

2012 SNM Highlights Lecture: General Clinical Specialties

From the Newsline Editor: The Highlights Lecture, presented at the closing session of each SNM (now SNMII) Annual Meeting, was originated and presented for more than 33 y by Henry N. Wagner, Jr., MD. Beginning in 2010, the duties of summarizing selected significant presentations at the meeting were divided annually among 4 distinguished nuclear and molecular medicine subject-matter experts. The 2012 Highlights Lectures were delivered on June 13 at the SNM Annual Meeting in Miami, FL. The first 2 presentations appeared in the September issue of Newsline, and the third is included here. Peter Herscovitch, MD, cochair of the Scientific Program Committee, introduced Alan Maurer, MD, who spoke on nuclear medicine in the general clinical specialties. The final Highlights presentation on oncology, by Richard Wahl, MD, will appear in a future issue of Newsline. Note that in the following presentation summary, numerals in brackets represent abstract numbers from The Journal of Nuclear Medicine (2012;53[suppl 1]).

Many challenges in the area of general nuclear medicine and general clinical specialties face practitioners in the United States today. We are challenged not only to develop new and innovative techniques to improve patient care, but we are coming under increasing pressure to provide evidence of cost effectiveness and enhanced patient outcomes.

The category of “General Clinical Specialties” includes some areas touched on by other highlights lecturers, including cardiology, neurology, and instrumentation, as well as overlaps with oncology in neuroendocrine tumors, thyroid cancer, and hepatocellular carcinoma. At this meeting, the majority of presentations in general nuclear medicine were in endocrinology, which reflects current interest in neuroendocrine imaging, with other abstracts in musculoskeletal, pediatric, infection, outcomes, pulmonary, and renal/hypertension areas. As other speakers have noted, we have broad participation from across the world at this meeting, and this is especially true in general clinical sciences. The meeting has become more and more an international event.

New Molecular Imaging Agents

Freeby et al. from Columbia University (New York, NY) and Avid Radiopharmaceuticals, Inc. (Philadelphia, PA) reported on “PET imaging of pancreatic beta cell mass in humans with type 1 and type 2 diabetes mellitus [DM] using ^{18}F -FP-DTBZ” [98]. The vesicular monoamine transporter type 2 (VMAT2) receptor is highly expressed by beta cells, co-localizes with beta cells of the pancreas, and may be a suitable surrogate target of beta cell mass imaging. Pancreatic PET imaging using the novel tracer ^{18}F -FP-DTBZ, with high affinity and long half-life (110 min), provides a means to noninvasively measure VMAT2. In a study of normal individuals and patients with type 1 or 2 DM, the authors found that ^{18}F -FP-DTBZ showed excellent pancreatic uptake. They found that beta cell mass in types 1 and 2 DM were only 38% and 76%, respectively, that of controls (Fig. 1) and concluded that “FP-DTBZ PET measures of beta cell mass are reduced in type 1 and type 2 diabetes” and that this “appears to be a promising beta cell mass imaging modality.”

Another unique ligand was presented by Wells et al. from the University of Tennessee (Knoxville), who reported on “Radioimmunotargeting of amyloid deposits in amyloid light-chain amyloidosis” [537]. They used a ^{124}I -labeled amyloid-reactive and amyloidolytic murine monoclonal antibody, 11-1F4, to serve as a unique means to determine the distribution and extent of amyloid deposits in patients with this disorder. Patients were imaged with PET/CT early and late in disease progression. Imaging showed increased amyloid deposition in liver, spleen, bone marrow, lymph nodes, bowel, adrenals, soft tissue, kidneys, and/or heart in 21 of 36 patients (Fig. 2). This is one of our strengths—to be able to monitor disease progress noninvasively so that (as with amyloid in the brain) we can identify optimal treatment strategies. These authors concluded that “ ^{124}I -11-1F4 PET/CT potentially can be utilized to identify candidates and assess response to immunotherapy using chimeric 11-1F4,” which is now under production for a phase 1 clinical trial.

Wild et al. from University Hospital Basel (Switzerland), Inselspital Bern (Switzerland), University Hospital Freiburg (Germany), University College London Hospitals (UK), Royal Free Hospital (London, UK), and University of Bern (Switzerland) reported on “Glucagon-like peptide-1 receptor SPECT/CT for the preoperative localization of benign insulinomas” [2072]. It is well known in the study of endocrine tumors that insulinomas have the lowest expression of somatostatin receptors and so are particularly challenging both in diagnosis and in providing information for surgery. In this study of patients with endogenous hyperinsulinemia, GLP-1 imaging showed sensitivity higher than that of CT and MR combined. The authors concluded that “GLP-1 receptor imaging defines a novel noninvasive method that may replace the invasive (surgical) approach to localize occult benign insulinomas.”



Alan H. Maurer, MD

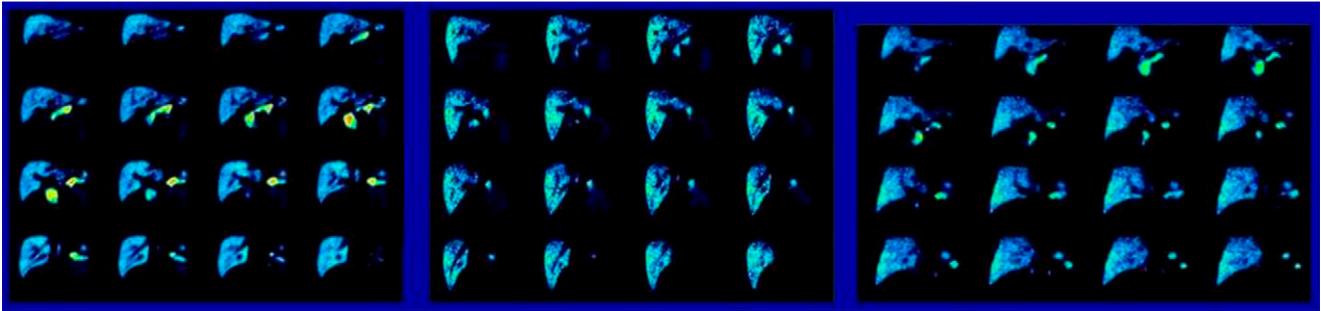


FIGURE 1. ^{18}F -FP-DT BZ PET scanning of pancreas in control subjects (left) and individuals with diabetes mellitus 1 (middle) and 2 (right).

Neuroendocrine Imaging: ^{68}Ga -DOTA

Interest in DOTA imaging has been strong for a number of years. It is well known that the uncinate process has high physiologic binding compared with tumors. One study addressing this issue at this meeting was that of Kroiss et al. from Innsbruck Medical University (Austria), who reported on “Uptake in tumor lesions and normal organs using ^{68}Ga -DOTA-TOC receptor PET/CT” [2094] in 238 patients. They showed the high physiologic uptake in the uncinate process and the difficulties involved in differentiating physiologic activity from known tumors (Fig. 3). They con-

cluded that “ ^{68}Ga -DOTA-TOC is an excellent tracer for imaging of tumors with somatostatin receptor expression.”

Some alternatives have been proposed to differentiate physiologic from pathologic ^{68}Ga -DOTATOC pancreatic activity. Froeling et al. from the Charité Universitätsmedizin (Berlin, Germany) pointed out the importance of using multiphase contrast CT as a part of PET/CT to improve specificity. The group reported on “Detection of pancreatic neuroendocrine tumors [PNET] using semiquantitative ^{68}Ga -DOTATOC PET in combination with multiphase contrast-enhanced CT” [2064]. They pointed out that use of arterial and late-phase venous imaging can identify a contrast-enhancing mass, improving specificity in interpretation of DOTA uptake in these lesions (Fig. 4). They concluded that “patients with PNET should undergo ^{68}Ga -DOTATOC PET/CT with at least an arterial and venous phase contrast CT scan and that maximum standardized uptake value (SUV_{max}) and SUV_{max} target-to-liver ratio provide additional information to help separate PNET from normal tracer uptake in the uncinate process.”

Another approach to achieving better soft-tissue differentiation is the use of combined PET/MR. Reports at this meeting highlighted the growing clinical interest in PET/MR hybrid units. Gaertner et al. from the Technische Universität Munich (Germany) reported on “Comparison of ^{68}Ga -DOTATOC PET acquired by an integrated hybrid PET/MR and a PET/CT scanner in patients with neuroendocrine tumors” [2075]. The authors showed a high correlation between the 2 techniques in assessing SUV and physiology in normal organs (Fig. 5). They concluded that the “diagnostic qualities of ^{68}Ga -DOTATOC PET sequentially acquired on a PET/CT and a PET/MR scanner were comparable,” with no significant difference in comparison SUVs. Subjective PET image quality and visual lesion scoring were slightly higher with PET/CT, most probably as a result of better count statistics. Future prospective studies in a larger patient group are now warranted to document the potential clinical benefit of diagnostic PET/MR.

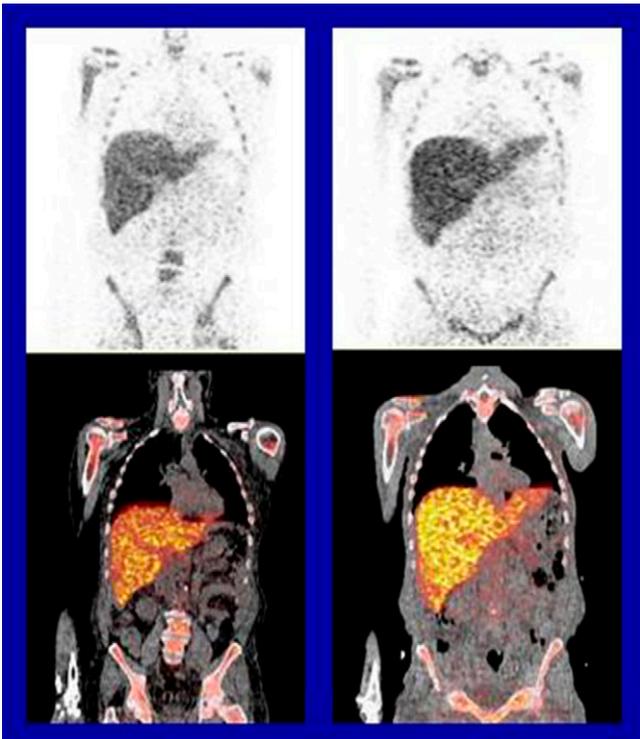


FIGURE 2. Repeat ^{124}I -11-1F4 PET/CT imaging of disease progression in patient with amyloid light-chain amyloidosis. Quantitative analysis of right image, acquired 18 mo after that on left and after limited treatment, showed ~58% increase in hepatic amyloid load as measured by organ volume and mean uptake values.

SPECT/CT: Novel Clinical Applications

SPECT/CT is increasingly becoming the standard of care over simple planar imaging for many clinical nuclear

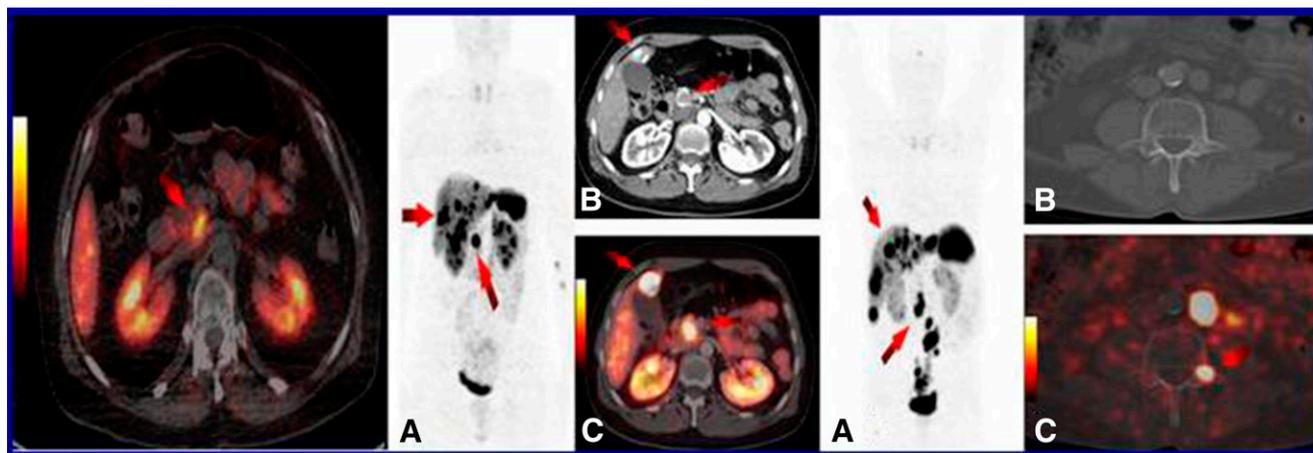


FIGURE 3. Left: Transverse PET/CT image of 72-y-old woman showed focal intense uptake in uncinus process of pancreas. SUV_{max} in uncinus process was 24.1 (arrow). CT showed no correlation. Endosonography, recommended to exclude somatostatin receptor (SST)-related malignancy, was negative. Middle A/B/C: 49-y-old woman with pancreatic NET ($SUV_{max} = 30.9$; T/NT ratio = 3.4) with liver metastases ($SUV_{max} = 40.0$; T/NT ratio = 4.3). Both SST-positive lesions (arrows) showed contrast enhancement on CT. (A) MIP. (B) diagnostic CT. (C) ^{68}Ga -DOTATOC PET/CT. Right A/B/C: 72-y-old man with: (A) hepatic and lymphatic SST-positive lesions of a sigma neuroendocrine tumor on MIP image. (B) No osseous lesion was detected on diagnostic CT imaging. (C) ^{68}Ga -DOTATOC showed SST-positive finding in skeletal system ($SUV_{max} = 18.5$; T/NT ratio = 11.6), and fused PET/CT indicated a small sclerosis in left pedicle of 4th thoracic vertebra (arrow).

medicine imaging applications. All the major camera manufacturers are now involved in production and marketing. This has provided a tremendous opportunity for growth through the introduction of new clinical applications and better diagnosis as a result of improved anatomic localization of conventional single-photon radiopharmaceuticals. Advances in image fusion and anatomic localization through coregistration have provided important lessons for all molecular imaging. Several clever applications of SPECT/CT technology were presented at this meeting. Lang et al. from the 3rd Medical Faculty and University Hospital Kralovske Vinohrady (Prague, Czech Republic) and the William Beaumont Hospital (Royal Oak, MI) reported that “Lung tissue density measured by low-dose CT as a part of pulmonary perfusion SPECT/CT could help to differentiate pulmonary embolism [PE] from chronic obstructive pulmonary disease [COPD]” [2217]. In patients with PE and COPD, the authors looked at lung density in areas of SPECT perfusion defects and measured low-dose CT Hounsfield units. They found that lung tissue density measured by CT is significantly lower in perfusion

defects caused by COPD than in those caused by PE and that the overlap of values is minimal (Fig. 6). This new application of SPECT/CT could help differentiate PE from perfusion abnormalities associated with COPD and, as the authors concluded, “potentially help avoid the performance of ventilation scintigraphy in patients with COPD.”

As we increase our utilization of SPECT/CT, we are also increasing the numbers of images and the amount of time required in diagnosis. The challenge is to identify optimal methods to integrate these more intensive technologies as the field grows. Szabados et al. from the University of Debrecen (Hungary) reported on “A new complex diagnostic protocol for the diagnosis of nasolacrimal duct obstruction: simultaneous dacryocystography and dacryoscintigraphy using SPECT/CT” [475]. The authors added a small amount of dilute CT contrast to add anatomical information to precise functional information (Figs. 7, 8). They concluded that the “SPECT/CT camera offers the opportunity to perform these 2 sensitive investigations simultaneously enabling us to localize anatomically the exact

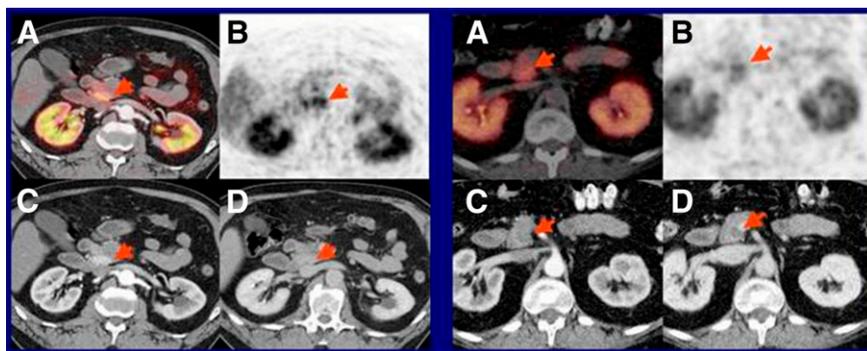


FIGURE 4. Detection of pancreatic neuroendocrine tumors (PNETs, arrows) with multiphasic contrast-enhanced ^{68}Ga -DOTATOC PET/CT with measurement of SUV_{max} . Left: Arterial CT phase: (A, B) PNET in uncinus process on PET/CT. (C) Corresponding conspicuous hyperperfusion in arterial CT is less obvious in (D) venous CT. Right: Venous CT phase: (A, B) PNET in uncinus process on PET/CT. (C) Corresponding low-density lesion is less obvious on arterial CT than on (D) venous CT.

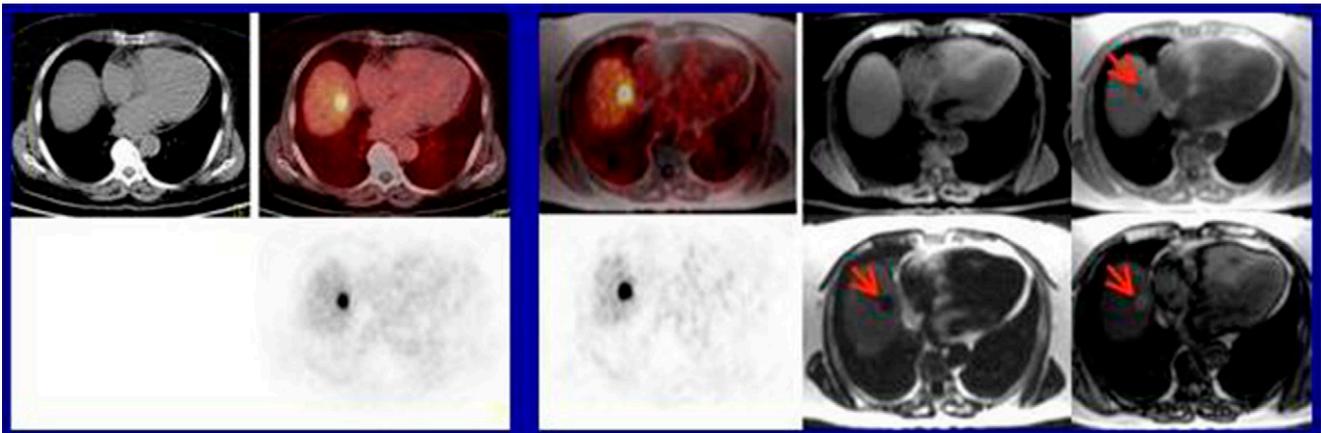


FIGURE 5. ^{68}Ga -DOTATOC PET/CT vs ^{68}Ga -DOTATOC PET/MR imaging in liver lesions. Left: Low-dose CT (top left); ^{68}Ga -DOTATOC PET/CT fusion (top right); PET (bottom). Right: Left to right (top): ^{68}Ga -DOTATOC PET/MR fusion, water-weighted MR, and in-phase MR images; (bottom) left to right: PET, fat-weighted MR, and opposed-phase MR images.

position of the radiolabeled tear, to identify any blockade, and to propose surgical intervention.”

Another creative study addressed a common challenge: to not only identify the presence of biliary leaks but also accurately direct surgical intervention and therapy. Arun et al. from the Postgraduate Institute of Medical Education and Research (Chandigarh, India), reported on the “Added role of SPECT-CT over planar $^{99\text{m}}\text{Tc}$ -mebrofenin hepatobiliary scintigraphy in evaluation of bile leak” [44]. In 76% of patients, PET/CT provided additional information over planar imaging. They also pointed out that the timing of SPECT/CT was important. After seeing the patient initially, it was helpful to wait. SPECT/CT was useful in 71% of cases when performed within 2 h, 75% within 26 h, and 81% after 6 h. Figure 9 shows an interesting example of

how this may be helpful to the surgeon for placement of drains/surgical decompression.

Pediatrics

Sonoda and Balan from Mount Vernon Hospital (London, UK) and Addenbrooke’s Hospital (Cambridge, UK) asked “What does the solitary lesion mean in bone scan of children with known malignancy?” [2150]. The classic teaching has been that a solitary lesion in adults is rarely metastatic disease. In this review of 215 pediatric bone scintigrams with suspected or known malignancy and a single bone lesion over 10 y, the authors found that 42% of lesions were confirmed as metastases. They concluded that “solitary skeletal abnormalities on $^{99\text{m}}\text{Tc}$ -MDP bone scintigraphy in children with known or suspected malignancy are common, and they carry higher risk of metastasis than in adults.”

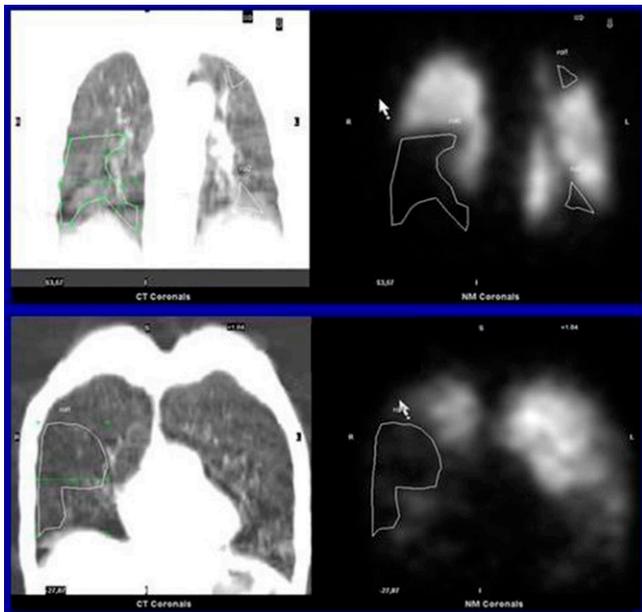


FIGURE 6. CT (left) and SPECT (right) images in pulmonary embolism (top) and chronic obstructive pulmonary disease (bottom).

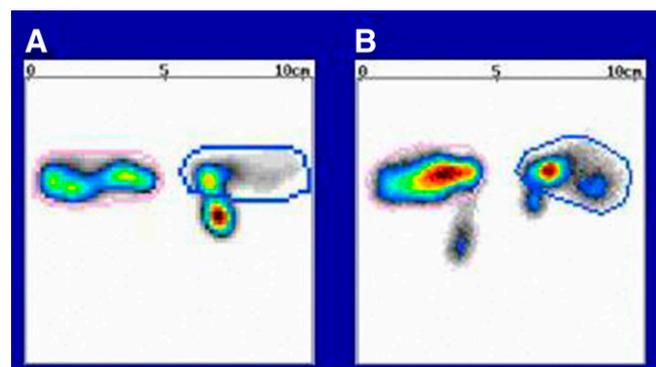


FIGURE 7. Dynamic dacroscentigraphy. $^{99\text{m}}\text{Tc}$ -sodium pertechnetate was instilled into lacrimal lake of both eyes. Images were acquired in a 128×120 matrix with a high-resolution gamma camera. Drainage was characterized based on time/activity curve generated for regions of interest in both eyes and nasolacrimal ducts. Dynamic studies (A) successfully confirmed obstruction, with patient proceeding to SPECT/CT, or (B) did not identify obstruction.

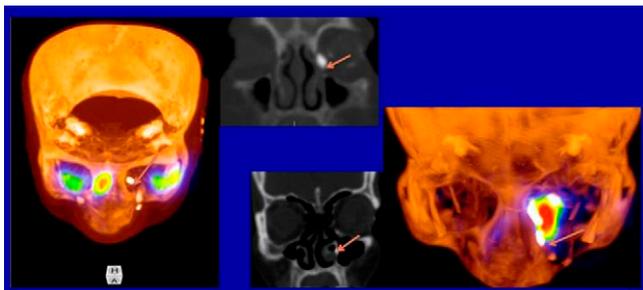


FIGURE 8. Dynamic dacroscentigraphy. Patients with confirmed obstruction proceeded to contrast-enhanced SPECT/CT. Left and top middle: upper obstruction (arrows). Bottom middle and right: lower (ostial) obstruction.

Yang et al. from Capital Medical University (Beijing, China) and Children's Hospital of Philadelphia (PA) reported on "Efficacy of FDG PET/CT in the evaluation of fever of unknown origin [FUO] in pediatric patients" [2214]. PET/CT proved helpful in guiding and leading to the correct final detection of the source of FUO in 30% (16/54) of patients studied. The preliminary conclusion was that "FDG PET/CT should be considered in the evaluation of FUO in pediatric patients."

We have a great need for better standardization of gastrointestinal pediatric studies. Ozcan et al. from the Ege University School of Medicine (Izmir, Turkey) reported on "The assessment of gastroesophageal reflux (GER) in children: a comparative study with scintigraphy and 24-h ambulatory pH monitoring" [2208] in 88 children. The authors found very good correlation between ^{99m}Tc scintigraphy and pH probe detection, which is invasive in children. However, they were challenged by a lack of standardization in pediatric values for gastric emptying, and so they did not obtain a high degree of correlation in gastric retention for the 2 techniques. They concluded that "scintigraphy seems to be a reliable diagnostic test to assess the presence of GER in symptomatic children." Discordant findings might indicate the potential limitations of both methods, limitations attributable to a lack of standardization of gastric emptying milk studies and of established standard and normal control studies (always a challenge in pediatrics).

Another interesting report came from Yang et al. from Capital Medical University (Beijing, China) and Children's Hospital of Philadelphia (PA), who reported that the "Salivagram is more likely to detect lung aspiration than is gastroesophageal scintigraphy in pediatric patient" [257]. With just a drop of ^{99m}Tc on the tongue, the salivagram was much more sensitive than a full-blown gastroesophageal reflux study using the milk scan. They concluded that the "salivagram should be performed before milk scan because it offers a better chance to detect lung aspiration."

Obesity is an escalating problem, and brown adipose tissue (BAT) has been the focus of much recent interest. Muzik et al. from Wayne State University (Detroit, MI) reported on "PET quantitative assessment of oxidative

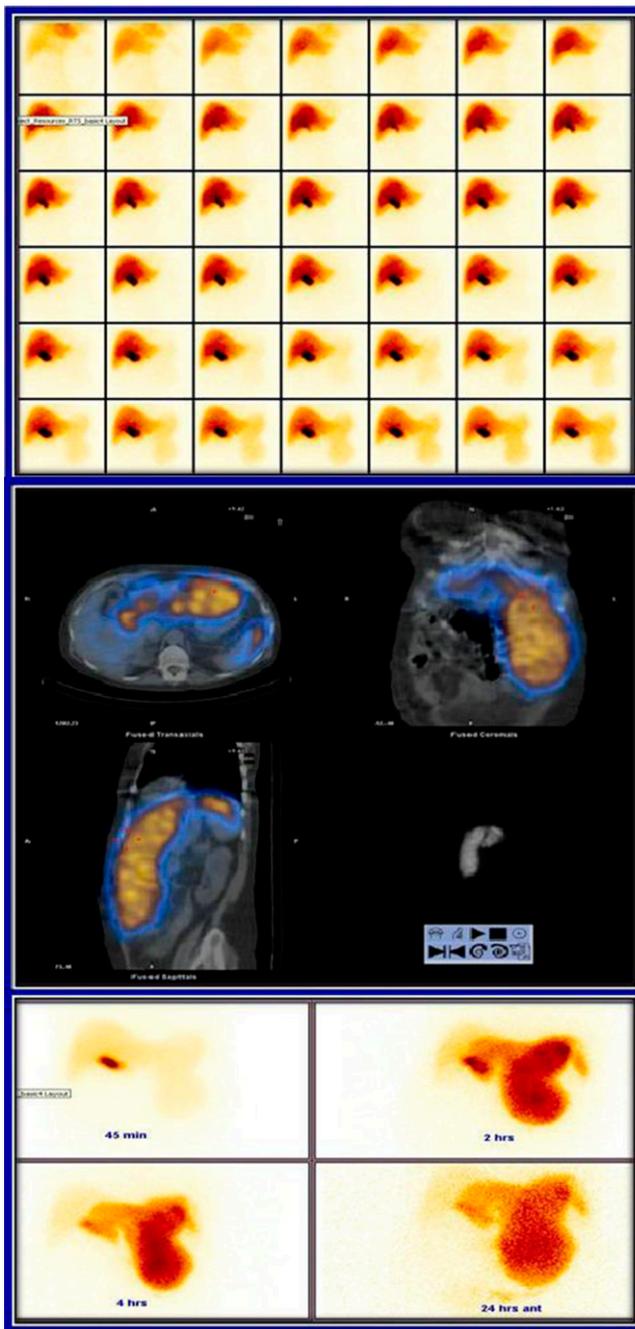


FIGURE 9. Forty-five-year-old woman 1 mo after laparoscopic cholecystectomy. Top: MR cholangiopancreatography showed no filling defect in biliary tract. Subhepatic drain in situ. Bottom: Planar images showed active bile leak with large intra-abdominal collection. Middle: SPECT/CT detailed biliary collection involving gall bladder fossa, left subdiaphragmatic and peri-splenic regions, and greater sac.

metabolism in activated brown fat" [592]. Study participants were divided into 2 groups (BAT+ and BAT-) based on cold-induced presence of active BAT. The authors looked at the amount of energy activation that could be achieved by activating brown fat (Fig. 10) and found that this energy was relatively small (roughly equivalent to that

expended by walking for 1 min at 4 mph). The authors concluded that “BAT thermogenesis in humans accounts for a very small fraction of daily energy expenditure during moderate cold stress, even in subjects with relatively large BAT depots” and that it is “unlikely that it can contribute significantly to weight management in obese individuals.”

Gastroenterology

Another challenge we face is the increasing focus on image utilization and outcomes. Data presented at the meeting emphasized the importance of this challenge. One example came from Tann et al. from Indiana University Medical Center (Indianapolis), who asked “Is morphine-augmented HIDA scan still accurate for diagnosing acute cholecystitis [ACC] in the era of CT and ultrasound? Can reporting be improved?” [43] We know that the sensitivity and specificity of a test depend on pretest likelihood in the population; unfortunately much of the early data suggesting that HIDA scans with morphine augmentation had very

high specificity and sensitivity were published before we had accompanying CT and ultrasound data. This group looked at 150 morphine-augmented HIDA scans over a 3-y period and found high sensitivity but very low specificity when compared with long-term outcomes and results from other imaging techniques. Today other prior imaging and clinical tests have been performed in many patients and were negative or equivocal for ACC, so that the clinical prevalence of ACC in these cases is much lower than when HIDA scans were first introduced. They concluded that these “results show low accuracy and high potential for false-positive results for morphine-augmented HIDA today due the lower disease prevalence” and that “to justify this study it is time to modify interpretation by incorporating all available imaging and clinical data...in a similar fashion to the interpretation of a V/Q lung scan where X-ray and clinical findings affect the test results and reporting routinely.”

Infection

We all know that FDG uptake is nonspecific. Tomas et al. from North Shore–Long Island Jewish Health System (New Hyde Park, NY) reported on “ ^{18}F -FDG uptake in uninfected prosthetic vascular grafts: frequency, patterns, intensity, and changes over time” [540] in patients imaged for oncologic indications. They found a high percentage (88%) of uptake in uninfected grafts and that this uptake can persist over time. They concluded that “because patterns and intensity of uptake in uninfected grafts are similar to those in infected grafts, the role of FDG-PET/CT for diagnosing prosthetic vascular graft infection needs more extensive investigation.”

Endocrine: Thyroid Cancer/Therapy

As noted earlier, endocrinology dominated general clinical medicine presentations at this meeting. An interesting report came from Vrachimis et al. from University Hospital Muenster (Germany), who reported on “Overall survival of patients with differentiated thyroid cancer [DTC]: comparison with that of the normal population” [202]. They looked at current TNM nodal staging for thyroid cancer in patients treated with conventional approaches and found no significant differences in survival rates between DTC patients in stages I to IVa and expected survival in the normal population matched for age and sex. However, patients in stage IVc showed significantly lower survival rates. Thus the large majority of thyroid cancer patients can be assured that if they are treated with ^{131}I their survival chances are as good as patients who have never had thyroid cancer.

High- vs low-dose ^{131}I treatment has been the focus of much interest. When I was in training we followed what was called the “Beierwaltes Rule” for ^{131}I dose: when residual thyroid disease is isolated to the neck, 75–100 mCi; when extending to local nodes, 150 mCi; and if distant

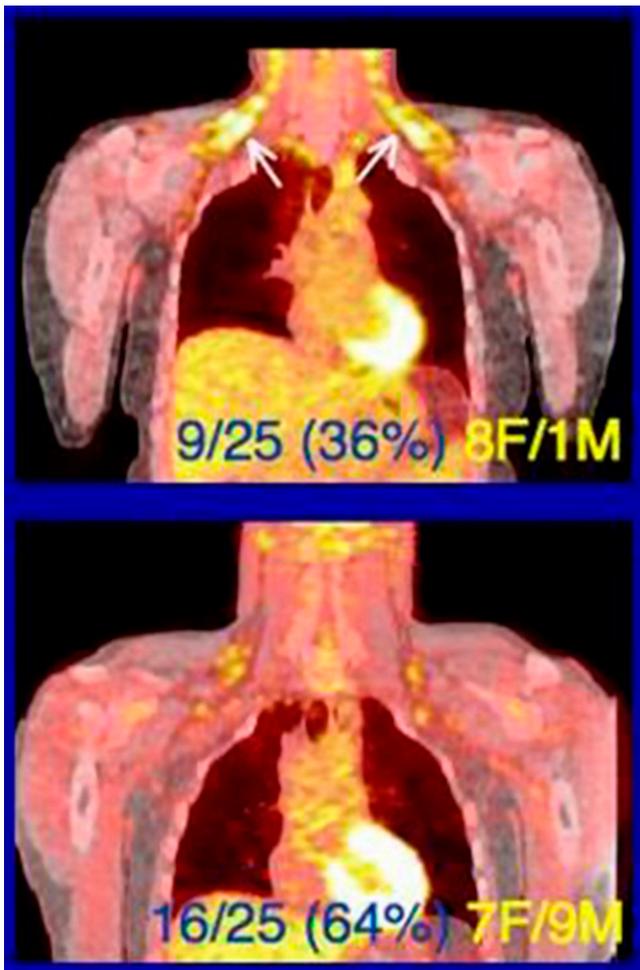


FIGURE 10. Participants were classified as brown adipose tissue (BAT)-positive (top, average $\text{SUV}_{\text{max}} = 10.3$) or -negative (bottom, $\text{SUV}_{\text{max}} = 3.5$) based on cold-induced presence of active BAT.

disease is detected, 200 mCi. This has been widely used as an unwritten standard. Recently, however, 2 articles in *The New England Journal of Medicine* (Schlumberger et al. 2012;366:1663–1673; Mallick et al. 2012;366:1674–1685) showed that low-dose ^{131}I ablation can be as successful as high-dose. Several presentations at this meeting offered similar results. Capelle et al. from the University of Alberta (Edmonton, Canada) reported on “Comparison of thyroid hormone [TSH] withdrawal and rhTSH-aided 1,850 MBq and 3,700 MBq radioiodine postsurgical remnant ablation in DTC” [206] in 732 patients. The bottom line was that the group that fared best in terms of recurrence and during 2-y follow-up were those who received recombinant TSH and the lower dose of ^{131}I , suggesting that we should rethink doses given for ablation.

Two presentations, one on early (at 7 d) and one on intermediate- to long-term effects of ^{131}I therapy, were also notable. Hall et al. from Washington Hospital Center (DC), Carolinas Medical Center (Charlotte, NC), Mayo Clinic (Rochester, MN), MedStar Health Research (Hyattsville, MD), and the Thyroid Cancer Survivors Association, Inc. (New York, NY), reported on “Characterization of salivary gland side effects secondary to ^{131}I therapy” [306] and on the results of a national survey for intermediate and long-term results [308]. With more than 2,500 respondents, the authors found a very high incidence of short-term (within 7 d of treatment) salivary effects. When they looked at intermediate-to-late side effects they found that ~30% of patients experienced lasting salivary gland symptoms.

McEwan et al. from the University of Alberta (Edmonton, Canada) reported on “ ^{18}F -FDG PET scans and high dose of ^{131}I treatment in patients with elevated thyroglobulin and negative ^{131}I scan DTC” [2111]. They routinely recommend high-dose ^{131}I in these patients. This group performed a retrospective review of 129 patients and outcomes over 7 y. They found that after ^{131}I treatment 53% had positive FDG scans, 50% had a >50% decrease in thyroglobulin, and that other factors probably should be considered in terms of who receives ^{131}I based on FDG imaging. This suggests that ^{131}I therapy has a therapeutic effect for only half of patients when the thyroglobulin level is considered an index of tumor burden.

Nakada et al. from the Hokko Memorial Hospital, Kaisei Hospital, Kamijo Thyroid Clinic, and Sapporo Kosei Hospital (all in Sapporo, Japan) reported that “Diffuse FDG uptake in the thyroid in rapidly enlarging goiter does not guarantee benign disease” [423]. We see this uptake frequently and commonly ascribe it to chronic thyroiditis. This group looked particularly at those with a rapidly enlarging gland. Although the scans looked the same and SUVs were similar, 33 of the 68 patients had primary thyroid lymphoma (Fig. 11). The only difference for these patients was their clinically rapidly enlarging glands. The authors concluded that diffuse FDG uptake in enlarging goiter does not guarantee benign conditions of disease and should be interpreted with caution.

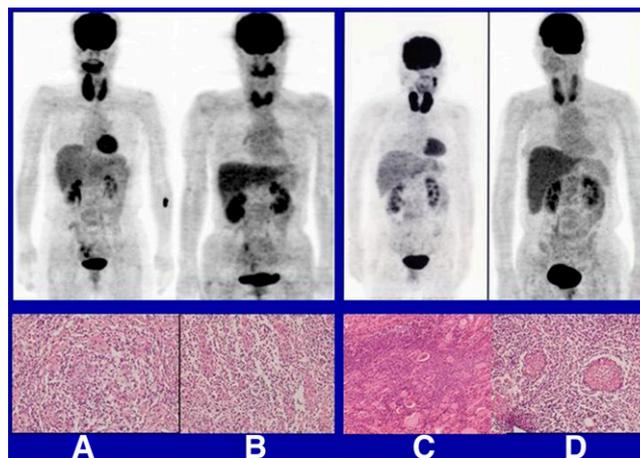


FIGURE 11. PET images (top) and hematoxylin/eosin pathologic staining (bottom) in patients with (left) primary thyroid lymphoma and (right) Hashimoto's thyroiditis. Scans and uptake values were similar in the 2 groups.

Interest in incidental FDG uptake remains high. Ciarallo et al. from McGill University (Montreal, Canada) and Brandon Regional Center (Canada) reported on “Significance of incidental thyroid ^{18}F -FDG uptake on PET/CT and its impact on patient management” [2042]. The authors noted that several reports have identified malignancy in 29%–55% of patients with focal FDG uptake in the thyroid gland. In their retrospective review of 7,252 cancer patients undergoing FDG PET/CT, 157 (2.2%) had FDG uptake in the thyroid gland. Of these, 128 went on to further analysis, in which only 14 (11%) were found to be malignant. They found no correlation between SUV and probability of malignancy, no clinically useful SUV threshold to identify malignancy, and found a large degree of SUV overlap in benign and malignant groups (Fig. 12). They concluded that the discrepancy between the incidence of malignancy in their study and that reported in the literature might be the result of selection bias. Almost half of articles addressing thyroid incidentalomas on FDG PET/CT originate from Korea or

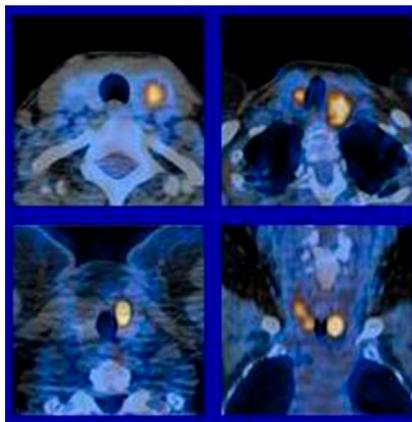


FIGURE 12. Benign (top) versus malignant (bottom) thyroid incidentalomas. Top left: follicular neoplasm ($\text{SUV}_{\text{max}} = 5.1$). Top right: Multinodular goiter with follicular neoplasm (SUV_{max} left = 7.8, right = 6.4). Bottom left: papillary carcinoma ($\text{SUV}_{\text{max}} = 11.8$). Bottom right: multifocal papillary carcinoma (SUV_{max} left = 9.2, right = 4.0).

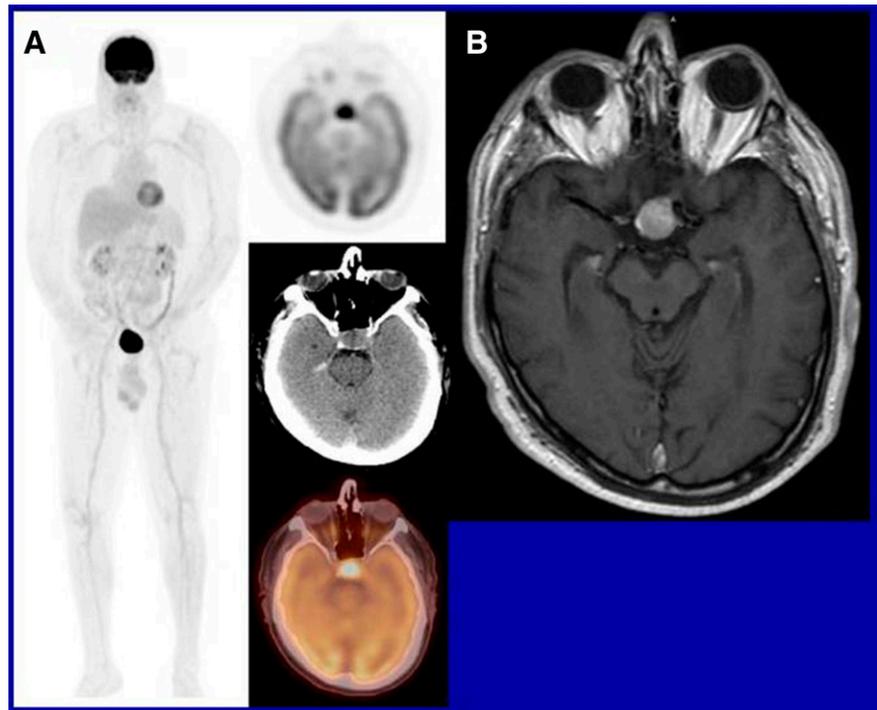


FIGURE 13. Fifty-nine-year-old man with adenocarcinoma of lung. (A) On follow-up PET/CT: MIP, transaxial PET, CT, and fused images showed incidental ^{18}F -FDG-avid cellular lesion ($\text{SUV}_{\text{max}} = 16.4$). (B) MR imaging confirmed this finding as a macroadenoma. Patient subsequently underwent transsphenoidal resection for progressive visual impairment.

Japan and may reflect higher thyroid malignancy rates in those populations.

Yang et al. from the Shanghai Cancer Center (China) reported on “Prevalence and risk of cancer of thyroid incidentaloma identified by ^{18}F -FDG PET/CT” [2047]. Out of a total of 15,948 nonthyroid patients who underwent FDG PET/CT, incidental uptake was found in 395 (2.5%). The frequency of incidentalomas in healthy patients was higher than that in patients with suspected or known cancer (3.1% and 2.3%, respectively). Of the 395 patients with incidentalomas, 146 underwent additional studies, and 43 incidentalomas (29.5%) proved to be malignant. The likely conclusion that we can draw from these studies is that the presence of focal uptake has a diagnostic relationship with geographic and risk factors—if the patient is in China, for example, the chance of malignancy is greater.

Abdelmalik et al. from St. Louis University Hospital (MO) reported on “Pituitary adenoma: incidentaloma identified by ^{18}F -FDG PET/CT” [101]. The authors found focal uptake in the pituitary gland in 13 (0.2%) of 8,431 patients. In this case there was good differentiation between SUV_{max} of true-positives and false-negatives. Figure 13 shows an example with very high pituitary uptake.

Musculoskeletal

Few new clinical musculoskeletal applications were presented at this meeting. This is clearly one of the areas in which we need new and original research, particularly in outcomes and cost effectiveness. Kulkarni et al. from the Zentralklinik (Bad Berka, Germany) reported on “ ^{18}F -sodium fluoride PET/CT in the diagnosis and evaluation of therapeutic

response in para-articular ossification [PAO] after paraplegia or quadriplegia: results in 176 patients” [533]. The authors imaged patients before and after external beam radiotherapy [EBRT] (Fig. 14) and concluded that “F-18 sodium fluoride PET/CT is very sensitive for early detection of PAO after paraplegia or quadriplegia” and “is effective for assess-

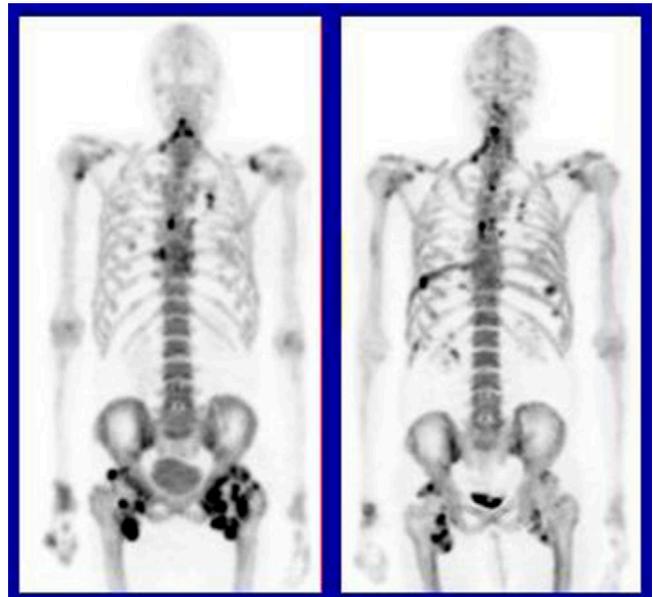


FIGURE 14. ^{18}F -NaF PET/CT performed at baseline (left) and 6–9 wk after (right) diagnosis of para-articular ossification after paraplegia and initiation of external beam radiotherapy. Imaging successfully assessed excellent therapeutic response in this patient and provided valuable prognostic information.

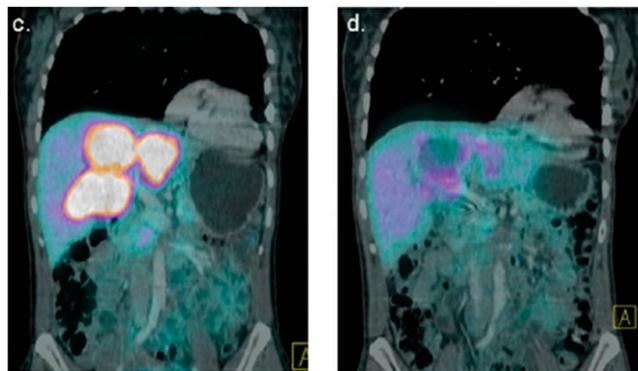
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SNM 2012 Image of the Year

The highly anticipated selection of the 2012 SNM Image of the Year was announced on June 12 at the SNM 59th Annual Meeting in Miami, FL. The individual panels that make up the image, from researchers at the European Commission Joint Research Centre Institute for Transuranium Elements (Karlsruhe, Germany) and University Hospital (Heidelberg, Germany), show the effectiveness of peptide receptor α -therapy with ^{213}Bi -DOTATOC for gastroenteropancreatic neuroendocrine tumors (GEP NETs) that do not respond to β -therapy.

A panel of experts selected these images from more than 2,000 presentations at the SNM Annual Meeting. Each year, SNM chooses an image that exemplifies cutting-edge molecular imaging research and that demonstrates the ability of molecular imaging to detect and diagnose disease and to identify the most appropriate therapies. "The images illustrating the effectiveness of ^{213}Bi -DOTATOC for GEP NETs show remarkable results that can be achieved in a clinical setting," said Peter Herscovitch, MD, chair of the SNM Scientific Program Committee. "This opens up a new door for those patients whose cancer does not respond to traditional chemotherapy."

Alfred Morgenstern, PhD, project leader of the Alpha-Immunotherapy Project at Karlsruhe, was lead author of the study "Synthesis of ^{213}Bi -DOTATOC for peptide receptor α -therapy of GEP NET patients refractory to β -therapy." The study described the synthesis of ^{213}Bi -DOTATOC using a microwave-assisted labeling protocol. The research included 17



2012 SNM Image of the Year: Two panels from the 2012 Image of the Year show response of multiple liver lesions at baseline (left) and after (right) therapy with 14 GBq ^{213}Bi -DOTATOC.

patients with GEP NETs who had previously shown resistance to treatment with ^{90}Y - or ^{177}Lu -DOTATOC and who were treated with escalating doses of the peptide receptor α -therapy (1–10–20 GBq). Researchers assessed response with contrast-enhanced sonography, MR imaging, ^{68}Ga -DOTATOC PET/CT, and analysis of tumor markers. In addition, organ toxicities were monitored during and after treatment. Patients tolerated escalating doses well, with no acute kidney, endocrine, or hematologic toxicities. Shrinkage of primary tumors as well as liver and bone metastases was observed.

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ing therapeutic response and has prognostic value after EBRT." We need more research in ^{18}F -sodium fluoride, including comparisons with conventional $^{99\text{m}}\text{Tc}$ -MDP bone scanning to assess real value.

Clinical Outcomes: Evidence-Based Medicine

I began by saying that the real challenge today is in getting appropriate data on clinical outcomes to support meaningful evidence-based medicine. One useful approach was presented by Stamm et al. from the University of Alberta (Edmonton, Canada), who reported on "A cost-efficient diagnostic imaging algorithm incorporating ^{123}I -MIBG SPECT/CT for suspected pheochromocytoma" [474]. The authors correlated 24-h fractionated urine metanephrine (FUM) results within 2 mo of SPECT/CT and found that when FUM values were normal, all of the SPECT/CT studies were negative (16/71). Conversely, 87% of patients with a total metanephrine (TM) $\geq 1.7 \mu\text{mol}/24 \text{ h}$ (15/71) had positive SPECT/CT studies. If the TM was $< 1.7 \mu\text{mol}/24 \text{ h}$ but one or more of the metanephrine fractions were abnormal (40/71),

only 39%–58% of SPECT/CT studies were positive. Of these, none had a positive SPECT/CT with a negative or benign CT and/or MR (14/71). The group used these data to develop an algorithm that indicated that the average cost could be lowered to \$1,897.94/patient (31 MIBG, 20 CT, 20 MR imaging) with no expected change in accuracy (an imaging cost savings of 42% or \$1,375.91/patient). Their decision tree indicated that patients with clinically suspected pheochromocytoma should be evaluated initially with 24-h FUM. If TM is $\geq 1.7 \mu\text{mol}/24 \text{ h}$, then the patient should be evaluated with ^{123}I -MIBG SPECT/CT. If FUM values are normal, no further imaging is indicated. A CT or MR study should be performed if the TM is $< 1.7 \mu\text{mol}/24 \text{ h}$ and one or more of the metanephrine fractions is abnormal. If the CT or MR is normal or benign, no further imaging is required. If abnormal, further evaluation with ^{123}I -MIBG SPECT/CT is indicated. We need to develop more of these types of cost effectiveness studies.

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