 2 sites in California. Pylarify, which will be manufactured by Lantheus Holdings, Inc. (North Billerica, MA), is anticipated to be distributed from multiple sites throughout the United States, leveraging the manufacture and distribution advantages of $^{18}$F, as well as the radionuclide’s long half-life. In a press release issued on the same day as the FDA announcement, Lantheus stated: “The product will be immediately available in parts of the mid-Atlantic and southern regions, and availability is expected to rapidly expand over the next 6 months with broad availability across the U.S. anticipated by year end.”

“The FDA approval of PYLARIFY is a significant milestone for Lantheus and the prostate cancer community in the United States,” said Mary Anne Heino, President and Chief Executive Officer of Lantheus. “We believe PYLARIFY represents a paradigm shift in the identification and management of patients with suspected metastasis or recurrent prostate cancer, providing more accurate and earlier detection of disease than conventional imaging so that doctors, along with patients and their families, can make more informed treatment decisions.”

The safety and efficacy of Pylarify were evaluated in 2 prospective clinical trials (OSPREY and CONDOR) with a total of 593 men with prostate cancer who each received a single injection of Pylarify. In the first trial, a cohort of 268 patients with biopsy-proven prostate cancer underwent PET/CT scans performed with Pylarify. These patients were candidates for surgical removal of the prostate gland and pelvic lymph nodes and were considered at high risk for metastasis. Among patients who proceeded to surgery, those with positive findings in pelvic lymph nodes on PET had a clinically important rate of metastatic cancer confirmed by surgical pathology. The improved specificity and high positive-predictive value led to the conclusion that $^{18}$F-DCFPyL-positive lesions are likely to represent disease, supporting the potential utility of $^{18}$F-DCFPyL PET/CT to stage men with high-risk prostate cancer for nodal or distant metastases and reliably detect sites of disease in men with suspected metastatic prostate cancer” (1).

The CONDOR trial enrolled patients who had rising serum PSA levels after initial prostate surgery or other definitive therapy (i.e., evidence of biochemical recurrence). Before a single Pylarify PET/CT scan, patients underwent baseline conventional imaging that was negative for metastases. Pylarify PET detected at least 1 positive lesion in at least 1 body region (bone, prostate bed, pelvic lymph node, other lymph nodes, or soft tissue) in 60% of participants. In patients with positive Pylarify findings who had results from conventional imaging, baseline or follow-up imaging by conventional methods, or serial PSA levels, local recurrence or metastasis was confirmed in ~85%–87% of cases. The study’s primary endpoint was achieved, demonstrating disease localization in the setting of negative standard imaging and providing “clinically meaningful and actionable information” (2). Additional results from the study were presented at the SNMMI Annual Meeting in June, with the authors again noting high positive-predictive values for $^{18}$F-DCFPyL PET/CT in detection and localization of metastatic disease regardless of anatomic region (3).

“Conventional imaging has significant limitations in detecting prostate cancer, both in initial staging and when the cancer has recurred or spread after initial primary treatment. Specifically, standard imaging poorly detects the early spread to distant organs, such as the lymph nodes, bones, and other organs,” said Michael J. Morris, MD, Prostate Cancer Section Head, Genitourinary Medical Oncology, Memorial Sloan Kettering Cancer Center (New York, NY) and lead study investigator in the CONDOR trial and study investigator in the OSPREY trial. “PYLARIFY can detect the spread of disease well before standard imaging and can be a transformative diagnostic tool that helps clinicians develop treatment plans based on a much more accurate understanding of a patient’s distribution of disease.”

REFERENCES

I am grateful for the opportunity to participate in my favorite part of the SNMMI Annual Meeting and honored to be a part of the Henry N. Wagner, Jr., MD, Highlights Symposium. I had the privilege to meet Dr. Wagner, who was a monumental figure in our field. In 2009 I received first an email and then a phone call from him, asking questions about our abstract submission that year. I was next to him at the June 15 press conference in Toronto (Canada), where he announced that figures from our submission had been named as the 2009 Image of the Year—an incredible honor that I cherish to this day.

COVID-19 and Nuclear Medicine

This has been a terrible year for so many people, and, although we are doing better here in the United States, much suffering is still associated with the COVID-19 pandemic. Many lives have been lost, including in the medical community and in nuclear medicine. These lives will not be forgotten. However, out of this darkness also came moments of solidarity. I am sure you have seen many institutions (like my own) at which the local fire department, police department, and public showed up to honor frontline health care workers. Let us hope that this solidarity will carry us forward and that together we will make a better world.

Among the effects of the pandemic in many nuclear medicine departments were temporary closures and reduced numbers of procedures. Pulmonary ventilation scans were among the most affected procedures. Gayed et al. from the University of Texas Health Science Center at Houston/Memorial–Hermann Hospital (Houston) and the University of Arkansas for Medical Sciences (Fayetteville), reported on “Perfusion lung scans without ventilation part: COVID 19 experience in a large trauma hospital” [145]. They evaluated the results of perfusion-only lung scans in 128 patients and the frequency with which the ventilation part of the scans was necessary to diagnose acute pulmonary embolism. They found that certainty was achieved in 122 patients (95.3%), even when the ventilation portion of the study was not performed, and concluded that the perfusion part of lung scans is sufficient for evaluation of acute pulmonary embolism in most patients. This illustrates one way in which we were able to do more with less, as well as how adaptable the nuclear medicine community has been and continues to be in the face of this extraordinary challenge.

Zhang et al. from Stanford University (CA) reported on “Perfusion-only scans with and without SPECT/CT in the era of COVID-19” [1390]. Figure 1 is an image demonstrating perfusion defects on planar images as well as on the $^{99m}$Tc–macroaggregated albumin SPECT fused with the normal chest CT. Sensitivity was increased with the addition of SPECT/CT to perfusion only, while accuracy was not significantly impacted. The authors concluded that “Given the tradeoff of detecting more false-negatives for more false-positives and the cost of performing SPECT/CT, the utilization of SPECT/CT may be selectively limited to higher-risk patients with high pretest probability or equivocal planar imaging.” With the limitations imposed by COVID-19 on concurrent ventilation scans, these findings suggested a more “nuanced role for SPECT/CT” in the pandemic.

One very important question being looked at by scientists and clinicians around the world involves identifying and addressing the long-term implications of COVID, and fibrosis is among these concerns. Sultan et al. from the Washington University School of Medicine in St. Louis/Mallinckrodt Institute of Radiology (MO) reported at this meeting on “Chemokine receptor 2 (CCR2)–targeted PET imaging in pulmonary fibrosis” [1695]. The authors described the development of $^{64}$Cu-DOTA-ECL1i, a radiotracer that targets the extracellular loop 1 of CCR2, which they used to track CCR2 expression in mouse models of fibrosis in progression of disease and after treatment. They also reported on imaging in both healthy volunteers and patients with idiopathic pulmonary fibrosis (IPF). Figure 2 shows minimal lung uptake and reasonable dosimetry in a healthy volunteer and specific uptake in patients with IPF. A close association was found...
between $^{64}$Cu-DOTA-ECL1i uptake on PET and fibrotic activity/changes on CT. The authors concluded that their preclinical and human studies “support a role for imaging CCR2 cells within the fibrogenic niche in IPF to provide a molecular target for personalized therapy and monitoring.” This is novel work and may be quite useful in the future, as we continue to evaluate patients who have had COVID, long after (hopefully) the pandemic is over.

**Novel Applications of Existing Technologies**

Last year was daunting as a result of the pandemic and terrible for us at Stanford and for the global nuclear medicine community because we lost our colleague, friend, mentor, and significant luminary, Sanjiv Sam Gambhir, MD, PhD (Fig. 3). The following 2 parts of my presentation are based on quotations from Sam, who had not only great wisdom but an ability to express his insights in memorable ways. He once said, “Innovation is not always a new device or technology, but simply finding a new/novel way to use an existing technology.” This observation was seen in many presentations at the SNMMI 2021 meeting, and I will review several here.

Kersting et al. from University Hospital Essen and University of Duisburg-Essen (Germany) reported on “Dynamic $^{68}$Ga-DOTA PET/CT and compartmental modeling to noninvasively estimate the glomerular filtration rate” [88]. They asked whether it was possible to estimate renal function from dynamic PET/CT without laboratory assessment of glomerular filtration rate (GFR) or dedicated renal imaging. Datasets were included from 12 patients who underwent dynamic $^{68}$Ga-DOTA PET imaging prior to $^{177}$Lu-DOTATOC or $^{177}$Lu-prostate-specific membrane antigen therapy. In addition to visual interpretation of renal cortical transition time–activity curves, the authors estimated GFR using single-compartmental kinetic modeling of the PET data. The results were compared with those from serum creatinine–derived GFR. In the 9 patients with undisturbed urinary efflux, reproducibility analyses showed good agreement and a linear correlation between PET-assessed GFR and serum creatinine results as well as dedicated renal scintigraphy. In 3 patients with urinary obstruction, however, PET-assessed GFR provided a significant underestimation compared with serum results. These same 3 patients had been diagnosed with urinary obstruction in previous renal scintigraphy. Figure 4 shows images from dynamic PET in a patient with normal renal function (left) and a patient with a urinary obstruction (right). This is a novel use of dynamic DOTATE PET to evaluate renal function.

Eberhardt et al. from Ulm University Medical Center and SI Praxisklinik Riedlingen (both in Germany) reported on “Evaluation of $^{11}$C-methionine PET/MRI in primary hyperparathyroidism” [1026]. This is a novel use for this tracer, which was not developed for this indication. In this retrospective study, PET/MRI images were retrospectively evaluated from 12 patients with laboratory evidence of primary hyperparathyroidism, and levels of diagnostic certainty for PET findings alone and for combined PET/MRI were assessed. PET showed at least 1 suspicious finding for parathyroid adenoma in every case (2 in 1 patient). MR provided excellent anatomic correlation and localization, with the best identification of parathyroid adenomas by early arterial enhancement in the dynamic contrast-enhanced (DCE) sequence improving overall diagnostic certainty. PET/MRI, in addition to resulting in no false-positive findings at surgery, substantially reduced radiation exposure compared with PET/CT.
(by 65%–80%). In Figure 5, a parathyroid adenoma located posterior to the left thyroid globe is easily appreciated on the PET and fused PET/MR images, as well as the DCE sequence shown.

“Fast” imaging is an important, novel, and rapidly expanding focus of research, particularly in PET/CT. Reasons for this are many: elderly patients, for example, may have difficulty lying flat in the scanner for long periods of time; in the youngest patients, avoiding or limiting sedation is desirable; and patients with claustrophobia benefit from shorter scans. Esmail et al. from the Jaber Alahmad Center for Nuclear Medicine and Molecular Imaging (Kuwait) reported on “Fast NaF PET/CT acquisition with digital PET/CT system: Single initial experience” [1160]. They compared independent interpretations of fast whole-body (~3.5 min) and routine (~16 min) image acquisitions with a silicon photomultiplier–based scanner to assess the presence of osteoblastic bone metastases in 14 patients (7 obese but with body mass index <40.1) (Fig. 6). The authors concluded that using fast PET acquisition for NaF PET/CT in a digital system is possible and feasible, reducing scan time by 80% or more. This is encouraging news about what we can do with advanced technology and how we can make the imaging experience better for patients while enhancing workflow.

No review of recent innovations in PET would be complete without mentioning the great work of the EXPLORER team at the University of California Davis (Sacramento) and colleagues elsewhere. Among multiple reports of innovations with this scanner at the 2021 SNMMI meeting, Abdelhafez et al. from the University of California Davis reported on “Ultra-low-dose total-body 18F-FDG PET/CT in patients with autoimmune inflammatory arthritis (AIA): Evaluation of image quality with shorter scan time” [1697]. The study included 11 men with an established AIA condition (rheumatoid arthritis, 3; psoriatic arthritis, 8) and 3 non-AIA controls (osteoarthritis). Imaging data were subsampled for reconstruction as a single frame (20 min), 4 5-min frames, and 20 1-min frames, looking specifically at coefficients of variance (COVs) in parameters associated with volumes of interest in the ascending aorta blood pool and liver and uptake in the most active arthritic lesion. Initial results indicated that scan times as short as 5 min, with ~75.5 MBq 18F-FDG injected dose, appeared to provide COVs below 15%. Despite some noise, even the 1-min acquisition was quite good for diagnostic purposes, and the 5-min acquisitions were as clear as those at 20 min (Fig. 7). The extent of disease involvement in the small joints is apparent even in the 1-min scan. For patients with arthritis, who cannot tolerate long scan times, this a welcome innovation. The authors also noted that analyses of temporal 18F-FDG uptake characteristics in lesions of
different types of arthritis have the potential to provide insights into underlying pathologic processes.

Long-term neurologic effects of high-dose chemotherapy in pediatric patients are a significant challenge, particularly given the lack of predictive metrics and the special research needs associated with this population. Baratto et al. from Lucile Packard Children’s Hospital (CA) reported on “Imaging chemotherapy-induced brain damage in pediatric cancer survivors” [89]. The study included 10 children (ages 2–24 y; mean, 17.5 ± 5.2 y) with osteosarcoma (6) or lymphoma (4), who underwent 18F-FDG PET/MR imaging before and after intravenous chemotherapy with high-dose methotrexate (range, 3,000–144,000 mg/m²; mean, 26,448 mg/m²). Hyper- or hypometabolic brain areas were noted in Brodmann areas associated with executive functions and intelligence quotient in 8 patients, in areas related to attention ability in 3 patients, in areas related to academic function in 6 patients, and in areas related to reading ability in 9 patients (Fig. 8). The researchers are continuing to follow this group of patients to determine correlations between these findings and serial neuropsychological testing. In addition to indicating that PET/MRI can detect early signs of chemotherapy-induced brain damage in this vulnerable population, these results suggest that there is a window of time between drug exposure and morbidity. Early detection of chemotherapy-induced drug damage could guide changes in management that would improve long-term outcomes.

First-in-Humans and Early Development Research

Sam Gambhir also said, “It is called re-search for a good reason.” Only rarely is a single experiment “successful” as a standalone achievement. Much more frequently, many experiments are required, and many of these may fail before they reach advanced research or clinical implementation. The following section of this lecture looks at presentations from the meeting in which researchers reported on novel, first-in-humans, or early development studies.

Imaging pain is an unmet need that many investigators continue to explore. Yoon et al. from Stanford University School of Medicine (CA) reported that “Sigma-1 receptor (S1R) PET/MRI of patients with chronic knee pain reveals potential pain generators not otherwise identified with standard care: Early experience” [143]. These researchers looked at the potential of 18F-FTC-146 PET and MR imaging in elucidating the etiology of chronic knee pain. The study included 10 patients whose pain was of >6 mo duration, had pain levels >4/10, and who had failed standard medical and surgical...
management. Patients underwent whole-body, time-of-flight 18F-FTC-146 PET/MR imaging, and results were compared with those from 9 asymptomatic individuals, assessing both uptake on PET and evaluating MR separately. PET showed significant abnormal uptake in all 10 patients in a variety of locations (joint, bone, muscle, synovia, menisci, and others). On MRI alone, only 6 patients showed an anatomic correlate (3 with expected postsurgical changes on MRI that were deemed to be unrelated to the pain and 3 with findings consistent with osteoarthritis and/or meniscal tear). MR often did not show abnormalities at sites of abnormal PET uptake, most notably in the bones and muscles. Clinical follow-up indicated that a subgroup of these patients benefited from PET/MR guidance in terms of treatment. Figure 9 is an example in which a synovial mass demonstrated uptake of the S1R on PET. After arthroscopic surgical resection based on PET, the patient saw complete resolution of long-term pain. This is a research area with great potential for larger group studies and expansion to other indications.

Horikawa et al. from the National Center for Global Health and Medicine (Tokyo, Japan) reported on “SUV-based quantification of 131I-6-β-iodomethyl-norcholesterol (NCL-6-I) SPECT/CT for the diagnosis of the responsible adrenal glands in patient with primary hyperaldosteronism: A preliminary result” [1025]. The study included 10 patients (ages 49 ± 8 y; 7 women, 3 men) with adrenal nodules ≥10 mm in diameter who underwent hormone tests, abdominal CT, adrenal vein catheterization with aldosterone sampling, and NCL-6-I SPECT/CT with pharmacologic adrenosuppression on d 3 and 7. SUV\textsubscript{max} and SUV\textsubscript{mean} of the adrenal region were compared to cortisol and aldosterone concentrations. Adrenal gland SUV changes between d 3 and 7 were assessed and compared with visual interpretation. This is a novel and promising approach to quantifying data.

Imaging is an increasing focus of research and a clear clinical need for the future. Dearing et al. from Boston Children’s Hospital/Harvard Medical School (Boston, MA) and Tel Aviv University (Israel) reported on “Colonic uptake of a 64Cu-labeled immunoprotein incorporating mucosal addressin cell adhesion molecule (MAdCAM) correlates with the degree of colitis” [1208]. As part of an effort to develop an immunoPET agent for colitis detection and quantification, they constructed an antibody that incorporates MAdCAM, which interacts with β7 integrins to recruit lymphocytes to regions of colitis. 64Cu-labeled MAdCAM and a nonbinding control were assessed for biodistribution in healthy mice and mice with induced colitis. They found that tracer uptake was increased in mice with colitis proportionally to colon density, a measure of disease severity, and decreased in disease-free controls. It is hoped that this work will successfully transition to human and then clinical use, where it could prove to be quite valuable.

Fibroblast activation protein inhibitor (FAPI) was a focus of multiple oncologic lectures at this meeting, and we are all interested as well. Ballal et al. from the All India Institute of Medical Sciences (New Delhi) and the Johannes Gutenberg University (Mainz, Germany) reported on “First clinical experience and initial outcomes of 177Lu-DOTAGA (SA.FAPi)\textsubscript{2} therapy in patients with end-stage radioiodine-refractory differentiated thyroid cancer: A salvage treatment option” [1701]. The study included 6 patients (4 women, 2 men; median age, 61.5 y; range, 46–67 y) with metastatic disease who were prospectively recruited after disease progression after standard treatments (>22.2 GBq of radioiodine, sorafenib followed by lenvatinib). Patients were screened with 68Ga-DOTAGA (SA.FAPi)\textsubscript{2} and 18F-FDG-PET/CT imaging to confirm high cancer-associated fibroblast expression. They then received intravenous 177Lu-DOTAGA (SA.FAPi)\textsubscript{2} at 8 weekly intervals. The biodistribution of this radiotherapeutic agent was normal in the oral mucosa, salivary glands, liver, gall bladder, pancreas, colon, and kidneys, with the desirable characteristics of high tumor affinity and long retention (an effective half-life in tumors of 86 h). In this small cohort of patients the authors identified biochemical response (thyroglobulin decrease) as well as clinical response (pain palliation), with no grade III or IV toxicities. The authors concluded that this new radiopharmaceutical opens new frontiers for treatment of end-stage thyroid cancer refractory to standard treatment. In the patient in Figure 10, the FDG scan shows the aggressiveness of disease in uptake in a lesion in the left shoulder as well as elsewhere in the skeleton. A post-131I therapy scan had shown some of these as avid, but the FAPI PET/CT identified significant uptake in those lesions as well as others not seen on previous imaging. 177Lu-DOTAGA (SA.FAPi)\textsubscript{2} uptake was retained and visualized up to 168 hours. The authors concluded that this therapy “adds a new dimension to the treatment of radioiodine-refractory differentiated thyroid cancer patients who have exhausted all standard line treatment options.” This is an area of unmet need, and we look forward to future results on the utility of this approach in salvage therapy as well as in wider applications.
Conclusion

I would like to acknowledge Umar Mahmood, MD, PhD, and Heather Jacene, MD, for entrusting me with this presentation, as well as time spent advising on preparation.

I will end by circling back to Sam Gambhir, who received numerous awards and was especially proud of the ones from SNMMI. I remember vividly the plenary talk he gave at the SNMMI Annual Meeting in 2018 in Philadelphia. He included a very personal and touching story, and, at the conclusion of the lecture, was met with a standing ovation. Despite his exceptional scientific, academic, and professional achievements, as well as innumerable awards and honors, he remained humble, approachable, kind, and generous—simply an amazing human being and I hope a role model for everyone in our field, especially for those riding the wave of successes during this renaissance time for nuclear medicine. He was particularly proud of the achievements of others working with him. During his tenure at Stanford, his faculty and collaborators received the SNMMI Image of the Year award 3 times, in 2005, 2009, and 2011.

In 2018, as the first in a series of discussions with leaders in *The Journal of Nuclear Medicine* (2018;59:1783–1785), Johannes Czernin, MD, talked with Sam. In discussing the practice of nuclear and molecular medicine, Sam said, “We shouldn’t be celebrating how full our hospitals are. We should celebrate when our hospitals are empty.” This far-sighted goal should be inspiring to us all. Over his career, Sam migrated his research from early cancer detection to a more overarching focus on precision health. I hope that in the coming years our nuclear medicine community will remain focused on early cancer detection, expand our contributions to precision health, and honor Sam by continuing his groundbreaking work. Perhaps one year soon, the Image of the Year will highlight both early cancer detection and precision health.

**FIGURE 10.** $^{177}$Lu-DOTAGA (SA FAPi)$_2$ therapy as a salvage treatment option in end-stage differentiated thyroid cancer. A. Pretreatment $^{18}$F-FDG PET/CT. B. Post-$^{131}$I therapy whole-body scans. C. $^{68}$Ga-DOTA (SA FAPi) PET/CT. D. $^{177}$Lu-DOTAGA (SA FAPi)$_2$ serial whole-body PET acquired at 1, 24, 48, 96, and 168 h after treatment. Rapid accumulation of radiotracer is seen in the 2-h image with long retention.
Steven M. Larson, MD, was named on June 14 as the 2021 recipient of the prestigious SNMMI Paul C. Aebersold Award for outstanding achievement in basic nuclear medicine science. Larson is the Hedvig Hricak Chair in Radiology and attending physician of the Molecular Imaging and Therapy Service in the Department of Radiology, member and lab head of the Molecular Pharmacology Program, director of Radioimmunotherapy and Theraanosics in the Ludwig Center for Cancer Immunotherapy, and coleader of the Imaging and Radiation Sciences Program for the Comprehensive Cancer Center Grant at Memorial Sloan Kettering Cancer Center (MSKCC; New York, NY). He is also professor of radiology at Cornell University Medical College (New York, NY). The award was announced by SNMMI during its 2021 Annual Meeting. Satoshi Minoshima, MD, PhD, chair of the SNMMI Committee on Awards, congratulated Larson on this achievement: “Steve is a giant. He is truly a pioneer in nuclear medicine. His contributions to cancer imaging and radionuclide therapy have been enormous. I am so fortunate to have crossed paths with him in this exciting field of nuclear medicine and molecular imaging.”

Larson, among the world’s foremost experts in radiopharmaceutical therapy and molecular imaging, has had long-term interests in radiopharmaceuticals for oncologic applications in nuclear medicine and is the inventor or coinventor on more than 40 patents for radioactive drugs. He developed one of the earliest 99mTc kit formulations (for 99mTc sulfur-collloid), a product that is still in active use more than 50 years later. He has worked in various aspects of PET since 1979, including a major role in the development of 2 large PET programs—at the National Institutes of Health (NIH) Clinical Center (Bethesda, MD) from 1983 to 1988 and as chief of nuclear medicine in the MSKCC PET program from 1988 to 2013. He has served on numerous government advisory committees and chaired the Radioactive Drug Advisory Committee of the U.S. Food and Drug Administration (FDA), where he was part of a team that developed the 21CFR361.1 Radioactive Drug Research Committee regulations. He has been principal investigator on several large grants from the U.S. Department of Energy and NIH, including the grant that provided funding for the MSKCC Center for Multidisciplinary In Vivo Molecular Imaging in Cancer.

Larson received his medical degree from the University of Washington School of Medicine (Seattle) and completed his residency at Virginia Mason Hospital (Seattle, WA). He has received numerous awards for excellence in nuclear medicine, including the Georg Charles de Hevesy Nuclear Medicine Pioneer Award, the Wagner Lectureship, and the Berson–Yalow award from SNMMI; the G.V. Hevesy Lecture Medal of the European Association of Nuclear Medicine; the Pendergrass Award and the Radiologic Researcher of the Year Award from the Radiological Society of North America; the Louise and Lionel Berman Foundation, Inc. award for accomplishments in the field of nuclear medicine involving the peaceful use of atomic energy; the Ralph G. Robinson Lecture Award of the American College of Nuclear Physicians; and the Gold Medal of the American College of Nuclear Medicine, among others. He was awarded the Wylie medal by the FDA for his contributions to development of radiopharmaceutical regulations. He is a member of the National Academy of Medicine.

The current primary foci of Larson’s lab are molecular imaging, targeted radionodagnosis, and therapy using small molecules and monoclonal antibodies, especially pretargeted radioimmuno-therapy. An expert on theranostic applications for targeted radiopharmaceuticals, Larson is currently corresponding primary investigator on a grant titled “124I-Nal PET: Building block for precision medicine in metastatic thyroid cancer.” Sponsored by the National Cancer Institute, this research seeks to develop image-based dosimetry to improve selection and management of patients with advanced cancers, using 131I therapy of thyroid cancer as a model paradigm for optimizing radiotargeted therapy treatment planning. Larson has authored or coauthored more than 700 articles in major peer-reviewed journals.

The Aebersold Award, first presented in 1973, is named for Paul C. Aebersold, PhD, a pioneer in the biologic and medical application of radioactive materials and the first director of the Atomic Energy Commission’s Division of Isotope Development. In accepting the award, Larson said, “I am truly honored to have been awarded the Aebersold Award by my peers in nuclear medicine. Today I find myself deeply grateful to my mentors—especially Wil B. Nelp, MD, director of nuclear medicine at the University of Washington Medical School in Seattle, and Henry N. Wagner, Jr., MD, director of nuclear medicine at Johns Hopkins University Health Sciences—who afforded me unparalleled instruction in basic and clinical aspects of nuclear medicine. It has also been my great privilege to have trained more than 150 MD and PhD clinical and postdoctoral fellows in nuclear medicine, and I hope that I have returned the favor of wise instruction by passing along what I was taught. Along with my trainees, each day I sought to remain a student, and together we learned much from clinical and laboratory experiments. With the help of outstanding collaborators at the University of Washington, NIH, and of course Memorial Sloan Kettering, I am proud to say that all of us working as a team were

(Continued on page 19N)
Ruth Receives SNMMI Georg Charles de Hevesy Nuclear Pioneer Award

Thomas J. Ruth, PhD, a scientist known for his contributions to nuclear medicine and nuclear chemistry, was named as this year’s recipient of the Georg Charles de Hevesy Nuclear Pioneer Award on June 13 as part of the SNMMI 2021 Annual Meeting. Ruth was recognized for his significant work in nuclear chemistry, specifically the identification and development of radioisotopes for PET imaging, which helped to advance acceptance for the technology. He also played a key role in development of cyclotron-based technology to produce the medical isotope $^{99m}$Tc without the need for a nuclear reactor.

“Dr. Ruth has been a pioneer in radiopharmaceutical sciences for many years,” said 2020–2021 SNMMI president Alan Packard, PhD. “He began his career as PET imaging was being introduced, and he has been a leader in the field ever since, as he investigated new radioisotopes, determined their optimal applications, and developed new ways to produce them. Many nuclear medicine scientists have benefited from Dr. Ruth’s mentorship over the years, and he has left a legacy that has greatly benefited the field.”

Ruth received his master’s degree in nuclear chemistry in 1967 from the College of William and Mary (Williamsburg, VA), followed by a doctorate in nuclear spectroscopy in 1973 from Clark University (Worcester, MA). He began his career in 1976 at Brookhaven Laboratory (Upton, NY) and in 1980 moved to TRIUMF (Vancouver, Canada) as a research scientist. There he continued to serve in many roles, including as director of the University of British Columbia–TRIUMF PET Program, until his retirement in 2012. He currently serves as a senior emeritus research scientist at TRIUMF and the British Columbia Cancer Agency. Ruth is also an adjunct professor in the department of medicine at the University of British Columbia (Vancouver, Canada) and in the department of physics and astronomy at the University of Victoria (Canada).

During his career at TRIUMF Ruth oversaw the installation of 4 PET scanners at the University of British Columbia Hospital, as well as installation of the TRIUMF-type 13-MeV (TR-13) cyclotron at TRIUMF. His career accomplishments helped secure investments to build TRIUMF’s Institute for Advanced Medical Isotopes, a new facility that will house much of TRIUMF Life Sciences research in the years to come.

“I am honored to receive SNMMI’s Georg Charles de Hevesy Nuclear Medicine Pioneer Award,” said Ruth. “I have had the pleasure to work with so many colleagues who encouraged me, challenged me, and worked with me throughout my career. My accomplishments would not have been possible without their support.”

Since 1960, SNMMI has presented the Georg Charles de Hevesy Nuclear Medicine Pioneer Award annually to an individual for outstanding contributions to the field of nuclear medicine. De Hevesy received the 1943 Nobel Prize in chemistry for his work in determining the absorption, distribution, metabolism, and elimination of radioactive compounds in the human body. His work led to the foundation of nuclear medicine as a tool for diagnosis and therapy, and he is considered the father of nuclear medicine. The list of previous recipients of this award includes numerous Nobel laureates—such as Ernest Lawrence, PhD, who built the world’s first cyclotron for the production of radionuclides, and Glenn Seaborg, PhD, who discovered more than half a dozen new elements.

Newsline 19N
SNMMI Honors Contributors at 2021 Annual Meeting

During its 2021 Annual Meeting, held virtually from June 11 to 15, SNMMI recognized contributions to the society and to the field of nuclear medicine. Several virtual award ceremonies were held to recognize service, scientific contributions, and the valuable roles SNMMI members play in advancing the diagnosis and treatment of cancer, heart disease, neurologic, and other conditions.

2021 SNMMI Fellows
Seventeen new SNMMI fellows were recognized on June 14 as part of a special plenary session during the society’s 2021 Annual Meeting. SNMMI fellowship was established in 2016 to recognize distinguished service to the society as well as exceptional achievement in the field of nuclear medicine and molecular imaging. It is among the most prestigious formal recognitions available to longtime SNMMI members. Alan Packard, PhD (Boston Children’s Hospital/Harvard Medical School; Boston, MA), the 2020–2021 SNMMI president, joined the new fellowship ranks. Also recognized as new fellows were Anca Avram, MD (University of Michigan Medical Center; Ann Arbor); Twyla Bartel, DO, MBA (Global Advanced Imaging, PLLC; Little Rock, AR); Wengen Chen, MD, PhD (University of Maryland School of Medicine; Baltimore, MD); Cathy Sue Cutler, PhD (Brookhaven National Laboratory; Upton, NY); Eric Frey, PhD (Johns Hopkins University; Baltimore, MD); Roger Howell, PhD (Rutgers New Jersey Medical School; Newark, NJ); Robert Mach, PhD (University of Pennsylvania; Philadelphia); David A. Mankoff, MD, PhD (University of Pennsylvania; Philadelphia); Darlene Metter, MD (UT Health San Antonio; TX); Helen Nadel, MD (Lucile Packard Children’s Hospital; Palo Alto, CA); Julie Price, PhD (Massachusetts General Hospital; Boston, MA); Buck Rogers, PhD (Washington University in St. Louis; MO); Heiko Schöder, MD, MBA (Memorial Sloan Kettering Cancer Center; New York, NY); Peter Scott, PhD (University of Michigan; Ann Arbor); Neil Vasdev, PhD (Centre for Addiction and Mental Health Research Imaging Centre; Toronto, Canada); and Jian Yu, MD (Fox Chase Cancer Center; Philadelphia, PA). Selection of SNMMI fellows is based on documented excellence of volunteer service to the society and at least 1 of 3 areas: excellence in scientific discovery and innovation, educational efforts in nuclear medicine and molecular imaging, or clinical practice of nuclear medicine and molecular imaging.

SNMMI Presidential Distinguished Service Awards
Sixteen SNMMI Presidential Distinguished Service Awards were given in recognition of long-term dedication to the society. The Presidential Distinguished Educator Award was presented to Hyewon Hyun, MD (Brigham and Women’s Hospital; Boston, MA). Members of the SNMMI Scientific Program Committee Cabinet received presidential awards, including Umar Mahmood, MD, PhD (Massachusetts General Hospital; Boston); Heather Jacene, MD (Dana-Farber Cancer Institute; Boston, MA); Giuseppe Esposito, MD, MBA (Georgetown University Hospital; Washington, DC); Donna J. Cross, PhD (University of Utah; Salt Lake City); Kathleen Krisak, BS, CNMT (Holyoke Medical Center; MA); and David Schuster, MD (Emory University; Atlanta, GA). SNMMI Annual Meeting staff members recognized with the Presidential Distinguished Service Awards included Ann Latham, Senior Director of Education and Meetings; Amy Schull, Director of Meetings; Lisa Dickinson, Associate Director of Education; Catherine Lamb, Associate Director of Corporate Relations; Caroline Krystek, Senior Association Specialist; Delicia Hurdle, Senior Program Manager of Education; Brandi Eden, Senior Meetings Manager; and Jane Kamm, Senior Program Manager of Education.

Saul Hertz, MD, Lifetime Achievement Award
The SNMMI Therapy Center of Excellence awarded Eric Krenning, MD, PhD, as the recipient of the Saul Hertz, MD, Award for lifetime achievement, recognizing individuals who have made outstanding contributions to radionuclide therapy. Krenning completed his MD in 1972, received a PhD from the Erasmus University of Rotterdam (The Netherlands in 1983, and is board certified in both internal medicine (1978) and nuclear medicine (2000). At Erasmus, he was a staff physician in the Department of Internal Medicine and Endocrinology from 1978 to 2012 and head of the Department of Nuclear Medicine from 1985 to 2012. He was made a fellow of the Royal College of Physicians (London, UK) in 1999. He is the founder and director of the research facility Cyclotron Rotterdam BV, situated on the campus of Erasmus Medical Center. A medical researcher for almost 50 years, Krenning’s main interests include thyroid disease and nuclear endocrinology with radiolabeled peptides. He was instrumental in the conception, development, and first approvals of somatostatin analog-based radiopharmaceuticals. He has authored more than 500 peer-reviewed articles and more than 150 text chapters and published proceedings.

SNMMI established the Dr. Saul Hertz Lifetime Achievement Award in honor of the professional achievements of Hertz as a pioneering physician in radioiodine therapy. He was among the first to develop experimental data on radioiodine and apply it in the clinical setting to treat hyperthyroidism.

Cardiovascular Council Awards
The SNMMI Cardiovascular Council (CVC) presented the 2021 Hermann Blumgart Award, its highest recognition, to Robert deKemp, PhD, head imaging physicist in cardiac imaging at the University of Ottawa Heart Institute (Canada). The CVC Board of Directors chooses the awardee based on dual criteria of scientific contributions to the field of cardiovascular nuclear medicine and service to the council. deKemp is also an associate professor of Medicine, Engineering, and Physics and a medical scientist in the Faculty of Medicine and member of the Faculty of Graduate and Postdoctoral Studies at the University of Ottawa. He received his PhD from McMaster University (Hamilton, Canada) and moved to Ottawa in 1994 to help establish the National Cardiac PET Centre at the Heart Institute. He is a leading expert in the physics of cardiac PET imaging and pioneered the application of $^{82}$Rb PET perfusion imaging in Canada.
Panithaya Chareonthaitawee, MD, was named by the CVC as the 2021 recipient of the Outstanding Educator Award and Lectureship. She is an associate professor of medicine in the Mayo Clinic College of Medicine (Rochester, MD). The award recognizes a current CVC member who has made extraordinary and consistent contributions to the nuclear cardiology community and to SNMMI. Chareonthaitawee received her undergraduate degree from Columbia University (New York, NY) and her MD from Northwestern University (Chicago, IL). After internal medicine residency and cardiology fellowship at Mayo, she was an advanced fellow in cardiac PET at the Imperial College School of Medicine (London, UK). She is a past president of the SNMMI CVC. She serves as director of the Mayo Clinic Nuclear Cardiology Laboratory, the Department Diversity Chair, and associate program director of the internal medicine residency at Mayo.

General Clinical Nuclear Medicine Council Awards

The General Clinical Nuclear Medicine Council (GCNMC) presented its Lifetime Achievement Award to Harvey A. Ziessman, MD, MBA. The award was established to recognize physicians and scientists who have distinguished themselves through a career dedicated to the advancement of patient care in the field of nuclear medicine. Ziessman’s nuclear medicine career began with a residency at the University of Michigan (Ann Arbor). He first practiced nuclear medicine at Georgetown University (Washington, DC) and spent 17 years at Johns Hopkins University (Baltimore, MD). He has been a leader and pioneer in nuclear medicine and molecular imaging and is well known for his research on gastrointestinal transit and cholecystokinin hepatobiliary imaging. He has published almost 100 peer-reviewed articles, numerous reviews and book chapters, and 11 books, including Nuclear Medicine and Molecular Imaging (with Janis O’Malley, MD, now in its 5th edition). He has organized and lectured at numerous categorical seminars and continuing education sessions at SNMMI meetings and is a past Speaker of the SNMMI House of Delegates. He has been the Newsline editor of The Journal of Nuclear Medicine for the past 9 years. He was instrumental in transforming the Gastrointestinal Council into the GCNMC and was one of its first presidents. He has served on the American Board of Nuclear Medicine and on the Accreditation Council for Graduate Medical Education Residency Review Committee.

The GCNMC Lectureship recognizes a speaker who presents original insights on the value of general clinical nuclear medicine in clinical practice. The 2021 GCNMC Lectureship awardee was Philip Wells, MD, MSc, chair of the Department of Medicine at the Ottawa Hospital (Canada) and professor at the University of Ottawa. He received his medical school education and specialty training in internal medicine at the University of Ottawa. He then studied hematology and completed a master’s degree in clinical epidemiology at McMaster University (Hamilton, Canada), concentrating on the special problems of venous thrombosis. He joined Ottawa University in 1994 and subsequently established the Thrombosis Treatment and Assessment Unit at the Ottawa Hospital, now the largest thrombosis clinical practice and clinical research unit in the world. He is best known for pioneering the concept of clinical prediction rules to assist in diagnosis of patients with suspected deep vein thrombosis and/or pulmonary embolism. His predictive models are used worldwide and are incorporated into many national and organizational guidelines. Wells has received more than $30 million in research funding and has authored nearly 400 peer-reviewed articles. His work has been acknowledged through a Canada Research Chair, the Ottawa Hospital J. David Grimes Career Achievement Award, a University of Ottawa Lifetime Achievement Award, a University of Ottawa Research Chair, and most recently, a Faculty of Medicine Distinguished Research Chair.

RPSC Berson–Yalow Award

The SNMMI Radiopharmaceutical Sciences Council named Ashley C. Knight, MSc, from the University of Toronto (Canada), as the 2021 Berson–Yalow Award recipient. The award celebrates the contributions of Solomon A. Berson, MD, and Rosalyn S. Yalow, PhD, who pioneered the principle of the competitive binding assay and used it to develop the field of radioimmunoassay, a mainstay of early nuclear medicine. Although radioimmunoassay is no longer used extensively, this award continues to recognize outstanding original work in the field of nuclear medicine and the use of competitive receptor binding assays in vitro and/or in vivo. Knight was recognized for basic research presented at the SNMMI Annual Meeting on in vitro evaluation of $^{3}H$-CPPC for imaging macrophage colony stimulating factor-1 receptors. Coauthors on the research included colleagues from the University of Toronto, the Centre for Addiction and Mental Health (Toronto), Codiak Biosciences (Cambridge, MA), and Harvard Medical School/Massachusetts General Hospital (Boston, MA).

Additional awards and recognitions from the 2021 SNMMI Meeting will appear in the September issue of Newsline.
The SNMMI 2021 Virtual Annual Meeting: Accessible, Exceptional Research and Education

Virginia Pappas, CAE, SNMMI CEO

Despite the challenging pandemic year, SNMMI’s 2021 Annual Meeting was a remarkable success. The society set out to offer a virtual event that mirrored the in-person event: multiple, concurrent sessions offering high-quality education as well as interactive opportunities allowing attendees to network and connect with peers and peer groups. We met the mark, reaching goals across the board. The meeting was packed with education, information, and activities, and the program attracted a wide audience.

More than 6,000 physicians, technologists, scientists, and exhibitors attended from more than 60 countries. With much more time to prepare the meeting than last year, the society was able to offer a greatly expanded scientific program, including 5 plenaries, 80 continuing education and scientific sessions, 189 scientific oral presentations, 14 satellite symposia, 1,000 scientific posters, and 115 exhibiting companies and organizations. The meeting offered up to 85 continuing education (CE) credits.

The Program. A premeeting program included 7 “Drink & Think” sessions on topics ranging from ethics and mentorship to FAPI and the axial extent of PET scanners. A full-day Technologist Program on Thursday was followed by categorical sessions and technologist oral presentations on Friday, and the day ended with a fascinating Value Initiative Leaders Symposium on the Potential, Promise, and Value of Radiopharmaceutical Therapy.

Saturday brought the official meeting kickoff, with opening speeches and informative and colorful presentations from Korea, this year’s official Highlight Country, which also celebrated its national nuclear medicine society’s 60th anniversary. The full program began Saturday afternoon, with 5 concurrent sessions offered in areas including cardiovascular, neurosciences, physics, instrumentation and data sciences, medical targeting probes, general clinical specialties, basic and translational oncology, and clinical oncologic therapy and diagnosis.

Scientific and CE sessions were interspersed with plenaries, satellite sessions, industry user meetings, and networking events. The Wagner Lecture on Sunday, presented by Satoshi Minoshima, MD, PhD, focused on brain PET and SPECT. Monday’s Anger Lecturer, Irène Buvat, PhD, discussed the transformative power of artificial intelligence in the practice of nuclear medicine.

The Technologist Section plenary was presented by Sampson Davis, MD, an emergency medicine physician and New York Times bestselling author, who discussed his life growing up, attending medical school, and being on the frontlines of the COVID-19 pandemic.

The final plenary—the Wagner Highlights Symposium—took place Tuesday evening. Four of the profession’s most respected experts provided insights on research presented during the meeting: Sharmila Dorbala, MD, MPH, cardiovascular; Andrei Iagaru, MD, general nuclear medicine; Julie Price, MD, neuroscience; and Heiko Schöder, MD, MBA, oncology and therapy.

Registered attendees can access sessions for 1 year via the SNMMI Learning Center (www.snmmilearningcenter.org).

The Platform. This year’s meeting was offered via a new platform that received strong, positive reviews from attendees. Oral sessions were presented in the Auditorium; abstract oral presentations and posters were located in the Science Pavilion. This year’s Exhibit Hall included more than 100 exhibitors offering webinars, videos, case studies, and other materials that attendees could carry away in a “briefcase.” New this year, a Relaxation Zone offered yoga, meditation, and other activities.

Networking. The society focused heavily this year on creating a variety of different ways for attendees to connect with peers. A Networking Lounge offered chat boards and discussions; Drink & Thinks offered focused group discussions; an “inclusive gathering” invited discussion of hot topics in diversity, equity, and inclusion; and special networking events were organized for residents and mentees. A number of social gatherings offered networking as well, including the Technologist Section 50th Anniversary Event featuring celebrity Ken Jeong; the annual Knowledge Bowl; the receptions for SNMMI President Alan Packard, PhD, and SNMMI-TS President Tina Buehner, PhD, CNMT, NMTCB(CT)(RS), RT(N)(CT); and the Women in Nuclear Medicine breakfast featuring Margie Warrell, PhD.

Miss the Meeting? All abstracts are available on The Journal of Nuclear Medicine website at https://jnm.snjmjournals.org/content/62/supplement_1.

Thank you to all the attendees, exhibitors, speakers, and SNMMI leaders and volunteers for making this year’s Annual Meeting an educational and enriching experience. I am eager to see everyone in person once again at our 2022 Annual Meeting in Vancouver, June 11–14, 2022!