

2013 RSNA (Filtered Schedule)

**Sunday, December 01, 2013**

10:45-12:15 PM • **SSA18** • Room: S505AB • Nuclear Medicine (PET/CT in Oncology)  
12:30-01:00 PM • **CL-NMS-SUA** • Room: S503AB • Nuclear Medicine - Sunday Posters and Exhibits (12:30pm - 1:00pm)  
01:00-01:30 PM • **CL-NMS-SUB** • Room: S503AB • Nuclear Medicine - Sunday Posters and Exhibits (1:00pm - 1:30pm)  
02:00-03:30 PM • **RC111** • Room: S505AB • Multi-modal Imaging Workup for Alzheimer's Disease, Parkinson's Disease, and Related Disorders: Case-based App...

**Monday, December 02, 2013**

08:30-10:00 AM • **RC217** • Room: S504CD • PET-MR/Hyperpolarized MR  
08:30-12:00 PM • **VSNM21** • Room: S505AB • Nuclear Medicine Series: Assessment of Cancer Treatment Response: Updates  
12:15-12:45 PM • **CL-NMS-MOA** • Room: S503AB • Nuclear Medicine - Monday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **CL-NMS-MOB** • Room: S503AB • Nuclear Medicine - Monday Posters and Exhibits (12:45pm - 1:15pm)  
03:00-04:00 PM • **SSE08** • Room: E353C • ISP: Gastrointestinal (Oncology: Staging and Distant Metastases)  
03:00-04:00 PM • **SSE19** • Room: S504CD • Nuclear Medicine (Quantitative Imaging)  
03:00-04:00 PM • **SSE20** • Room: S505AB • Nuclear Medicine (SPECT/CT)

**Tuesday, December 03, 2013**

08:30-10:00 AM • **MSCC31** • Room: S406A • Case-based Review of Nuclear Medicine: PET/CT Workshop-Head and Neck Cancers (In Conjunction with SNMMI) (An I...  
08:30-10:00 AM • **RC321** • Room: S102D • Medical Physics 2.0: Nuclear Imaging  
08:30-10:00 AM • **RC351** • Room: E353C • CT/PET in the Abdomen and Pelvis: How and When (How-to Workshop) (An Interactive Session)  
08:30-12:00 PM • **VSNM31** • Room: S505AB • Nuclear Medicine Series: Non-FDG PET Radiotracers in Oncology  
10:30-12:00 PM • **MSCC32** • Room: S406A • Case-based Review of Nuclear Medicine: PET/CT Workshop-Cancers of the Abdomen and Pelvis (In Conjunction with ...  
10:30-12:00 PM • **SSG01** • Room: E451A • ISP: Breast Imaging (Nuclear/Molecular Imaging)  
12:15-12:45 PM • **CL-NMS-TUA** • Room: S503AB • Nuclear Medicine - Tuesday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **CL-NMS-TUB** • Room: S503AB • Nuclear Medicine - Tuesday Posters and Exhibits (12:45pm - 1:15pm)  
01:30-03:00 PM • **MSCC33** • Room: S406A • Case-based Review of Nuclear Medicine: PET/CT Workshop-Lymphoma/Melanoma/Sarcoma (In Conjunction with SNMMI) (...  
03:00-04:00 PM • **SSJ21** • Room: S505AB • Nuclear Medicine (GI, GU and Endocrine)  
03:30-05:00 PM • **MSCC34** • Room: S406A • Case-based Review of Nuclear Medicine: PET/CT Workshop-Cancers of the Thorax (In Conjunction with SNMMI) (An I...  
04:30-06:00 PM • **RC403** • Room: N228 • Cardiac PET/CT and PET/MR  
04:30-06:00 PM • **RC411** • Room: S505AB • Improving PET Interpretation: Present Updates in GI and GYN Cancers with Case Examples (An Interactive Session)  
04:30-06:00 PM • **RC423** • Room: S403B • Minicourse: Current Topics in Medical Physics-Nuclear Cardiac Imaging for Physicists

**Wednesday, December 04, 2013**

08:30-10:00 AM • **RC511** • Room: S505AB • High-Resolution Radionuclide Breast Imaging (An Interactive Session)  
08:30-10:00 AM • **RC525** • Room: S102AB • Quantitative Imaging: Quantitative Imaging in FDG-PET  
10:30-12:00 PM • **SSK09** • Room: N228 • Genitourinary (Functional and Anatomic Imaging in Staging and Follow-up of Gynecologic Cancers)  
10:30-12:00 PM • **SSK17** • Room: S505AB • Nuclear Medicine (PET/MRI for Oncology)  
12:15-12:45 PM • **CL-NMS-WEA** • Room: S503AB • Nuclear Medicine - Wednesday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **CL-NMS-WEB** • Room: S503AB • Nuclear Medicine - Wednesday Posters and Exhibits (12:45pm - 1:15pm)  
03:00-04:00 PM • **SSM17** • Room: S505AB • Nuclear Medicine (Comparative Technologies and Modalities)  
04:30-06:00 PM • **SSPC45** • Room: S404CD • Controversy Session: The Heart of the Matter: Nuclear Stress Test vs CTA for Low to Intermediate Risk Cardiac ...

**Thursday, December 05, 2013**

07:15-08:15 AM • **SPSH50** • Room: E350 • Hot Topic Session: Multimodality Imaging with MR-PET  
08:30-10:00 AM • **RC611** • Room: S505AB • Advances in Cardiac Nuclear Imaging: SPECT/CT and PET/CT  
10:30-12:00 PM • **SSQ16** • Room: S505AB • ISP: Nuclear Medicine (Neurologic Imaging)  
12:15-12:45 PM • **CL-NMS-THA** • Room: S503AB • Nuclear Medicine - Thursday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **CL-NMS-THB** • Room: S503AB • Nuclear Medicine - Thursday Posters and Exhibits (12:45pm - 1:15pm)  
03:00-04:00 PM • **SPSH54** • Room: S404AB • Hot Topic Session: Amyloid Imaging  
04:30-06:00 PM • **RC711** • Room: S505AB • Head and Neck Cancer PET Interpretation with Case Examples (An Interactive Session)

**Friday, December 06, 2013**

08:30-10:00 AM • **RC811** • Room: S504CD • Advances and Updates in SPECT/CT  
08:30-10:00 AM • **RC823** • Room: S403B • Minicourse: Recording and Reporting Radiation Dose: Nuclear Medicine  
10:30-12:00 PM • **SST12** • Room: S505AB • ISP: Nuclear Medicine (Cardiovascular Imaging)

**Biodistribution of Positron Emitting Radionuclides. The Basic Step to Understand the Wide Spectrum of the PET CT Studies**

[Back to Top](#)

**CL-NME3051**

**Ailan H Barrientos-Priego**, MD  
**Liliana M Correa**, MD  
**Erika Morrongo Bastida**  
**Juan Pablo Chavez-Torres**  
**Irma Soldevilla-Gallardo**  
**Jorge Vazquez-Lamadrid**, MD  
**Ivan E Casanova Sanchez**, MD

**PURPOSE/AIM**

1 Describe biodistribution of the radiopharmaceuticals used in positron emission tomography (PET) 2 Review physics of positron emitting radionuclides 3 Clinical application of new PET CT studies

**CONTENT ORGANIZATION**

1 Describe PET radiotracers labeled with 18F, 11C and 68Ga used in Mexico 2 18F-Fluoride, 18F-Fluorothymidine, 18F-Fluoroestradiol, 18F-Fluorocholina, 18F-Fluoromisonidazole, 11C-Acetate, 68Ga-DOTATOC 3 They represent new ways to study specific pathologies 4 To interpret the images obtained, it is necessary to know the biochemical and metabolic pathways that we represent with them as well as the sites of physiological uptake and elimination way

**SUMMARY**

1 It is Basic to understand the biodistribution of PET radiopharmaceuticals in order to identify abnormal uptake 2 Lack of awareness of many tracers makes easy to slip when reading this kind of studies 3 Representing with images the cell process is an amazing tool we count with

## 18F -Sodium Fluoride PET/CT: Indications, Technical Aspects, and Role in the Management of Oncology Patients

[Back to Top](#)

### CL-NME3052

**Michael E O'Keeffe** , MBBCh  
**Jennifer Murphy** , MBBCh, MRCPI  
**Siobhan O' Neill** , MBBCh  
**Fiachra G Moloney** , MBBCh, MRCPI  
**Peter Murphy**  
**Kevin N O'Regan** , MD

#### PURPOSE/AIM

To describe the clinical indications, technical aspects and impacts on patient management of (18F)-NaF PET/CT in oncology patients with suspected osseous metastatic disease.

#### CONTENT ORGANIZATION

We illustrate a number of clinical cases from a tertiary oncology centre where (18F)-NaF PET/CT offered significant improvement in detection of osseous metastatic disease, in particular for patients with prostate and breast malignancy. Impact on patient management is described for each case. Pearls and pitfalls of (18F)-NaF PET/CT interpretation are outlined. We demonstrate the advantages of this technique over standard imaging modalities, particularly 99mTc-MDP isotope bone scan.

#### SUMMARY

This pictorial review highlights the increased accuracy of (18F)-NaF PET/CT in comparison to standard bone imaging techniques. Benefits include decreased scan time, increased accuracy for osseous metastatic disease and meaningful changes in patient management.

## Understanding the Impact of the Time-of-Flight and the Point-spread-Function Recovery in PET Imaging

[Back to Top](#)

### CL-NME3053

**Silvano Gnesin** , PhD  
**Jean Delacoste**  
**Martin Pappon**  
**John O Prior** , MD, PhD  
**Sebastien Baechler**  
**Francis R Verdun** , PhD

#### PURPOSE/AIM

The purpose of this exhibit is:

1. To review the main features of time-of-flight (TOF) and point-spread-function (PSF) recovery implemented in latest generation PET scanners.
2. To present phantom study results supporting the main educational points.
3. To understand the impact of TOF and PSF in improving patient radioprotection.

#### CONTENT ORGANIZATION

The features of TOF and PSF in PET are reviewed. A phantom study characterizing the TOF and PSF recovery performances with recovery coefficients (RCs), image noise, and contrast will be presented and further assessed by activity spillover from hot lesions. The impact of TOF and PSF in small hot lesions visibility is presented, as well as whether PSF recovery leads to any quantitative bias. Determination of PET parameters for optimal patient care is discussed.

#### SUMMARY

TOF improved contrast and quantitation especially in cold regions. PSF recovery significantly improved hot lesion contrast and RCs, especially for small-sized (10mL) hot lesions, but can be controlled by adopting appropriate image smoothing.

Small hot lesion visibility is improved by the use of TOF and PSF separately and is maximized when used together, which can significantly impact delivered dose and patient management.

## Low Dose FDG PET Imaging of Brown Adipose Tissue: A Capability Demonstration for Nutrition and Metabolism Research

[Back to Top](#)

### CL-NME3055

**Michelle I Knopp**  
**Jun Zhang** , PhD  
**Nathan C Hall** , MD, PhD \*  
**Xiaoli Liu**  
**Michael V Knopp** , MD, PhD

#### PURPOSE/AIM

The objective, qualitative and quantitative visualization of brown adipose tissue (BAT) is an important capability for nutrition and metabolism research. In this exhibit we introduce the pathophysiology of using FDG to image BAT, the optimized PET imaging approach that we developed to image adults using a low dose technique, the current approaches that may be used to activate BAT, review the imaging findings, the ability to perform follow up examination and appropriate assessment methodologies as well as current and potential applications.

#### CONTENT ORGANIZATION

Background on brown adipose tissue (BAT) The Physiology of FDG to image BAT How we perform a low dose BAT PET Current approaches to activate BAT Review of BAT Imaging Findings including follow up Image Assessment methodologies Potential Human Research and Clinical Applications References

#### SUMMARY

Low dose FDG PET Imaging can be performed to visualize brown adipose tissue with excellent image quality as well as providing quantitative readouts. The presented methodological approach makes PET a highly capable and viable methodology for nutrition and metabolism research in adult subjects and patients.

## Functional Imaging of Neuroendocrine Tumors: A Pictorial Review

[Back to Top](#)

### CL-NME3056

**Jagadeesh Singh** , MD, FRCR  
**Sumeet Virmani** , MD  
**Amjad Ali** , MD

#### PURPOSE/AIM

Neuroendocrine tumors are a heterogeneous group of tumors characterized by variable clinical symptoms and presentation. Functional imaging has an important role in tumor localization, evaluating extent of the disease, monitoring the effect of treatment and selecting patients for therapy. This pictorial review highlights the importance of planar, SPECT and PET CT imaging in the management of various

common and uncommon neuroendocrine tumors.

#### CONTENT ORGANIZATION

- Tabular form of contents with various targets, ligands and available diagnostic and therapeutic radiopharmaceuticals.
- Describe the technique and advantages of the routinely used functional imaging agents like 111In-Octreotide, 123 I-MIBG and 18F-FDG-PET.
- Highlight the role of newer agents (68)Ga-DOTA-TOC, (68)Ga-DOTA-NOC, (18)F-FDOPA and (11)C-5HTP (hydroxy tryptophan). The following neuroendocrine tumors are presented with illustration. Insulinoma, Zollinger Ellison syndrome, Vipoma, Gastrinoma, Medullary cancer of thyroid, Neuroblastoma, Pheochromocytoma, Extra-adrenal paraganglioma, Carinoid tumor, Neuroendocrine tumor of the cervix, Neuroendocrine tumor of the lung.

#### SUMMARY

The above exhibit with illustrations will help the viewers to better understand the role of functional imaging in neuroendocrine tumors and help in the selection of appropriate study and aid in patient management.

### Practical Overview of PET/MR Technology: Instruments, Quality Control, Clinical Workflow and Imaging Protocols

[Back to Top](#)

#### CL-NME3057

**Kimberly Jackson**  
**Kent P Friedman**, MD

#### PURPOSE/AIM

The purpose of this exhibit is to provide a practical overview of PET/MR technology for practicing physicians, technologists and physicists and to review quality control, clinical workflow and imaging protocols as implemented at a large university research center.

#### CONTENT ORGANIZATION

A. Overview of the three main PET/MR scanner designs B. PET/MR scanner quality control (daily, weekly, quarterly) C. Technologist workflow in the PET/MR suite D. Radiation Safety and MR safety E. Imaging protocols F. PET/CT versus PET/MR; operational considerations G. PET/MR artifacts and how to minimize their impact

#### SUMMARY

PET/MR is a powerful new hybrid modality that is expected to significantly advance patient care. This exhibit provides a practical overview of PET/MR for imaging centers considering adoption of this technology.

### Cardiac Sympathetic Denervation - Diagnosis and Differentials Based on Radioactive Iodine-123 MIBG Scintigraphy

[Back to Top](#)

#### CL-NME3058

**Lucy V Childs**, MBCh, MRCP  
**Hannah Du Preez**, MBCh  
**Hikmat Jan**, MD, MBChB  
**Anshul Rastogi**, MBBS, FRCR \*

#### PURPOSE/AIM

To explain the uses of the functional imaging modality 'Iodine 123-metaiodobenzylguanidine (MIBG)' for evaluation of cardiac sympathetic denervation. Explain how I-123 MIBG can be used to differentiate between Parkinson's disease and Parkinsonism, amongst other diagnoses. Explain how I-123 MIBG can be used to identify patients at risk of ventricular arrhythmias, and therefore patients most suitable for implantable cardiac defibrillators.

#### CONTENT ORGANIZATION

#### SUMMARY

### The Utilisation of Dacryoscintigraphy in the Management of Epiphora due to Lacrimal Obstruction: A Pictorial Review

[Back to Top](#)

#### CL-NME3059

**Shao J Ong**, MBBS, PhD  
**Jason Z Ho**, BSC, MBBS  
**Ewa Nowosinska**, MBBS, MRCP  
**John R Buscombe**, MD  
**Heok Cheow**, MBCh, MSc

#### PURPOSE/AIM

Dacryoscintigraphy (DSG) is a functional imaging modality for investigating epiphora. We present a pictorial review of commonly encountered pathology in DSG, and outline the technique, potential pitfall and radiation burden to the patient.

#### CONTENT ORGANIZATION

The identification of the site of obstruction in epiphora can significantly increase the chance of successful treatment. There are multiple techniques that can be used to localise the site of obstruction; some based on direct visualisation such as dye, probe and syringing, while others are imaging based such as macro-, CT-, MR- dacryocystography. DSG is an under utilised imaging modality which can assess the functional aspect of the lacrimal system while other modalities which are predominantly anatomical based are unable to do so. It has been reported to have a better agreement between clinical evaluation and DSG than dacryocystography for lacrimal obstruction.

#### SUMMARY

DSG is a safe, effective, functional imaging modality that should be considered in the early part in the paradigm in epiphora investigation and it should also be considered if other modalities have failed to identify the underlying cause.

### Individualized Planning in Radionuclide Therapy of Neuroendocrine Tumors Using Lu-177: How and Why to Do?

[Back to Top](#)

#### CL-NME3060

**Tadeu T Kubo**, MSc  
**Silvia M Oliveira**  
**Marcelo Mamede**

#### PURPOSE/AIM

To review imaging quantification methods (2D and 3D) important in neuroendocrine radionuclide therapy, type of acquisition protocol, softwares that can aided quantification and clinical relevance.

#### CONTENT ORGANIZATION

A. Neuroendocrine tumor B. Radionuclide therapy C. Diagnostic Imaging (Planar, SPECT and PET/CT) D. Acquisition protocol (MIRD 16 and MIRD 23) E. Image quantification software available (open source and paid) F. Merging all data (Workflow) G. Outcomes (include complications)

#### SUMMARY

Individualized planning in radionuclide therapy is necessary due to the wide variability between patients metabolic behavior. This exhibits reviews:

- a. the types of neuroendocrine tumor
- b. the radionuclide available for treatment (tumor size)
- c. the planar, SPECT and PET methods useful for imaging acquisition

- d. the protocol suggested by MIRD 16 and MIRD 23 and how to use the software
- e. the outcomes provide by image quantification to be used in worksheet or paid software

## SPECT Quantification of Lung Shunting Leads to Dose Optimization in Radioembolization

[Back to Top](#)

### CL-NME3061

**Cicero Matthew Habito** , MD  
**Georges El Fakhri** , PhD  
**Jonathan S Adams** , BS, ARRT  
**Edwin L Palmer** , MD

#### PURPOSE/AIM

Discuss a reproducible approach to SPECT quantification of hepatopulmonary shunting, and its value for dose optimization in radioembolization.

#### CONTENT ORGANIZATION

Current standards in nuclear imaging prior to radioembolization

- Limitations of planar imaging
- Rationale for SPECT quantification

Approach to SPECT quantification of pulmonary shunting

- Image acquisition protocol
- Potential pitfalls
- Measurement and outlining of regions of interest

Clinical value of SPECT quantification of pulmonary shunting

#### SUMMARY

The major teaching points of this exhibit are: 1. Lung shunt fractions can be grossly overestimated using planar imaging prior to Y90 radioembolization. 2. With a reproducible approach, SPECT imaging can be utilized for more reliable assessment when lung shunt fractions are significantly elevated. 3. Used clinically prior to radioembolization, SPECT quantification eliminates unnecessary dose reductions due to falsely elevated lung shunt fractions.

## Added Value of SPECT/CT in the Evaluation of Benign Bone Disease

[Back to Top](#)

### CL-NME4123

**Gad Abikhzer** , MD  
**Srouf F Saher** , MD  
**Zohar Keidar** , MD, PhD  
**Rachel Bar-Shalom** , MD  
**Olga Kagna** , MD  
**Ora Israel** , MD  
**Daniela Militianu** , MD

#### PURPOSE/AIM

Bone scintigraphy is a sensitive method to detect altered bone mineralization. Its limited specificity has dramatically improved with the advent of SPECT/CT. A spectrum of bone scan cases performed on a hybrid 16-slice SPECT/CT device demonstrates the added value of skeletal hybrid imaging in the evaluation of benign bone disease.

#### CONTENT ORGANIZATION

Interesting cases will be presented, including whole body bone scan and selected SPECT/CT images of the region of interest. Findings will be described on bone scan and on the CT images. Cases will include benign bone tumors, fractures, degenerative disease, congenital bone disease and variants, bone infarcts and additional rare bone conditions. Key differential diagnostic points will be highlighted in the discussion of each case, with emphasis on the role of CT in narrowing the differential diagnosis.

#### SUMMARY

Bone scintigraphy with SPECT/CT is of great value in the evaluation of benign bone disease. By reviewing these cases, the viewer will be able to improve the knowledge related to the clinical presentation of these entities, some of them rare, and to recognize them based on bone scan and CT imaging patterns.

## DaTscan: Parkinsonism versus Essential Tremor When Clinical Presentation Is Nonspecific

[Back to Top](#)

### CL-NME4124

**Britton J Carter** , MD  
**Brent D Griffith** , MD  
**Xiaoni Hong** , MD

#### PURPOSE/AIM

Parkinson's disease (PD) can be a diagnostic challenge clinically, especially in patients with mild or ambiguous symptoms. Imaging of the dopamine transporter with DaTscan has been shown to be useful in differentiating PD and essential tremor (ET). The purpose of this exhibit is to discuss the utility of DaTscan in differentiating these entities, as well as the underlying physiology and technique for imaging patients.

#### CONTENT ORGANIZATION

1. Discuss the molecular basis of Parkinsonism, and the use of [123I]-FP-CIT binding to dopamine receptors in differentiating Parkinsonism from essential tremor.
2. Describe DaTscan performance, including patient preparation, imaging protocol, visual interpretation/grading of images, and potential side effects.
3. Provide case-based examples from our institution discussing patients' clinical presentations and the resulting impact of DaTscan on patient management.

#### SUMMARY

Differentiating Parkinsonism from entities such as essential tremor has important implications for patient management, especially when the clinical presentation is atypical or treatment is deemed ineffective. DaTscan has become an important diagnostic tool for effectively managing these patients. The proposed exhibit will provide radiologists with an understanding of this modality, including its physiologic basis, imaging findings, and technique.

## Retooling Nuclear Medicine Education in Diagnostic Radiology: Interactive Strategies Using Audience Response System Technology to Prepare for the ABR Core Examination

[Back to Top](#)

### CL-NME4125

**M. Elizabeth Oates** , MD  
**Michael A Brooks** , MD

#### PURPOSE/AIM

Audience response system (ARS) technology has been used successfully in many health-related educational settings, including radiology residencies. ARS can provide an interactive experience for learning nuclear medicine (NM) in preparation for the new image-rich, computer-based ABR Core Examination.

#### CONTENT ORGANIZATION

Mimicking the ABR Core Examination in NM, a one-hour case conference can be organized around the 10 clinical organ system domains (breast, cardiac, gastrointestinal, musculoskeletal, neuro, pediatrics, reproductive/endocrine, thoracic, urinary, vascular) and the two non-clinical domains of nuclear physics and radioisotope safety (RISE). This exhibit will present illustrative examples of each, showcasing how ARS can be integrated as a self-assessment tool to facilitate active participation, thereby engaging the residents to draw on their knowledge, apply their observational, analytical and synthetic skills, develop a differential diagnosis, and determine appropriate patient management.

#### SUMMARY

ARS can augment traditional methods by injecting interactivity and offering immediate feedback for self-assessment on the part of the learner and adaptive instruction on the part of the faculty. This educational strategy can help prepare residents for the new image-rich, computer-based ABR Core Examination in NM.

### A Practical Guide to I-131 Therapy: What Every Radiologist Should Know

[Back to Top](#)

#### CL-NME4126

**Abigail V Berniker**, MD  
**Oleg Teytelboym**, MD

#### PURPOSE/AIM

This exhibit aims to:

- Review the biophysical properties and clinical indications of radioiodine (I-131) therapy
- Provide a practical approach to I-131 dose selection for the treatment of hyperthyroidism and thyroid carcinoma
- Discuss I-131 radiation safety
- Provide examples of simplified dose-dependent I-131 patient instructions adapted from the most recent Nuclear Regulatory Commission and American Thyroid Association guidelines

#### CONTENT ORGANIZATION

- Overview/purpose
- I-131 drug information and radiation physics
- Clinical indications for I-131 therapy: hyperthyroidism and thyroid carcinoma
- I-131 dose selection: review of current guidelines with emphasis on a practical approach for everyday use
- I-131 radiation safety: information for health care providers, implications on patient management and review of current guidelines
- Dose-dependent I-131 patient instructions: examples of patient handouts derived from current guidelines
- Summary/future directions

#### SUMMARY

I-131 plays an important role in the management of patients with hyperthyroidism and thyroid carcinoma. The administration of I-131 requires a multidisciplinary team, including radiologists, endocrinologists, surgeons and radiation safety officers. Understanding radiation safety and I-131 dose selection guidelines minimizes patient inconvenience and improves overall patient care.

### IgG4-related Disease (IgG4-RD) with Whole Body FDG-PET/CT: Image Characteristics and How to Differentiate from Other Diseases

[Back to Top](#)

#### CL-NME4127

**Satoshi Yabusaki**, MD  
**Noriko Oyama-Manabe**, MD, PhD  
**Osamu Manabe**  
**Kenji Hirata**  
**Naoya Hattori**, MD, PhD  
**Nagara Tamaki**, MD  
**Kohsuke Kudo**, MD  
**Hiroki Shirato**, MD, PhD

#### PURPOSE/AIM

The purpose of this presentation is to review image characteristics and distributions of IgG4-RD lesions with FDG-PET/CT.

#### CONTENT ORGANIZATION

Thirty-two cases diagnosed as IgG4-RD before starting steroid therapy were included in this study. Total 384 sites including 12 organs (eg: pancreas, biliary system) were evaluated for FDG-uptake.

#### 1. Incidence and distributions of IgG4-RD

Thirty patients (94%) showed more than 2 organ involvements. The most common sites were lymph nodes (88%) and salivary glands (81%). High FDG-uptake in rare lesions such as pituitary gland and pericardium were observed.

#### 2. Pitfalls mimicking tumors of IgG4-RD

Autoimmune pancreatitis (AIP) could form a mass similar to a pancreatic cancer (PC). SUV max do not differ significantly between AIP and PC. However, the extra-pancreatic involvement was seen in all AIP cases and was a key finding for AIP. Other lesions (eg: prostate, pituitary gland) in IgG4-RD could form a mass with high FDG-uptake. We have reviewed the differences in FDG-uptake between IgG4-RD and malignancies.

#### 3. Fatal complications

Aortic and pericardial involvements have a risk of fatal outcome.

#### 4. How to use the reformatted images for the correct diagnosis

#### SUMMARY

IgG4-RD sometimes forms a mass and mimics malignancies. To know the common site and findings is useful for diagnosis of IgG4-RD.

### Managing Sugar: The Sweet Problem in Diabetics Undergoing FDG PET/CT

[Back to Top](#)

#### CL-NME4128

**Amol Takalkar**, MBBS \*  
**Scott C Adams**, MD  
**Stephen Lokitz**, PhD  
**Melissa Andrews**  
**Debra Diebold**

#### PURPOSE/AIM

1. To review and discuss the influence of blood glucose level (BSL) and insulin on FDG biodistribution in FDG PET/CT imaging and understand its impact on the quality of FDG PET/CT scans. 2. To explain the utility of short-acting intravenous insulin administration in patients with high BSL undergoing FDG PET/CT imaging.

#### CONTENT ORGANIZATION

1. Impact of BSL and insulin on FDG biodistribution with sample cases
2. Standard patient preparation for FDG PET/CT Imaging



3. Method to manage high BSL in diabetic patients with sample cases

#### SUMMARY

Small dose of short acting human insulin administered intravenously and waiting an appropriate amount of time before proceeding with FDG administration is an effective way to manage high BSL in diabetic patients allowing them to be scanned the same day without being rescheduled and without affecting FDG biodistribution/image quality.

### Radionuclide Mandibular Bone Graft Viability Assessment - An Additional Valuable New Indication to the Most Commonly Used Old Study

[Back to Top](#)

#### CL-NME4129

**Erik D Weiss**, MD  
**Anson L Thaggard**, MD  
**Vani Vijayakumar**, MD

#### PURPOSE/AIM

We demonstrate the role of three-phase bone scintigraphy with SPECT in the evaluation of mandibular bone graft viability.

#### CONTENT ORGANIZATION

In the surgical management of mandibular defects secondary to trauma, infection, or tumor resection, both nonvascularized and vascularized bone grafts have been used to improve both mechanical and aesthetic outcomes. However, discontinuity between graft and native bone produces limitations. Incorporation of any bone graft requires both blood supply and viable osteoblasts. Clinical methods, color Doppler sonography, and angiography have been used with some success to assess graft viability. We will present: 1. Technique: Mandibular reconstruction with bone graft

2. Reasons for graft failure

3. Imaging protocol: 3-phase planar and delayed SPECT

4. Imaging findings: Uptake patterns and scoring system

5. Case examples: Viable and nonviable grafts. Figure: Failed right mandibular bone graft

#### SUMMARY

Three-phase scintigraphic planar and SPECT bone imaging performed within 10 days after mandibular reconstruction is a useful tool to predict graft viability and detect early complications of vascularized mandibular bone grafts. It is simple, useful, reproducible, and noninvasive additional tool of a common nuclear medicine study for precision assessment of bone graft viability.

### Back Pain but No Spondylolysis? What Else to Look for in SPECT/CT Exams of the Pediatric Lumbar Spine

[Back to Top](#)

#### CL-NME4130

**Andrew T Trout**, MD  
**Christopher G Anton**, MD  
**Michael J Gelfand**, MD \*  
**Susan E Sharp**, MD

#### PURPOSE/AIM

To familiarize the nuclear physician with causes of low back pain in children other than spondylolysis that may be identified by Tc99m methylene diphosphonate (MDP) SPECT/CT.

#### CONTENT ORGANIZATION

We will review the normal SPECT/CT appearance of the pediatric spine on Tc99m MDP imaging and will show examples of imaging findings of the spectrum of spondyloyses. We will then emphasize findings of alternative causes of low back pain that can be identified by Tc99m MDP SPECT/CT including: facet arthropathy, avulsion injuries, spinous process impingement, transitional vertebral anatomy, disk and endplate abnormalities, benign osseous lesions, etc. The scintigraphic and CT features of these entities will be discussed.

#### SUMMARY

SPECT/CT Tc99m MDP imaging is becoming a preferred modality for the assessment of low back pain in pediatric patients. Generally, these exams are performed to identify spondylolysis. There are, however, multiple other causes of low back pain that can be identified by SPECT/CT. This exhibit reviews some of the more common alternative causes of low back pain identified in pediatric patients.

### Common and Uncommon Causes of False-positive Lung Nodules on PET-CT: A Primer

[Back to Top](#)

#### CL-NME4131

**Darryl W Ramsewak**, MD  
**Kiran R Nandalur**, MD  
**Michael C Farah**, MD  
**Hai M Tien**, MD  
**Paul Grant**, DO

#### PURPOSE/AIM

1. To review basic FDG mechanism and distribution and calculation of standardized uptake value (SUV). 2. To explain the PET-CT protocol utilized at our institution for lung nodules, including dual-time point PET/CT. 3. To illustrate numerous common and uncommon causes of false-positive results, with emphasis placed on PET-CT images and correlating surgical pathology. 4. To identify and avoid pitfalls such as artifacts.

#### CONTENT ORGANIZATION

PET-CT and pathological findings in 50 consecutive patients with pathology proven benign lung nodules from the past 5 years from our institution will be presented, including: A) Inflammatory conditions such as sarcoidosis, amyloidosis, radiation fibrosis, and pneumoconiosis with combined massive fibrosis B) Infectious conditions such as tuberculoma, cryptococcosis, lipid pneumonia, pulmonary abscess, and histoplasmosis

#### SUMMARY

Accurate lung nodule evaluation for malignancy is critical for both prognosis and therapy planning. PET-CT is a robust modality in the evaluation of lung nodules. However, awareness of the mechanism of FDG uptake and various benign conditions which can demonstrate abnormal uptake, along with utilization of dual-time point PET-CT, which can potentially lead to a more specific diagnosis, is important for nuclear medicine physicians and radiologists and ultimately lead to better patient care.

### Fortuitous Detection of Additional Tumors at 18F-FDG PET/CT: Incidence, Tips for not Overlooking Their Presence, and Clinical Significance

[Back to Top](#)

#### CL-NME4132

**Daisuke Komoto**, MD  
**Chihiro Tani**, MD  
**Yoko Kaichi**  
**Yukiko Honda**, MD  
**Shuji Date**  
**Kazuo Awai**, MD \*

#### PURPOSE/AIM

1. Alert radiologists to additional tumors fortuitously detected at  $^{18}\text{F}$ -FDG PET/CT for known or suspected malignancies
2. Demonstrate the clinical significance of tumors fortuitously detected at  $^{18}\text{F}$ -FDG PET/CT

#### CONTENT ORGANIZATION

1. Frequency of the detection of unexpected tumors at  $^{18}\text{F}$ -FDG PET/CT
2. Presentation of cases with tumors fortuitously detected at  $^{18}\text{F}$ -FDG PET/CT
3. Tips for the detection of unexpected tumors at  $^{18}\text{F}$ -FDG PET/CT
4. Clinical significance of tumors fortuitously detected at  $^{18}\text{F}$ -FDG PET/CT
5. Value of delayed scanning for differentiating between pathologic and physiologic contrast uptake at  $^{18}\text{F}$ -FDG PET/CT

#### SUMMARY

Screening for malignant tumors or for evaluating therapeutic effects using  $^{18}\text{F}$ -FDG PET/CT frequently detects unexpected tumors. As the detection of secondary malignancies may require a change in the management of the known malignancy, their type and detection rate must be understood. We demonstrate the clinical significance of delayed scanning for the differentiation between the pathologic and physiologic contrast uptake at  $^{18}\text{F}$ -FDG PET/CT.

### Unexpected Distribution of Sentinel Lymph Nodes in Patients with Truncal Cutaneous Melanoma

[Back to Top](#)

#### CL-NME4133

**Mohammed Rashid Akhtar** , MBBS, BSc  
**Rohit Malliwal** , MBBS, BSc  
**Hannah Du Preez** , MBChB  
**Ashok Thalagavara** , MD, FRCP  
**Teresa Szyszko** , MSc, MRCS  
**Hikmat Jan** , MD, MBChB

#### PURPOSE/AIM

- The incidence of malignant melanoma in the US has increased 2000% since the 1930's and is increasing globally.
- Lymphoscintigraphy is now the standard of care for localisation of sentinel lymph nodes (SNL) in patients with a new or recurrent diagnosis of melanoma.
- Lymphoscintigraphy prior to surgical lymphnode resection allows for limited surgery with less extensive postoperative morbidity.
- There is great variation in lymphatic drainage in patients with malignant melanoma with recent studies demonstrating drainage to lymph nodes outside of expected nodal basins.

#### CONTENT ORGANIZATION

1. Define the technique of lymphoscintigraphy and the importance of whole body acquisition of imaging.
2. Diagrammatic and pictorial demonstration of normal lymphatic drainage in the body.
3. Demonstration of unusual distributions of SLN on lymphoscintigraphy outside of conventional nodal basins.

#### SUMMARY

By the end of the review, the viewer should:

- Understand the fundamental processes which underpin lymphoscintigraphy in the identification of interval nodes and SLN.
- Be familiar with the usual drainage patterns of cutaneous melanoma's e.g. cervical, axillary and inguinal.
- Have awareness that anatomically unexpected drainage patterns can occur and thereby whole body image acquisition is essential to not miss potential multiple sites of SLN.

### $^{18}\text{F}$ -FDG-PET Findings of Various Hematologic Diseases

[Back to Top](#)

#### CL-NME4134

**Kaneko You**  
**Hironori Nishibori** , MD  
**Hiroki Kato**  
**Takahiko Asano** , MD  
**Haruo Watanabe** , MD  
**Satoshi Goshima** , MD, PhD  
**Hiroshi Kondo** , MD  
**Hiroaki Hoshi** , MD  
**Masayuki Kanematsu** , MD

#### PURPOSE/AIM

The purpose of this exhibit is:

1. To review and discuss  $^{18}\text{F}$ -FDG-PET findings of various hematologic diseases.
2. To discuss disease conditions that can cause diffuse bone marrow uptake on  $^{18}\text{F}$ -FDG-PET.

#### CONTENT ORGANIZATION

- To review and discuss  $^{18}\text{F}$ -FDG-PET findings of various hematologic diseases, including acute/chronic myeloid/lymphoblastic leukemia, myelodysplastic syndrome, multiple myeloma, plasmacytoma, Waldenström's macroglobulinemia, myelofibrosis, essential thrombocythemia, and so forth.
- To discuss disease conditions of diffuse bone marrow uptake on  $^{18}\text{F}$ -FDG-PET

#### SUMMARY

The major teaching points of this exhibit are:

1. We present a variety of hematologic diseases exhibiting diffuse bone marrow or focal abnormal uptake on  $^{18}\text{F}$ -FDG-PET.
2. We suggest the usefulness of  $^{18}\text{F}$ -FDG-PET in pre-treatment tumor staging or post-treatment tumor response assessment for some hematologic diseases.
3. We also present diffuse bone marrow uptake with  $^{18}\text{F}$ -FDG-PET in various disease conditions other than hematologic diseases.

### Fatty Hypermetabolic Masses on FDG PET-CT: A Spectrum of Benign and Malignant Conditions

[Back to Top](#)

#### CL-NME4135

**Anil Chauhan** , MD  
**Hubert H Chuang** , MD, PhD  
**Sunil Jeph**  
**Eric M Rohren** , MD, PhD \*  
**Priya R Bhosale** , MD

#### PURPOSE/AIM

-To show imaging appearance of fatty masses on PET/CT

-To demonstrate diagnostic dilemma of hypermetabolic fatty masses on PET/CT and discuss approach to a differential diagnosis.

#### CONTENT ORGANIZATION

FDG PET-CT is usually performed in oncologic patients for staging and restaging after therapy of malignancies. Malignant masses such as liposarcomas can show hypermetabolic activity. However, benign fatty lesions such as hibernomas, and hepatic adenomas can also be hypermetabolic on PET-CT. Lipomatous hypertrophy of interatrial septum may show increased activity on PET-CT, and should not be mistaken for malignancy. Inflammatory conditions with fatty necrosis with omental infarcts, after surgery, or in the liver following radiation and radiofrequency ablation, can also have increased activity on PET-CT. We will discuss differential diagnosis along with diagnostic approach to hypermetabolic fatty masses on PET-CT, and exemplify them with imaging appearance. We will also discuss the role of additional imaging modalities in such lesions.

#### SUMMARY

Hypermetabolic fatty masses on PET-CT may create diagnostic dilemma on interpretation. The differential diagnosis is broad, but clinical history, anatomical location, knowledge of anatomical variants and imaging features can help radiologist to avoid misinterpretation of benign lesions as malignancy.

## Central Nervous System Nuclear Imaging: The Role in the Treatment and Diagnosis of Epilepsy, Neoplasm, Movement Disorders, and Alzheimer's Disease

[Back to Top](#)

### CL-NME4136

**Joseph P Whitlock**, MD  
**Joseph M Accurso**, MD  
**Julia Whitlock**, MD  
**Christopher M Coleman**, MD  
**Manoj K Jain**, MD

#### PURPOSE/AIM

Educational review of select nuclear imaging studies currently available for diagnosis of CNS abnormalities with imaging focus on normal and abnormal cases. Brief discussion of pathologies with concise review of study results for each individual test.

#### CONTENT ORGANIZATION

##### A. FDG PET in the evaluation of epilepsy and neoplasm.

###### Epilepsy

a. PET has increased sensitivity for detecting epileptic focus in comparison with MRI. EEG has inherent flaws in localization.

b. Does not require ictal state and can predict better surgical outcomes. *CNS neoplasm*

a. Primary neoplasm detection.

b. Alternative to MR spectroscopy in the evaluation of neoplasm vs. post treatment necrosis B. Dopamine transporter imaging in patients with movement disorders

a. Differentiation between non-parkinsonian and parkinsonian movement disorders

b. Imaging post treatment to monitor response. C. Amyloid imaging

a. Radiotracer uptake into amyloid plaques which are implicated in Alzheimer's disease.

b. High sensitivity in atypical clinical cases.

#### SUMMARY

The utilization of CNS nuclear imaging can improve surgical outcomes in epilepsy, increase confidence in differentiation of neoplasm and post treatment changes, and allow more confident diagnosis of Parkinson's and Alzheimer's diseases.

## VQ-SPECT: Breathing New Life into Pulmonary Embolus Imaging

[Back to Top](#)

### CL-NME4137

**Nicholas F Bassett**, MBBS  
**Samira Rostampour**, MBBS, BSc  
**Julia C Fowler**, MBBCh, FRCR

#### PURPOSE/AIM

To demonstrate the benefits of VQ-SPECT (ventilation/perfusion single photon emission computed tomography) imaging in the investigation of Pulmonary Embolism (PE) and how this technique can be successfully introduced into general radiology practice.

#### CONTENT ORGANIZATION

VQ-SPECT is a newly validated extension of the planar VQ method with equivalent sensitivity to CTPA and very low radiation exposure. It is particularly sensitive for demonstrating subsegmental PE which may be below the resolving capacity of CT. VQ-SPECT is easier to report than planar VQ and CTPA and has been taken up enthusiastically by radiologists and referring clinicians in our centre.

We will describe the introduction and use of a novel dual isotope imaging VQ-SPECT technique covering the following:

- 1) Equipment and tracer requirements with phantom validation
- 2) Image acquisition, processing, display and reporting
- 3) Examples of normal and abnormal findings
- 4) A review of relative advantages and disadvantages compared to planar VQ and CTPA in our centre
- 5) Training issues

#### SUMMARY

An overview of the methods and benefits used in VQ SPECT imaging and how such a service can be implemented in a general radiology department.

## What's My Line? Linear PET-CT Uptake in Small Blue Round Cell Tumors (SBRCT)

[Back to Top](#)

### CL-NME4138

**Shlomit Goldberg-Stein**, MD \*  
**Owen J O'Connor**, MBBCh  
**Renee Moadel**, MD  
**David Geller**, MD  
**Beverly A Thornhill**, MD  
**Michael A Blake**, MBBCh \*

#### PURPOSE/AIM

To demonstrate unusual linear perineural, leptomeningeal, thoracic ductal, intravascular, and rare hematogenous spread of SBRCT, as detected by PET-CT.

#### CONTENT ORGANIZATION

Linear local tumor extension and unusual hematogenous dissemination of SBRCT's is often either undetected or misinterpreted on PET alone, CT alone, and on PET combined with a non-diagnostic CT (PET-ACT), but may be more readily elucidated by PET combined with a diagnostic CT (PET-CT). Illustrative cases include:

1. Linear thoracic duct FDG uptake extending within the posterior mediastinum, due to lymphomatous involvement of the thoracic duct from colonic lymphoma
2. Ewing Sarcoma of the humerus with perineural extension along the radial nerve
3. Leptomeningeal spread of lymphoma with linear extension along exiting spinal nerves
4. Ewing Sarcoma of iliac bone invading IVC with linear upward extension mimicking hydronephrosis on PET-ACT
5. Symmetric adrenal gland FDG uptake in normal-appearing adrenals by CT appearance with thin linear limbs; with a history of cerebral lymphoma, uptake prompted CT-guided adrenal biopsy confirming involvement



## SUMMARY

1. PET-CT demonstrates otherwise occult or misinterpreted patterns of local tumor extension and distant tumor involvement of SBRCT. 2. Knowledge of these linear tumor spread patterns aids in optimal interpretation.

## Tangle between the Sheets: Deciphering the Role of Florbetapir F18 in $\beta$ -amyloid PET Imaging of Alzheimer's Dementia

[Back to Top](#)

### CL-NME4139

**Allen Prober**, MD  
**Salar Hakham**, DO  
**Michael Lanfranchi**, MD  
**Elaine Shiang**, MD  
**Nayer Nikpoor**, MD

#### PURPOSE/AIM

Deposition of  $\beta$ -amyloid has long been known to be associated with Alzheimer's disease (AD). Changing diagnostic methods and clinical trials of AD-therapeutics suggest an increased role of amyloid PET imaging. This exhibit will discuss Florbetapir F18, the first FDA-approved Flourine-18 PET radiotracer for use in imaging  $\beta$ -amyloid plaques.

#### CONTENT ORGANIZATION

1. Pathophysiology and clinical manifestations of AD and its spectrum. 2. Florbetapir F18 radiotracer history, dynamics, and a pictorial guide of amyloid PET manifestations. 3. Utility and impact on outcome, with review of latest studies and other radiotracers in development. 4. Appropriate use criteria for amyloid PET imaging. 5. Future trends and applications.

#### SUMMARY

Alzheimer's disease is a leading cause of death in the United States and the most common cause of dementia. By 2050, it is projected to afflict 16% of Americans 65 and older. Changing clinical and neuropathological diagnostic criteria, as well as trials for AD-therapeutics suggest an increased role of PET in diagnosis and treatment. Florbetapir F18 is the newest FDA-approved radiotracer for evaluating  $\beta$ -amyloid deposition, demonstrating high sensitivity, specificity, and accuracy. Amyloid PET imaging can guide workup of cognitive impairment and helps establish a framework upon which imaging and therapeutic advances can build.

## Another "Great Mimicker": FDG-PET/CT Imaging Findings of Sarcoid like Reaction

[Back to Top](#)

### CL-NME4140

**Ayse T Karagulle Kendi**, MD  
**Bruce J Barron**, MD \*  
**Dacian V Bonta**, MD, PhD  
**Raghuveer K Halkar**, MD \*  
**Bhawana Rathore**, MD  
**David M Schuster**, MD

#### PURPOSE/AIM

Sarcoid like reaction (SLR) is a cause of non-caseating granulomas in cancer patient with otherwise no signs or symptoms of sarcoidosis. SLR may also result in hypermetabolic activity in FDG PET/CT, resulting in false positive reporting for malignancy. The purpose of this exhibit is to expose residents/practicing physicians who interpret PET/CT to a series of cases illustrating findings of SLR.

#### CONTENT ORGANIZATION

A retrospective review of whole body FDG-PET/CT scans was performed from 2010-2013. The cases with findings suggestive for SLR were identified and chart review performed. The following examples will be presented in our exhibit: Head and neck: 1 tongue cancer patient - SLR of spleen and bone marrow. Breast: 3 breast cancer patients - SLR of mediastinal/hilar lymph nodes. Hematologic: 2 lymphoma patients - SLR of mediastinal/hilar lymph nodes and splenic lesions. Abdominal/pelvic: 1 colon cancer patient - SLR of mediastinal/hilar lymph nodes. Genitourinary: 1 bladder cancer patient - SLR of mediastinal/hilar lymph nodes and spleen.

#### SUMMARY

It is paramount to be aware of a variety of mimickers of cancer in FDG-PET/CT including SLR in order to avoid false positive interpretation resulting in unnecessary treatment and over-staging.

## Added Value of F18-FDG PET/CT Scan for the Diagnosis and Management of Intramedullary and Extramedullary Lesions Diagnosed with MRI

[Back to Top](#)

### CL-NME4141

**Carl Seynnaeve**, MD  
**Christopher T Taylor**, MD  
**James M Mountz**, MD, PhD  
**Badreddine Bencherif**, MD

#### PURPOSE/AIM

1.) Our purpose is to review and summarize the utility of F-18-FDG PET/CT imaging in helping to diagnose, guide, and/or follow treatment response of intramedullary, extramedullary intradural, and extradural lesions diagnosed on MRI. 2.) Describe the utility in F-18-FDG PET/CT imaging evaluating known spinal lesions in patients where further MRI imaging is suboptimal or contraindicated.

#### CONTENT ORGANIZATION

1.) Review commonly encountered spinal tumors and their typical appearance on MRI and F-18-FDG PET/CT imaging. 2.) Illustrate examples of how F-18-FDG PET/CT imaging help in securing the diagnosis of equivocal MRI spinal lesions, as well as determining treatment response of different spinal cord lesions. 3.) Provide examples of further characterization of spinal lesions with F-18-FDG PET/CT where MRI is suboptimal or contraindicated.

#### SUMMARY

1.) Intramedullary, extramedullary intradural, and extradural spinal masses are encountered on MRI imaging in everyday practice. 2.) F-18-FDG PET/CT imaging can provide essential information about spinal lesions to help guide clinical decision making and limit unnecessary further imaging in appropriate settings. 3.) F-18-FDG PET/CT imaging is useful in further evaluating spinal lesions where MRI imaging is contraindicated or suboptimal, including post-surgical patients with extensive hardware.

## Safety First! Radiation Safety Concerns and Regulations for Alpha Emitter Therapy

[Back to Top](#)

### CL-NME4142

**Fathima Fijula Palot Manzil**, MBBS  
**Michael T Azure**, PhD \*  
**Samuel E Almodovar-Regteguis**, MD  
**Padma Priya Manapragada**, MD  
**Pradeep G Bhambhani**, MD  
**Devaki Shilpa Surasi**, MD  
**Robert Heath**  
**Janis P O'Malley**, MD

#### PURPOSE/AIM

Alpha particle radioimmunotherapy is a rapidly emerging tool in the battle against cancer. High linear energy transfer (LET) increases effect but leads to serious health threats if internalized by staff or the public. AUs with infrequent unsealed source contact may underestimate contamination potential, and regular users must increase vigilance compared to routine agents. As most AUs and RSOs have little personal experience, many centers encounter roadblocks from their local or state regulators. Safety programs simply require frequent inspections and stringent precautions. This exhibit will outline a radiation safety program for alpha emitter therapy.

#### CONTENT ORGANIZATION

1. Discuss training requirements for AUs.
2. Describe practical safety precautions that may exceed suggestions from commercial vendors.
3. Evaluate safety practices for the patient (especially those unable to perform selfcare or sharing facilities) and their caregivers, including travel issues and hygiene measures.
4. Discuss issues with radiation licenses and local regulators.

#### SUMMARY

Alpha emitters require extreme safe handling to avoid accidental intake. Instituting ALARA principles are easy if a strong structured program is set up.

### Solitary Pulmonary Nodule: Narrowing the Differential and Guiding Patient Management with F18-FDG PET-CT

[Back to Top](#)

#### CL-NME4143

**Shana Elman**, MD  
**Irene W Cruite**, MD  
**Lorenzo Mannelli**, MD, PhD  
**Tina D Taylor**, MD  
**Sanaz Behnia**, MD  
**Hubert J Vesselle**, MD, PhD \*

#### PURPOSE/AIM

1. Review CT characteristics of solitary pulmonary nodules (SPNs)
2. Illustrate situations when F-18 FDG PET-CT could be used to improve accuracy of SPN diagnosis and guide patient management
3. Discuss potential false positives and false negatives in the evaluation of SPN with PET-CT

#### CONTENT ORGANIZATION

1. CT characteristics of SPNs
2. SPN diagnosis using PET-CT a. Typical characteristics of benign and malignant SPNs b. Integration of clinical history to improve diagnostic accuracy c. Potential false positives and negatives
3. Staging of malignant SPN using PET-CT a. Evaluating extent of malignant involvement b. "Hot" lymph nodes, normal by CT criteria c. Expected patterns of nodal FDG uptake in benign and malignant processes

#### SUMMARY

Integrated PET/CT is more sensitive and accurate for evaluating SPNs than PET or CT images alone. However, the FDG avidity of malignant and benign SPNs is variable. Therefore, an understanding of typical imaging findings, patterns of disease distribution, and expected course of disease are important. These findings should be interpreted in conjunction with other available correlative imaging and clinical information to establish accurate diagnoses and effectively guide patient management.

### Radionuclide Shuntogram to Evaluate for CNS Shunt Malfunction: Standard Technique and Problem-solving Strategy for Challenging Cases

[Back to Top](#)

#### CL-NME4144

**Shana Elman**, MD  
**Arnold Kang**, MD  
**Lorenzo Mannelli**, MD, PhD  
**Irene W Cruite**, MD  
**Sanaz Behnia**, MD  
**Hubert J Vesselle**, MD, PhD \*

#### PURPOSE/AIM

1. Review standard shuntogram technique to evaluate for CNS shunt malfunction
2. Review normal and abnormal shuntogram findings
3. Illustrate problem-solving techniques to be considered in difficult cases

#### CONTENT ORGANIZATION

- A. Brief review of types of CSF diversionary shunts and complications
- B. Standard shuntogram technique
- C. Problem-solving strategies
- D. Interpretation of findings a. Typical patterns suggestive of normal shunt flow, proximal limb obstruction, distal limb obstruction, overshunting, and position-dependent flow b. Case examples with correlative imaging and outcomes

#### SUMMARY

The shuntogram is a simple, effective, and low radiation-dose method to evaluate the flow characteristics of a CSF shunt. Problems such as ventricular catheter obstruction, incorrect valve settings, and distal catheter obstruction can be detected, guiding the neurosurgeon in how to proceed with patient management. Correlation of shuntogram findings with correlative imaging can further distinguish causes for shunt malfunction, such as catheter kinking or disconnection, overshunting, CSF pseudocyst, or malpositioning of shunt catheter in the ventricle, atrium, or peritoneal cavity.

### FDG PET/CT Utility in Genitourinary Malignancies: A Comprehensive Review

[Back to Top](#)

#### CL-NME4145

**Bital Savir-Baruch**, MD  
**Jaime L Montilla-Soler**,  
**Nicholas A Plaxton**, MD  
**Eric Jablonowski**  
**Hamilton E Reavey**, MD  
**Adina L Alazraki**, MD  
**Bruce J Barron**, MD \*

#### PURPOSE/AIM

1. Review of the main clinical features of the genitourinary (GNU) cancers including the kidney, prostate, bladder, testes, and penis.
2. Demonstrating the role of FDG PET/CT in staging, treatment planning, and surveillance of these malignancies.
3. Correlate anatomical illustrations with conventional imaging of GNU malignancies.

#### CONTENT ORGANIZATION

The American Cancer Society estimates 385,800 new cases of GNU malignancies will be diagnosed by the end of 2013 and 59,290 will die from it. Nuclear medicine (NM) has important role in the clinical workout of these malignancies. Our objective was to review and demonstrate the characteristic FDG patterns associated with the male GNU neoplasms. Over the years we collected strong key representative FDG/PET images demonstrating the importance of NM in the diagnosis and treatment plan of these malignancies, in addition to pitfalls. Understanding the key findings in male GNU lesions is crucial to allow a proper diagnosis, staging, treatment, and surveillance. Additional rare metastatic lesions and the use of other imaging modalities will be described.

#### SUMMARY

At the end of this presentation the reviewer will be asked to identify the anatomic landmark, pathological findings, staging, rare clinical features, and other nuclear medicine modalities of each cancer presented.

**CL-NME4146**

**Sriram Vaidyanathan** , MBBS, MRCS  
**Kamna Mehta** , MBBS  
**Ki Yap** , MBBCh, BMedSc  
**Fahmid Chowdhury** , MBBS, FRCR  
**Chirag Patel** , FRCR  
**Andrew F Scarsbrook** , FRCR

## PURPOSE/AIM

- 1) To review the role of FDG PET-CT in suspected infection and inflammation.
- 2) To illustrate the spectrum of conditions in which PET-CT may help guide patient management.

## CONTENT ORGANIZATION

1. Introduction
2. Suspected Infection - Established Indications (Evaluation of fever of unknown origin; suspected bone or vertebral osteomyelitis; vascular graft infection; evaluation of infection in polycystic disease; differentiation of infection (toxoplasmosis) from lymphoma in the immuno-compromised)
3. Inflammatory Diseases - Established Indications (Vasculitis; Sarcoidosis; Inflammatory bowel disease; IgG4 related systemic disease)
4. Evolving Applications (Diagnostic work-up of high-risk patients with gram-positive bacteraemia; suspected prosthetic joint infection; location of infections in AIDS patients; assessment of the diabetic foot)
5. Limitations of FDG PET-CT
6. Novel Tracers (68Gallium-Citrate; FDG labeled white blood cells)

## SUMMARY

FDG PET-CT is rapidly evolving as a valuable adjunct in selected patients with suspected infection or inflammation. The technique often has a complementary role when there is clinical uncertainty or equivocal findings on other imaging techniques. There are a range of potential clinical applications emerging and PET-CT using novel tracers offers the promise of highly accurate "one-stop" imaging in the future.

**Prostate Cancer: PET/CT with 18 F-Choline****CL-NME4147**

**Manuel Recio Rodriguez**  
**Antonio Maldonado** , MD  
**Silvia Fuertes**  
**Vicente Martinez de Vega**  
**Raquel Cano Alonso**  
**Mar Jimenez De La Pena**

## PURPOSE/AIM

The aim of this exhibit is to:

- Describe basic concepts of 18 F-Choline regarding molecular biology and biodistribution.
- Establish a PET/CT protocol with a first early static pelvic acquisition and a delayed static acquisition.
- Review the role of PET/CT with 18 F-Choline in primary staging and restaging of prostate cancer patients.

## CONTENT ORGANIZATION

The goal of current prostate cancer care is to administer risk-adjusted patient-specific treatment . We review 18 F-Choline PET/CT imaging of prostate cancer analyzing:

- Molecular biology correlates of tumor choline uptake.
- PET/CT protocol.
- Staging: Primary Tumor, lymph node metastases and bone metastases.
- Therapeutic management
- Biochemical failure and restaging.

## SUMMARY

18F Choline PET/TAC can be useful in guiding biopsy for the assessment of primary prostate cancer; however, it cannot accurately differentiate BPH or chronic prostatitis from cancerous prostate lesions by means of SUV. It is useful in the evaluation of patients with prostate cancer who are at high risk for extracapsular. disease, and it could be used to preoperatively exclude distant metastases. It could led to a change in therapy of the patients, especially in high risk patients and may have a role in the management of men with biochemical recurrence of prostate cancer and restaging.

**POEMS Syndrome: A Case-based Guide with Multimodality Imaging and Pathologic Correlation****CL-NME4148**

**Andrew B Crush** , MD  
**Benjamin M Howe** , MD  
**Christopher H Hunt** , MD  
**Geoffrey B Johnson** , MD, PhD  
**Robert C Murphy** , MD, PhD  
**Robert F Morreale**  
**Patrick J Peller** , MD \*

## PURPOSE/AIM

- 1) To review the heterogeneous clinical manifestations of POEMS syndrome; 2) To discuss the varied multimodality imaging patterns of POEMS syndrome; 3) To emphasize the unique utility of PET/CT to both detect the extent of skeletal lesions as well as to define the degree of metabolically active disease.

## CONTENT ORGANIZATION

- I. Clinical manifestations of POEMS syndrome
- II. Case-based review of the imaging manifestations of the disease
  - a. Common imaging patterns
  - b. Challenging imaging patterns with uncommon appearances, including extramedullary disease
  - c. Correlation with multimodality imaging and pathology
- III. The implications of the anatomic and functional information provided by PET/CT for optimizing management of this complex patient population

## SUMMARY

POEMS syndrome is characterized by a polyneuropathy and monoclonal gammopathy yet otherwise demonstrates heterogeneous clinical manifestations. Evaluation of these patients with imaging, therefore, is critical in both their diagnosis and follow up. Given the rarity as well as the diverse imaging manifestations of this condition, knowledge of the multimodality appearances of POEMS syndrome, including a firm awareness of the advantages of PET/CT, is essential to optimize the care of these complex patients.

**CL-NME4149**

**Ankit Agarwal** , BS  
**Erica L Martin-Macintosh** , MD  
**Alin Chirindel** , MD  
**Pat W Whitworth** , BS  
**Jennifer Xiao**  
**Patrick J Peller** , MD \*  
**Rathan M Subramaniam** , MD, PhD \*

## PURPOSE/AIM

1. To discuss the use and limitations of conventional radiography in multiple myeloma (MM)
2. To review the value of FDG PET/CT and MRI in the diagnosis and staging of MM
3. To review the pitfalls of FDG PET/CT and MRI in the management of MM.

## CONTENT ORGANIZATION

1. Review of definition, genetics, and presentation of MM
2. Overview of benefits and shortcomings of conventional radiography in MM
3. Review of current evidence and case based illustration regarding use of FDG PET/CT and MRI in MM
  - a. Correlation with clinical features and histopathology
  - b. Role in diagnosis, staging, and prognosis
  - c. Influence on intended management and evaluation of response to therapy
  - d. Pitfalls

## SUMMARY

Despite serious shortcomings, radiography remains the reference standard for imaging of MM. We demonstrate through cases and a review of current evidence how PET/CT and MRI can more consistently identify precursor lesions from myeloma lesions, malignant lesions at diagnosis, provide a more precise prognosis, result in significant changes in intended management, and more accurately assess therapeutic efficacy, for chemo therapy and bone marrow transplant. We emphasize the potential impact on clinical decision making and patient outcomes of incorporating PET/CT and MRI into restaging and evaluation of response to therapy.

**Understanding the Role of Vascular Mapping and 99mTc MAA Hepatic Perfusion Scintigraphy prior to Hepatic Radioembolization-Keys to Study Interpretation**[Back to Top](#)**CL-NME4150**

**Livnat Uliel** , MD, MSc  
**Henry D Royal** , MD  
**Darryl A Zuckerman** , MD

## PURPOSE/AIM

1. Discuss the aims of the endovascular procedure and the 99mTc-MAA hepatic perfusion scintigraphy
2. Review the normal and variant hepatic arterial anatomy relevant for hepatic radioembolization
3. Present an approach to analyze the angiographic findings and the 99mTc-MAA hepatic perfusion SPECT-CT imaging to clinically oriented interpretation
4. Illustrate the variety of findings and potential pitfalls the reader may encounter

## CONTENT ORGANIZATION

1. Introduction
2. Normal and variant anatomy of the hepatic arterial vasculature
3. Description of the technique of the 99mTc MAA hepatic perfusion scintigraphy
4. Illustrative cases of the spectrum of findings on angiography and on the associated 99mTc MAA hepatic perfusion; excessive lung shunting, extrahepatic perfusion to nontargeted organs and unexpected 99mTc MAA distribution
5. Illustrative cases of imaging and postprocessing pitfalls; free 99mTc-pertechnetate, concurrent administration of 90-Yttrium-microspheres and 99mTc-MAA

## SUMMARY

By the conclusion of the presentation the viewer will; 1. Gain an approach to interpret the study 2. Identify the variety of findings on 99mTc MAA hepatic perfusion scintigraphy, including findings that necessitate exclusion from therapy or further intervention to prevent complications 3. Identify pitfalls encountered on 99mTc MAA hepatic perfusion scintigraphy

**Clinical Value of FDG PET/CT in Patients with IgG4-related Disease**[Back to Top](#)**CL-NME4151**

**Yuka Yamamoto** , MD, PhD  
**Yoshihiro Nishiyama** , MD

## PURPOSE/AIM

IgG4-related disease is a systemic disease characterized by extensive IgG4-positive plasma cell infiltrations of various organs. We describe the clinical value of FDG PET/CT in patients with IgG4-related disease.

## CONTENT ORGANIZATION

FDG PET/CT imaging in patients with IgG4-related disease

- Autoimmune pancreatitis
- Sclerosing cholangitis
- Sclerosing sialadenitis
- Retroperitoneal fibrosis
- Prostatitis
- Hypertrophic pachymeningitis
- Follow-up FDG PET/CT imaging after therapy
- Comparing the uptake of C-11 methionine (MET) and FDG

## SUMMARY

The major teaching points of this exhibit are:

1. FDG PET is useful for detecting IgG4-related disease.
2. Follow-up FDG PET/CT is helpful for monitoring therapeutic assessment.
3. MET is more sensitive than FDG for detecting cranial lesions.

**Simultaneous [18F] FDG PET/MR in Patients with Head and Neck Cancer: Clinical Application and Pitfalls**[Back to Top](#)**CL-NME4152**

**Eun Kyoung Lee** , MD  
**Ji-Hoon Kim** , MD  
**Gi Jeong Cheon**  
**Chul-Ho Sohn** , MD  
**Seung Hong Choi** , MD, PhD  
**Tae Jin Yun** , MD  
**Inseon Ryoo** , MD  
**Jisang Park** , MD

## Koung Mi Kang

### PURPOSE/AIM

1. To demonstrate the feasibility and indication of simultaneous [18F] FDG PET/MR in evaluation of patients with head and neck cancer
2. To present various concordant and discordant cases between PET and MR
3. To describe the merits and challenges of simultaneous PET/MR in head and neck cancer

### CONTENT ORGANIZATION

1. Protocol description for head and neck MR integrated with whole body PET/MRI
2. Utilities of simultaneous PET/MR in characterization of various head and neck tumor, staging head and neck cancer, evaluation of tumor recurrence, response evaluation of chemoradiotherapy and work-up for metastasis of unknown origin
3. Descriptions of various concordant and discordant cases between PET and MR along with their final outcome
4. Technical and interpretation pitfalls of simultaneous PET/MR in patients with head and neck cancer

### SUMMARY

Simultaneous PET/MR is a novel and feasible imaging modality for evaluation of head and neck cancer. Knowledge of its various clinical application and pitfalls may help to better interpret patients with head and neck cancer.

## FDG PET for Detecting Malignancies Complicating Chronic Disease

[Back to Top](#)

### CL-NME4153

**Yoshihiro Nishiyama**, MD  
**Yuka Yamamoto**, MD, PhD

### PURPOSE/AIM

FDG PET is a well-established functional imaging technique for diagnostic oncologic imaging that provides information about glucose metabolism in lesions. Association between some chronic diseases and malignancy are well recognized. The purpose of this exhibit is to review FDG PET imaging for detecting such associated malignancies.

### CONTENT ORGANIZATION

FDG PET imaging for detecting an associated malignancy

- Esophageal cancer complicating achalasia
- Renal cell carcinoma complicating chronic renal failure
- Small bowel cancer complicating Sjögren's syndrome
- Malignant lymphoma complicating Sjögren's syndrome
- Malignant lymphoma complicating Hashimoto's thyroiditis
- Colon cancer complicating polymyositis
- Biliary tract carcinoma complicating congenital biliary dilatation
- Sarcoma complicating neurofibromatosis

### SUMMARY

The major teaching point of this exhibit is:  
FDG PET is useful for detecting malignancies complicating chronic disease.

## Hot or Not? Benign Diseases That Are Metabolically Active and Malignant Diseases That Are Not. A Radiology/Pathology Compendium

[Back to Top](#)

### CL-NME4154

**Jessica Hung**, MD  
**Clayton R Taylor**, BS  
**Wei Chen**, MD  
**Kristin M Dittmar**, MD

### PURPOSE/AIM

Fluorodeoxyglucose-18 (FDG) imaging with computed tomography (CT) provides anatomic and functional/ metabolic information in the evaluation for malignancy. FDG avid lesions are commonly referred for tissue sampling in order to diagnosis, stage or evaluate for recurrence of cancer. Although useful in identifying metabolically active lesions, it is important to keep in mind that not all FDG avid lesions represent cancer. Additionally, many cancers are not metabolically active. This radiologic/ pathologic compendium of cases highlights the importance of keeping a range of differential diagnoses when evaluating metabolically active pathologies.

### CONTENT ORGANIZATION

Representative cases of FDG avid lesions on FDG CT imaging of benign etiologies are presented as a review of the alternative diagnosis of FDG avid lesions. Categories of benign etiologies include infection, inflammation, autoimmune disease, active granulomatous disease, interstitial lung disease and other benign lesions such as, adenomas. Finally, cases of malignancies that are not FDG avid are also reviewed with corresponding pathology.

### SUMMARY

This educational exhibit demonstrates pathology proven cases of false positive and false negative findings on FDG CT imaging through an image rich, case based review to emphasize the complex role FDG avidity plays in the decision to biopsy these lesions.

## PERCIST 1.0 Pitfalls

[Back to Top](#)

### CL-NME4155

**Joo Hyun O**, MD  
**Martin A Lodge**, PhD  
**Richard L Wahl**, MD \*

### PURPOSE/AIM

PET response criteria in solid tumors (PERCIST) 1.0 can be used for objective assessment of tumor metabolic response with 18F-FDG PET. Issues that need clarification for the current version of PERCIST 1.0 are explored.

### CONTENT ORGANIZATION

PERCIST 1.0 does not address what the reader should do for numerous challenging situations. The following issues require further clarification: 1) when the image acquisition conditions are not met; 2) when the tumor lesion is below the suggested minimum threshold for evaluation; 3) how to compute and utilize total lesion glycolysis (TLG) 4) how to objectively define complete metabolic response; 5) whether to use the same absolute and percentage thresholds for response or progression at different time points following therapy; and 6) how to interpret cases with simultaneous mixed response and progression.

### SUMMARY

Future studies directed for input and validation of quantified response using 18F-FDG PET should address the current limitations of PERCIST 1.0.

## Value of F18 FDG PET/CT in a Variety of Cardiovascular Lesions: Collaborative Interpretation with Other Imaging Modalities

[Back to Top](#)

### CL-NME4156

**Hongju Son**, MD  
**Susan K Hobbs**, MD, PhD



PURPOSE/AIM

FDG-avid cardiovascular lesions may represent either benign or malignant processes. We present a variety of cardiovascular uptake seen on PET/CT imaging, correlating with other imaging modalities (CT, MR, US).

CONTENT ORGANIZATION

1. Review physiologic cardiovascular uptake on PET/CT. 2. Review FDG avid non-tumorous conditions: Illustrations of atherosclerosis, endovascular graft, vasculitis, Erdheim-Chester disease, vascular dissection, myocarditis, sarcoidosis, interatrial lipomatous hypertrophy, chemotherapy/radiation related changes, pulmonary embolism related changes. 3. Review tumorous conditions: myocardial/pericardial metastasis, tumor extension from adjacent malignancies, tumor pulmonary embolism, lymphoma, cardiac/pulmonary angiosarcoma, venous (portal/IVC/SMV/iliac) tumor thrombi. 4. Correlate PET/CT findings with other imaging findings, discussing the advantage of collaborative interpretation.

SUMMARY

Various cardiovascular FDG uptake can be detected on PET/ CT in oncology patients, which may represent benign or malignant processes. The added value of PET/CT over other imaging modalities allows better disease characterization and evaluation. Familiarity with their etiologies and PET/CT findings is essential to facilitate accurate diagnosis and appropriate patient management.

**Cardiac PET-MR Fused Imaging: Potential Incremental Value in Cardiomyopathy**

[Back to Top](#)

**CL-NME4157**

**Marina Falgas Lacueva , MD**  
**Andrew Sher , MD**  
**Prabhakar Rajiah , MD, FRCR**  
**James K O'Donnell , MD \***

PURPOSE/AIM

Cardiac PET-CT and MRI have important roles in assessing myocardial physiologic and anatomic alterations comprising ischemic and nonischemic cardiomyopathies. This exhibit investigates the potential incremental value of contemporaneous PET and MRI imaging with fused image sets for correlation of pathologic findings and their extent.

CONTENT ORGANIZATION

**PET-CT imaging findings in ischemic cardiomyopathy:**

- Matched Rb/FDG PET defect indicates infarction.
- Mismatched defect indicates hibernating myocardium

**MRI imaging findings in ischemic cardiomyopathy:**

- DCE on MRI indicates infarct
- No DCE is suggestive of hibernating myocardium

**PET-CT imaging findings in non-ischemic cardiomyopathy:**

- Increased uptake on FDG-PET

**MRI imaging findings in non-ischemic cardiomyopathy:**

- DCE in a pattern atypical for infarction

**Fused images of PET-CT and MRI with delayed contrast enhancement**

- Fusion of modalities shows correlation of PET-CT and MRI findings in both ischemic and non-ischemic cardiomyopathies.

SUMMARY

PET-CT and MRI have their benefits and drawbacks in evaluation of cardiomyopathies. Fused images provided incremental value for assessment of ischemic and non-ischemic cardiomyopathies. Further investigations with PET-MR combined scanners will improve the assessment and management of cardiomyopathies.

**Alpharadin (Radium-223) Therapy in Management of Osseous Metastases in Castrate Resistant Advanced Prostate Cancer**

[Back to Top](#)

**CL-NME4158**

**Alireza Mojtahedi , MD**  
**Neeta Pandit-Taskar , MD**

PURPOSE/AIM

To review the clinical indications of Alpharadin (radium-223) therapy

To review the advantages and disadvantages of Alpharadin (radium-223) therapy versus Quadramet (Samarium SM 153 Lexidronam)

CONTENT ORGANIZATION

1. Brief review of the physics of alpha particles and its use in treatment of cancer. 2. Discuss the radionuclide therapy in management of patients with prostate cancer 3. Discuss the current update on Alpharadin (radium-223) in managing the metastatic prostate cancer.

SUMMARY

After this presentation, participants will appreciate that:

Ra-223 is useful therapy agent for management patients with osseous metastases from prostate cancer. It improves overall survival (OS) in men with castrate resistant advanced prostate cancer (CRPC) having bone metastases. It is relatively easy to administer and safe procedure. It can be done as an outpatient quick procedure with no additional radiation to others.

**Hepatobiliary PET/CT: Hot or Not?**

[Back to Top](#)

**CL-NME4159**

**John R McGrath , MD**  
**Hongju Son , MD**  
**John G Strang , MD**  
**Deborah J Rubens , MD**

PURPOSE/AIM

We plan to illustrate PET/CT findings of various tumors and non-tumorous lesions occurring in the liver and biliary tree, which will aid in image interpretation and diagnosis.

CONTENT ORGANIZATION

1. Review PET/CT findings of common and uncommon hepatobiliary lesions. a. Malignant and benign neoplastic processes: Illustrations of focal or diffuse metastasis, recurrent tumors status post treatment, lymphoma, cholangiocarcinoma, hepatocellular carcinoma (HCC), portal venous/IVC tumor thrombus, gallbladder cancer, non-HCC vascular tumors, neuroendocrine tumors, and solitary or diffuse cysts. b. Non-tumorous conditions: Illustrations of infection/abscesses, focal or diffuse hepatic steatosis, surgery or radiation related changes, drug toxicity, trauma, iatrogenic injury, and cholecystitis. 2. Correlate PET/CT findings with contrast enhanced CT or MR, discussing the

advantage of collaborative interpretation.  
SUMMARY

Since hepatobiliary imaging in patients with a history of malignancy or chronic liver disease is important, and benign liver lesions are common, imaging strategies should incorporate strategies for hepatobiliary lesion detection and characterization. Knowledge of the PET findings of these lesions is of paramount importance to the radiologist to facilitate diagnosis and early institution of appropriate treatment.

## Florbetapir F-18 PET: A Review of the Concept, Protocol and Imaging

[Back to Top](#)

### CL-NME4160

**Ivan M Dequesada**, MD  
**David C Brandon**, MD

#### PURPOSE/AIM

1. Present a summary of the indication and protocol for Florbetapir F-18 PET (Amyvid) imaging.
2. Review cases of normal and abnormal exams.

#### CONTENT ORGANIZATION

1. Florbetapir imaging
  - Concept
  - Indication
  - Radiopharmaceutical composition
  - Protocol
2. Anatomy
  - Review of pertinent anatomy
3. Image examples
  - Normal
  - Abnormal

#### SUMMARY

Cognitive impairment in patients may be due to a reversible or irreversible cause of dementia. Florbetapir F-18 PET of the head allows for the qualitative assessment of  $\beta$ -amyloid neuritic plaque which is present in patients with Alzheimer's dementia (AD). A normal scan in a patient with cognitive impairment would prompt workup for a reversible type of dementia. An abnormal scan provides additional evidence to support a clinical diagnosis of AD, although it can be seen in patients with other neurologic conditions or normal cognition. Teaching points:

- Florbetapir F-18 PET uses a radiopharmaceutical that indicates the presence of  $\beta$ -amyloid neuritic plaques in the brain.
- Normal images demonstrate a normal gray and white matter differentiation and are inconsistent with a diagnosis of Alzheimer's dementia (AD).
- Abnormal images demonstrate abnormal loss of gray and white matter differentiation and may be observed in normal cognition or various neurological conditions including AD.

## F18 NaF PET/CT in the Assessment of Metabolic Bone Disease and Monitoring of Response to Therapy - Preliminary Results

[Back to Top](#)

### CL-NME4161

**Bhushan Desai**, MD  
**Evan Allgood**  
**Vivian Pham**, BS

#### PURPOSE/AIM

1. To investigate the diagnostic utility of F18 NaF PET/CT in detection and localization of metabolic bone disease and assess its role in therapy monitoring.
2. To determine the utility of F18NaF PET/CT in capturing benign skeletal disease.
3. To illustrate cases for determining its clinical utility and compare its diagnostic performance to conventional bone scintigraphy.

#### CONTENT ORGANIZATION

- I. Current literature review
- II. SNMMI practice guideline: scanning protocol
- III. Diagnostic utility of NaF PET/CT in:
  - a) Metastatic disease: prostate, breast and lung cancer
  - b) Treatment response evaluation
  - c) Capturing benign conditions
- IV. Truth Panel: Hard and Soft criteria
- V. Discuss advantages of F18 NaF PET/CT over conventional bone scintigraphy
- VI. Pearls and Pitfalls
- VII. Clinical case examples
- VIII. National Oncologic PET Registry (NOPR)

#### SUMMARY

The major teaching points of this exhibit are:

1. F18 NaF PET/CT is useful in detection of locally recurrent and/or metastatic disease, in monitoring response to systemic therapies, and in prognostication.
2. F18 NaF PET/CT has emerged as a promising imaging tool which can become a routine clinical procedure.

## Ventilation/Perfusion SPECT-CT: Spectrum of Utility

[Back to Top](#)

### CL-NME4162

**Irene W Cruite**, MD  
**Lorenzo Mannelli**, MD, PhD  
**Shana Elman**, MD  
**Arnold Kang**, MD  
**Manuela C Matesan**, MD, PhD  
**Fatemeh Behnia**, MD  
**Hubert J Vesselle**, MD, PhD \*

#### PURPOSE/AIM

To describe the clinical utility of ventilation/perfusion (V/Q) SPECT-CT.

#### CONTENT ORGANIZATION

1. Introduction that includes advantages of integrated V/Q SPECT-CT imaging over planar V/Q imaging.
2. Illustration of V/Q SPECT-CT utility using clinical images. Utility includes:
  - i) Diagnosis of pulmonary embolism.
  - ii) Pre-operative prediction of post-operative forced expiratory volume in 1 second (FEV1) in patients with lung cancer suffering from concurrent emphysema.
  - iii) Planning lung cancer radiotherapy treatment.
  - iv) Planning lung volume reduction surgery in patients with severe emphysema.
  - v) Assessment of pathophysiology of lung diseases in clinical and research settings.

#### SUMMARY

V/Q SPECT-CT provides both anatomical and functional information, which improves overall diagnostic accuracy compared to planar V/Q imaging. Moreover, SPECT/CT provides attenuation-corrected images enabling a more accurate regional and fractional assessment of lung perfusion. Consequently, V/Q SPECT-CT imaging has a wide range of applications in both clinical and research settings as described.

## Nuclear Medicine Case of the Day

[Back to Top](#)

### LL-EDE3010

**Moderator**  
**Murray D Becker**, MD, PhD  
**Puneet Belani**, MD

**Richard K. J. Brown** , MD \*  
**Daniel J Wale** , DO  
**Anjani P Naidu** , MD  
**Pranay C Uppuluri** , MD  
**Jeffrey S Kempf** , MD

PURPOSE/AIM

1) To recognize perfusion patterns on renal scintigraphy that indicate acute renovascular abnormalities. 2) To understand the incidence and etiologies of acute renal thrombosis in a newborn.

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### Nuclear Medicine Case of the Day

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[Back to Top](#)

#### LL-EDE3010

**Moderator**

**Murray D Becker** , MD, PhD  
**Puneet Belani** , MD  
**Richard K. J. Brown** , MD \*  
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[Back to Top](#)

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[Back to Top](#)

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[Back to Top](#)

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### Nuclear Medicine Case of the Day

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[Back to Top](#)

#### LL-EDE3010

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**Murray D Becker** , MD, PhD  
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**Jeffrey S Kempf** , MD

PURPOSE/AIM

1) To recognize perfusion patterns on renal scintigraphy that indicate acute renovascular abnormalities. 2) To understand the incidence and etiologies of acute renal thrombosis in a newborn.

## Nuclear Medicine (PET/CT in Oncology)

Sunday, 10:45 AM - 12:15 PM • S505AB



[Back to Top](#)

SSA18 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Moderator  
Andrew Quon, MD

### SSA18-01 • Anti-3-[18F] FACBC PET Is Useful to Improve Salvage Radiotherapy Failure Rates in Recurrent Prostate Cancer

Oluwaseun Odewole MBBS, MPH (Presenter); Ashesh B Jani MD; Pooneh Taleghani MD; Bitai Savir-Baruch MD; Leah M Bellamy; Weiping Yu PhD; Peter Nieh MD; Viraj Master MD; Mark M Goodman PhD\*; David M Schuster MD; Raghuveer K Halkar MD\*

#### PURPOSE

Salvage radiotherapy after prostate cancer recurrence is associated with failure rates of up to 50% (Radiation Medicine Rounds 2:1 (2011) 59-80), probably from failure to detect extra-regional disease. Therefore, detection of such disease on imaging has substantial value. anti-3-[18F] FACBC is a synthetic amino acid PET radiotracer with utility in detection of prostate cancer (Radiology 2011; 259:852). Our aim was to determine if FACBC PET could be used to improve salvage radiotherapy failure rates

#### METHOD AND MATERIALS

Retrospective analysis of 11 patients who had salvage radiotherapy for prostate cancer recurrence (9 post-prostatectomy; 2 non-prostatectomy) selected by findings from FACBC PET-CT. PSA failure was defined as nadir PSA + 0.2 ng/mL for prostatectomy and nadir PSA + 2.0 ng/mL for non-prostatectomy.

#### RESULTS

11 patients without FACBC PET extra-pelvic disease were qualified for salvage radiotherapy. Mean original Gleason score ( $\pm$ SD, range) was 7 ( $\pm$ 0.74, 6 - 8). 9/11 patients had radiotherapy to the prostate bed and 2/11 also to the pelvis. Average time ( $\pm$ SD, range) from FACBC to radiotherapy was 7.9 ( $\pm$ 5.9, 4-22) months; average pre-radiotherapy PSA ( $\pm$ SD, range) was 4.4 ( $\pm$  5.2, 0.2-15.3) ng/ml. Average PSA follow-up from time of scan ( $\pm$ SD, range) was 29.9 ( $\pm$ 9.5, 15-54) months and 20.9 ( $\pm$ 7.2, 8-35) months from time of radiotherapy. 18.2% (2/11) of our patients had PSA failure at time of analysis. Of these, one did not receive radiotherapy until 16 months after FACBC scan. Salvage radiotherapy was successful in 3/5 patients with PSA > 2.0 ng/ml at time of radiotherapy.

#### CONCLUSION

Guidance with advanced molecular imaging using anti-3-[18F] FACBC PET-CT may be valuable in selecting recurrent prostate carcinoma patients for salvage radiotherapy. Impact on salvage radiotherapy outcomes is currently being studied at our institution in a prospective randomized controlled trial.

#### CLINICAL RELEVANCE/APPLICATION

Patient selection for salvage radiotherapy guided by molecular imaging with anti-3-[18F] FACBC PET-CT may enable better response rate at higher PSA's as compared with conventional imaging guidance.

### SSA18-02 • Pre-treatment Whole-body Total Lesion Glycolysis and Metabolic Tumor Volume at FDG PET-CT as Prognostic Indicators in Advanced Cervical Cancer

Mohammad A Husainy MD (Presenter); Farhina Sayyed MRCS; Helene Thygesen PhD; Chirag Patel FRCR; Mark Barnfield; Andrew F Scarsbrook FRCR

#### PURPOSE

To study the prognostic value of whole body total lesion glycolysis (TLG) and total metabolic tumor volume (MTV) derived from pre-treatment fluorine 18 fluorodeoxyglucose (FDG) positron emission tomography - computed tomography (PET-CT) in locally advanced cervical cancer.

#### METHOD AND MATERIALS

Patients with locally advanced cervical cancer who underwent pre-treatment FDG PET-CT from the year 2010-12 were identified from an institutional cancer database. Mean and maximum standardized uptake value and MTV of each primary tumor and any nodal or distant disease were determined. Whole body MTV was calculated by summation of the primary tumor and any other disease site volumes. TLG was calculated by summation of individual tumor volume multiplied by mean SUV. Univariate analysis was performed to assess the prognostic significance of clinical stage, SUVmax, whole-body MTV and TLG on subsequent patient outcome.

#### RESULTS

34 patients were included in data analysis. Median follow up time was 2.2 years. The estimated median overall survival (OS) for the cohort was 2.1 years. The 1-year OS was 64.7% for patients with high whole-body TLG (> 385.29) and 88.2% for those with low whole-body TLG (67) and 88.2% for those with low whole-body MTV (14.7). Univariate Cox analysis showed that whole-body TLG, whole-body MTV and clinical stage were significant prognostic factors for OS. For statistical test, we used the confidence level 95%. Cox proportional hazard modeling showed a significant prognostic value of whole body-TLG (hazard ratio= 3.63; 95% confidence interval: 1.15, 11.43; p

#### CONCLUSION

Whole-body TLG and MTV may be better prognostic indicators than primary tumor SUVmax for predicting outcome in advanced cervical cancer.

#### CLINICAL RELEVANCE/APPLICATION

Whole-body TLG and MTV may be better prognostic indicators in the advanced cervical cancer and could have a role for treatment stratification in the future.

### SSA18-03 • Is MDP Bone Scan Necessary for Initial Staging of Ewing Sarcoma If FDG PET/CT Is Performed?

Gary A Ulaner MD, PhD (Presenter); Heather Magnan MD; John Healey MD; Wolfgang A Weber MD\*; Paul Meyers MD

#### PURPOSE

To determine whether MDP bone scans are necessary during initial staging of Ewing sarcoma (ES) patients, if FDG PET/CT is performed.

#### METHOD AND MATERIALS

An IRB approved retrospective review was performed of patients who underwent FDG PET/CT and MDP bone scan prior to treatment of newly diagnosed ES from 1/04 to 11/12. Studies were reviewed to document suspected primary and metastatic malignancy. Pathology and imaging follow-up were used to determine the presence or absence of disease at suspected sites.

#### RESULTS

60 patients were identified with FDG PET/CT and MDP bone scans performed prior to treatment of newly diagnosed ES. 44 primary malignancies demonstrated a lytic CT appearance, 3 were sclerotic, and 13 involved only soft tissue. 11/12 patients with osseous

metastases were detected on PET/CT, with the 1 false negative occurring in a sclerotic primary tumor. 9/12 patients with osseous metastases were detected on MDP bone scan, with the 3 false negatives occurring in patients with lytic primary tumors. Only 1 of 13 patients with a soft tissue primary malignancy demonstrated bone metastases, evident on both bone scan and PET/CT. PET/CT also demonstrated 8 patients with lung metastases and 3 patients with lymph node metastases, which were not evident on MDP bone scan.

#### CONCLUSION

When ES is lytic, MDP bone scan does not add to staging performed by FDG PET/CT, thus MDP bone scanning may be omitted. However, when ES is sclerotic, MDP bone scan may detect patients with osseous metastases which are not detected by FDG PET/CT.

#### CLINICAL RELEVANCE/APPLICATION

Bone scan may be omitted from the staging of newly diagnosed ES when the primary tumor is lytic. When the primary tumor is sclerotic, MDP bone scan may detect osseous metastases missed on FDG PET/CT.

### SSA18-04 • Prognostic Value of Concurrent Staging 18F-FDG PET/CT and Staging Endoscopic Ultrasound in Esophageal Cancer

**Vinod Malik** MBBCh, MA (Presenter) ; **Ciaran J Johnston** MD ; **Julie A Lucey** PhD ; **Zieta Claxton** BSc ; **Dermot O'Toole** MD ; **John V Reynolds** MD

#### PURPOSE

Staging of esophageal cancer is improved by the concurrent use of 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) and endoscopic ultrasound (EUS). This study ascertained if these complementary adjuncts can enhance staging by proposing correlating independent prognostic factors in esophageal cancer.

#### METHOD AND MATERIALS

From December 2008 to May 2011, 150 patients with biopsy-proven cancer of the esophagus or esophagogastric junction underwent concurrent staging 18F-FDG PET/CT and staging EUS. 18F-FDG PET/CT obtained maximum standardized uptake value (SUVmax) and metabolic tumor volume (MTV) of the primary tumor was recorded. EUS evaluated the tumor for T stage (T1-T4), regional lymph node metastases (N0 or N+) and the presence or absence of celiac axis nodes and hepatic metastasis. Relationships between parameters were investigated using the spearman rho correlation coefficient, survival analysis performed using Kaplan-Meier and independent prognostic factors determined using Cox regression multivariate analysis.

#### RESULTS

A strong positive correlation between 18F-FDG PET/CT MTV and EUS  $\diamond T \diamond$  stage was demonstrated ( $r=0.566$ ,  $p18F-FDG$  PET/CT MTV was noted between early EUS tumors (T1/T2) and late EUS tumors (T3/T4) ( $p18F-FDG$  PET/CT MTV  $< 7.5cm^3$  ( $p=0.0013$ ), 18F-FDG PET/CT SUVmax  $< 4.1$  ( $p=0.0014$ ), EUS  $\diamond T \diamond$  stage ( $p18F-FDG$  PET/CT MTV  $< 7.5 cm^3$  ( $p=0.0006$ ), EUS  $\diamond T \diamond$  stage ( $p=0.01$ ) and EUS  $\diamond N \diamond$  stage ( $p=0.01$ ).

#### CONCLUSION

MTV, a volumetric parameter of 18F-FDG PET/CT is a valuable independent prognostic factor in esophageal cancer, more so than SUVmax and enhances staging when used in conjunction with EUS  $\diamond T \diamond$  stage and EUS  $\diamond N \diamond$  stage by predicting survival.

#### CLINICAL RELEVANCE/APPLICATION

Independent prognostic factors identified by staging 18F-FDG PET/CT and EUS in esophageal cancer may facilitate selection of patients to treatment regimens with the benefit of enhanced outcomes.

### SSA18-05 • Intratumoral Heterogeneity of Tracer Uptake on 18F-FDG PET/CT for Characterization of Peripheral Nerve Sheath Tumors in Patients Suffering from Neurofibromatosis Type 1

**Johannes M Salamon** MD (Presenter) ; **Peter Bannas** MD ; **Jasmin D Busch** MD ; **Jochen Herrmann** MD ; **Gerhard B Adam** MD ; **Victor F Mautner** MD ; **Thorsten Derlin**

#### PURPOSE

Peripheral nerve sheath tumors (PNSTs) in patients with neurofibromatosis type 1 (NF1) may undergo focal malignant transformation, and heterogeneity of tumor composition is therefore a histopathological hallmark of malignant PNSTs (MPNSTs). MPNSTs usually demonstrate strongly increased and inhomogenous tracer uptake. The aim of this study was to evaluate the potential usefulness of intratumoral tracer uptake heterogeneity on 18F-fluorodeoxyglucose (FDG) PET/CT as compared to a cut-off SUVmax for characterization of PNSTs in NF1.

#### METHOD AND MATERIALS

50 patients suffering from NF1 underwent 18F-FDG PET/CT. Intralesional 18F-FDG uptake was analyzed qualitatively and semiquantitatively by measuring the mean and maximum standardized uptake value (SUV). Heterogeneity of tracer uptake was evaluated by computing a SUV-based heterogeneity index (HISUV) and qualitatively graded using a three-point scale. Inter- and intrarater agreement was determined using Cohen's  $\kappa$ . Histopathologic evaluation as well as clinical and radiological follow-up served as reference standard.

#### RESULTS

Using either intralesional heterogeneity or SUVmax malignant tumors could be identified with a sensitivity of 100%. Qualitative intratumoral uptake heterogeneity and malignant transformation in peripheral nerve sheath tumors showed a significant association ( $p$

#### CONCLUSION

18F-FDG PET/CT reveals strong intratumoral heterogeneity of tracer uptake in MPNSTs in patients with NF1. Either a SUVmax cut-off value or a heterogeneity index can be used to identify malignant PNSTs with a sensitivity of 100%, however the approach using a cut-off value leads to a higher specificity. There is no significant improvement in diagnostic performance using both methods in combination.

#### CLINICAL RELEVANCE/APPLICATION

New imaging parameters for the characterization of peripheral nerve sheath tumors in NF1 patients may help reducing unnecessary morbidity due to biopsies or surgery.

### SSA18-06 • Can I-124 PET/CT Predict the Uptake of Therapeutic Dosages of Radioiodine (I-131) in Differentiated Thyroid Carcinoma?

**Gauke K Lammers** MD (Presenter) ; **P.C.M. Pasker** ; **M. E. Sanson-Van Praag** ; **John M De Klerk** MD, PhD

#### PURPOSE

Follow up of differentiated thyroid carcinoma (DTC) is currently mainly based on monitoring of serum thyroglobulin (Tg) levels. In the case of an elevated serum Tg level and suspected recurrent DTC, but negative diagnostic imaging, a so called  $\diamond blind \diamond$  I-131 therapy is recommended, followed by whole body scintigraphy to assess the extent of disease. Regrettably, in a significant number of patients this  $\diamond blind \diamond$  I-131 therapy results in no visible abnormal I-131 uptake and hence in probably no beneficial therapeutic effect. Iodine-124 PET/CT is a promising tool for identifying patients who will benefit from I-131 therapy, by predicting iodine uptake. I-124 PET/CT could therefore be important in personalizing treatment for patients with DTC.

#### METHOD AND MATERIALS

The results of 34 I-124 PET/CT scans performed in our hospital between 2007 and 2012 were retrospectively evaluated. All scans were made in patients under follow up, replacing the diagnostic I-131 scintigraphy. In all cases Tg was stimulated (by recombinant TSH or thyroid hormone withdrawal). A dosage of 40MBq I-124 was used, with scans at 24 hours and 96 hours after administration. Results were compared to subsequent I-131 post-treatment scans (6 cases) and a combination of follow up, stimulated Tg and other imaging tools results available to assess presence of recurrence.



## RESULTS

Recurrence of DTC was found in 14/34 cases. I-124 PET/CT correctly detected recurrence in 2 cases, with false negative results in 12 cases. In 1 case a false positive I-124 PET/CT result was recorded. 19 true negative results were found. For I-124 PET/CT this meant a sensitivity of 14% and a specificity of 95%. PPV was 67%, NPV 61%. Post-treatment I-131 uptake (6 cases) was correctly predicted in 1 case, with false negative results in 4 cases and 1 true negative result.

## CONCLUSION

In this study I-124 PET/CT did not reliably detect recurrent differentiated thyroid carcinoma. More importantly it failed to predict I-131 uptake on post-treatment scintigraphy in a significant number of cases, which would lead to under-treatment.

## CLINICAL RELEVANCE/APPLICATION

I-124 PET/CT in follow up of differentiated thyroid cancer cannot reliably identify the patients who would benefit from I-131 treatment.

## SSA18-07 • Whole-body MRI vs. Co-registered Whole-body FDG-PET/MRI vs. Integrated Whole-body FDG-PET/CT: Capability for TNM and Stage Assessment in Non-small Cell Lung Cancer Patients

**Yoshiharu Ohno MD, PhD (Presenter) \***; **Shinichiro Seki**; **Mizuho Nishio MD \***; **Hisanobu Koyama MD**; **Maho Tsubakimoto MD**; **Hitoshi Yamagata PhD \***; **Kota Aoyagi \***; **Yumiko Onishi MD**; **Takeshi Yoshikawa MD \***; **Sumiaki Matsumoto MD, PhD \***; **Nobukazu Aoyama RT**; **Katsusuke Kyotani RT**; **Akiko Kusaka RT**; **Kazuro Sugimura MD, PhD \***

## PURPOSE

To directly and prospectively compare the capability for TNM and clinical stage assessments among whole-body MR imaging (MRI), co-registered FDG-PET/MRI and integrated FDG-PET/CT in non-small cell lung cancer (NSCLC) patients.

## METHOD AND MATERIALS

70 consecutive pathologically diagnosed NSCLC patients (37 men, 33 women; mean age 73 years) prospectively underwent whole-body MRIs at 3T system, integrated FDG-PET/CTs, conventional radiological examinations, surgical biopsies and/or treatments, pathological examinations and follow-up examinations. Final diagnosis of TNM factors and clinical stage in each patient was determined according to all examination results. All co-registered FDG-PET/MRIs were generated by means of our proprietary software. Then, TNM factor and clinical stage on all methods were visually assessed by radiologists and nuclear medicine physicians. Then, final diagnosis in each patient was made by consensus of two readers on each method. To determine the agreements of TNM factor and clinical stage between each method and final diagnosis, kappa statistics were performed. To compare the diagnostic capability for operability assessment (T factor: T1 or T2 vs. T3 or T4, N factor: N0 or N1 vs. N2 or N3, M factor: M0 vs. M1, clinical stage: stage I or II vs. stage III or IV) among all methods, sensitivities, specificities and accuracies were statistically compared each other by using McNemar's test.

## RESULTS

Each agreement with final diagnosis was as follows: T factor, 0.90=0.93; N factor, 0.60=0.88; M factor, 0.78=0.93; clinical stage, 0.55=0.87, respectively. When compared each operability assessment capability according to TNM factor, accuracies (97.1 [68/70] %) of N factor on MRI and FDG-PET/MRI were significantly higher than that on FDG-PET/CT (88.6 [62/70] %, p

## CONCLUSION

Whole-body MRI and co-registered FDG-PET/MRI are more useful than integrated FDG-PET/CT for TNM and clinical stage assessments in non-small cell lung cancer patients.

## CLINICAL RELEVANCE/APPLICATION

Whole-body MRI and co-registered FDG-PET/MRI are more accurate than integrated FDG-PET/CT for TNM and clinical stage assessments in non-small cell lung cancer patients.

## SSA18-08 • Correlations between FDG Uptake Indices and the Expression of Various Type Oncogenes (KRAS, BRAF, HIF-1, EGFR, CDH13, p53, Ki67, Glut 1 and Glut 3) in Biliary Cancer: A Comparison Study to MRI Diffusion Weighted Image Parameters

**Shigeki Nagamachi MD, PhD (Presenter)**; **Ryuichi Nishii MD, PhD**; **Youichi Mizutani**; **Syogo Kiyohara**; **Nobuhiro Shibata**; **Kazuhiro Kondo**; **Masahiro Kai**; **Shozo Tamura MD, PhD**; **Kazuo Chijiwa**; **Keiichi Kawai**; **Seigo Fujita MD**; **Hideyuki Wakamatsu MD**; **Shigemi Futami**

## PURPOSE

We investigated the correlations between FDG uptake and the expression of various type oncogenes in biliary cancer. In addition, we also analyzed the correlation between parameters of diffusion weighted MRI image (DWI) and oncogenes expression. Then, we compared both correlation coefficients to find which imaging parameters were more associated with the expression of which oncogenes in biliary cancer.

## METHOD AND MATERIALS

We investigated forty-three patients of biliary cancer who underwent both MRI and FDG-PET/CT before operation. Using Reverse Transcription-Polymerase Chain Reaction (RT-PCR) analysis, we measured the various DNA content (EGFR, CDH13, p53, Ki67, KRAS, BRAF, HIF-1, Ki-67, p53, Glut 1 and Glut 3) in surgically resected cancer tissues. We investigated the correlation coefficients between the expression of oncogenes DNA and FDG uptake parameters (SUV max early and SUV max delayed), or between the expression of oncogenes DNA and apparent diffusion coefficient (ADC mean and ADC min).

## RESULTS

FDG uptake parameters (SUV max early and SUV max delay) were positively correlated with B-RAF (0.34 and 0.43), HIF-1(0.41 and 0.48), Glut1 (0.45 and 0.52) or Glut 3(0.35 and 0.48). In contrast, DWI parameters (ADC mean or ADC min) showed positive correlation only with HIF-1 (0.48 and 0.16). However, there was not any significant correlation in other parameters.

## CONCLUSION

In biliary cancer, both SUV max and DWI parameters showed the close association with the expression of oncogenes related with hypoxia. In addition, SUV max was more associated with the expression of oncogenes associated with RAF/MEK/ERK signaling pathway.

## CLINICAL RELEVANCE/APPLICATION

By the correlation analysis, we may estimate the expression of oncogenes such as B-RAF or HIF-1 by the values of SUVmax. We may estimate the expression of HIF-1 by ADC also.

## SSA18-09 • Incremental Value Of FDG PET CT in Differentiating Benign and Malignant Cardiac Masses

**Kavitha Yaddanapudi DMRD, MBBS (Presenter)**; **Michael A Bolen MD**; **Ahmed El-Sherief MD**; **Carmela Tan MD**; **Richard Brunken MD \***

## PURPOSE

To evaluate the incremental value of FDG-PET CT over contrast enhanced magnetic resonance imaging (CE MRI) and computed tomography (CT) in differentiating benign cardiac masses from malignant lesions.

## METHOD AND MATERIALS

Retrospective evaluation of eleven patients with cardiac masses who underwent CE MRI (n=9), CT (n=2) and FDG-PET (n=11) was performed. The gold standard was histopathology after surgical excision (n=8) and long term follow up of more than 2 years (n=3). Patients were divided into two groups benign (n=7) and malignant (n=4) cardiac masses. On FDG PET CT the maximum standardized uptake values (SUV max) of the lesions was determined. A SUV max cutoff of 3.5 was used to differentiate benign from malignant lesions. MRI and CT characteristics as size, invasiveness and tissue characterization were evaluated. The ability of SUV max on FDG PET to differentiate benign and malignant lesions was then compared to morphological imaging diagnosis and correlated with pathology and follow up.

## RESULTS

The mean SUV max for malignant lesions was  $5 \pm 2.5$ . The mean SUV for benign lesions was 0.85. No FDG uptake was seen in 5 of the 7 benign lesions (71%). The sensitivity and specificity for determining malignancy by FDG PET CT was 75% and 100% respectively. FDG PET CT has a 100% positive predictive value for diagnosing malignancy with a SUV max cut off of 3.5. Morphological imaging could not differentiate between benign and malignant lesions in 36% (n=4) cases. In 3 of these 4 cases FDG PET CT was able to differentiate between benign and malignant lesions. In one case of osteosarcoma of left atrium that was densely calcified both FDG PET CT and morphological imaging could not point towards the malignant nature preoperatively.

## CONCLUSION

FDG PET CT is a useful adjunct to morphological imaging in differentiating benign from malignant cardiac masses. FDG uptake by the mass with a high SUV ( $>3.5$ ) has a good positive predictive value for malignancy.

## CLINICAL RELEVANCE/APPLICATION

FDG PET CT with a high positive predictive value can noninvasively differentiate benign from malignant lesions in most situations and is a powerful tool in the evaluation of cardiac masses.

## Nuclear Medicine - Sunday Posters and Exhibits (12:30pm - 1:00pm)

Sunday, 12:30 PM - 01:00 PM • S503AB

[Back to Top](#)

NM

CL-NMS-SUA • AMA PRA Category 1 Credit™:0.5

Host

Ukihide Tateishi, MD, PhD

### CL-NMS-SU1A • Evaluating the Metastatic Cure Probability (MCP) of Targeted Radionuclide Therapy (TRT) for Head and Neck Cancer (HNC) Using a Pretargeting System

Tod W Speer MD (Presenter) ; Jenna Borkenhagen MD

#### PURPOSE

Purpose/Objectives: TRT is a systemic radiotherapy that uses radionuclides to target malignant tissue. Clinical data has been generated using 90Y (anti-CEA, B72.3 antibody) for the treatment of HNC with TRT using pretargeting. A maximum of 70 mCi 90Y was instilled. This study simulated the mean equivalent dose (Deq) required to cure metastatic carcinoma using 90Y and assesses the theoretical feasibility of delivering this dose in terms of the current reported administered activity.

#### METHOD AND MATERIALS

A model for tumor growth (Gompertzian) and metastatic formation was developed using human data. Monte Carlo simulations were performed to determine the 90% metastatic cure probability (MCP) for the metastatic formation rate constants ( $c = \%$ [day/g]) of 0.01, 0.1, 1.0, 10 and corresponding total metastatic mass (g) groups of 1.4, 16, 160, 1600. Calculations were performed to estimate the required administered activity (mCi) that would result in the simulated Deq that accomplishes the MCP for each metastatic mass group. The following were assumed: uniform dose distribution, radionuclides completely decay, all decay energy was absorbed by the mass group.

#### RESULTS

Simulated metastatic mass distributions for  $c$  of 0.01, 0.1, 1.0, 10 resulted in detectable metastasis (lesions  $> 1.0$  g) of 0.17, 1.7, 17, 180 and a total number of metastases of 0.92, 9.7, 170, 9000, respectively. The Deq (Gy) required for MCP for 90Y against the total metastatic mass (g) of 1.4, 16, 160, 1600 was: 5,200 Gy, 11,000 Gy, 17,000 Gy, 28,000 Gy. The required administered activities (mCi) to exercise the MCP are: 3.97 mCi, 96 mCi, 1483 mCi, 24,429 mCi.

#### CONCLUSION

If a large amount of administered activity of TRT is focused in malignant tissue, current data indicates a potential to cure systemic disease with a mass range of 1.4 to 16 grams. Strategies should be employed to use TRT earlier in the therapeutic process and to increase dose to malignant tissue (pretargeting, fractionation, bone marrow support).

#### CLINICAL RELEVANCE/APPLICATION

Because current administered TRT activities have the potential to cure a limited range of metastatic disease, the future direction of TRT should be to employ early and increase overall dose.

### CL-NMS-SU2A • Estimation of Pulmonary Nodule Malignancy: Effect of a Computer-aided Diagnosis System Integrating PET and HRCT Findings on the Performance of Radiologists

Daisuke Komoto MD (Presenter) ; Masahito Aoyama PhD ; Yuichirou Takaki ; Toru Higaki PhD ; Wataru Fukumoto ; Kazuo Awai MD \*

#### PURPOSE

High-resolution CT (HRCT) and  $^{18}\text{F}$ -FDG PET are major techniques to differentiate malignant- from benign pulmonary nodules; however, the interpretation of these images relies on the knowledge and experience of the radiologist who is performing the interpretation. We developed a computer-aided diagnosis (CAD) system that integrates HRCT and PET findings for the differentiation between malignant and benign pulmonary nodules and investigated the effect of our system on the diagnostic performance of radiologists.

#### METHOD AND MATERIALS

We evaluated 39 non-calcified solitary pulmonary nodules less than 3.0 cm in maximal diameter in 39 patients who underwent HRCT and PET imaging. Our CAD system analyzes 6 morphological features on HRCT images and one PET feature (standardized uptake value). Receiver operating characteristic (ROC) analysis on a continuous rating scale was used to compare observer performance for estimating the likelihood of malignancy. The readers were 5 attending radiologists with board certification for PET diagnosis and 5 radiology residents. HRCT and PET images were first presented without the CAD output. After each reader marked the initial level of confidence, the CAD output for likelihood of malignancy (0: absolutely benign, 100: absolutely malignant) was displayed on the monitor and each reader could change his/her confidence level. Before the observer performance study all readers were shown that the true positive rate, false positive rate, and the area under the ROC curve (AUC) were 0.84, 0.25, and 0.84.

#### RESULTS

For the attending radiologists the mean AUC values without and with CAD were  $0.90 \pm 0.02$  (standard deviation) and  $0.89 \pm 0.03$ , respectively ( $p = 0.62$ ). For the residents they were  $0.74 \pm 0.07$  and  $0.79 \pm 0.07$ , respectively ( $p = 0.02$ ).

#### CONCLUSION

Use of the CAD system significantly ( $p = 0.02$ ) improved the diagnostic performance of radiology residents assessing the malignancy of pulmonary nodules but not of attending radiologists.

#### CLINICAL RELEVANCE/APPLICATION

Use of the CAD system that integrates PET and HRCT findings can improve the diagnostic performance of less experienced readers assessing pulmonary nodules for malignancy.

### CL-NMS-SU3A • A New Radiation Dose Minimization Protocol in Early Chemotherapy Response in Lymphoma Using $^{18}\text{F}$ -FDG

## PET-CT

**Luke I Sonoda** PhD, FRCR (Presenter) ; **Bal Sanghera** PhD ; **Subhadip Ghosh-Ray** ; **Thomas Wagner** ; **Kyoko Sonoda** ; **Wai Lup Wong**

### PURPOSE

There is ever-increasing evidence of 18F-FDG-PET-CT being useful in monitoring early response to chemotherapy in lymphoma. With a concern of radiation burden this study aimed to assess if PET-CT acquisition area could be minimised in order to reduce radiation dose and acquisition time.

### METHOD AND MATERIALS

Retrospective analysis of 1000 consecutive lymphoma patients (553 male, mean 42.4years-old, 421 Hodgkin's Lymphoma (HL), 579 Non-HL) was performed to record sites of disease on pre-chemotherapy PET-CT and the first post-chemotherapy PET-CT. The body is divided into four conventional parts (head-and-neck, thorax, abdomen and pelvis) for recording sites of disease. The potential reduction in radiation dose and time-saving achieved by limiting to the sites of known disease identified on pre-chemotherapy PET-CT was calculated.

### RESULTS

No FDG-uptake was seen in 744/1000 first post-chemotherapy PET-CT. FDG-uptake at known disease sites was seen in 256/1000 cases. 902/1000 of the patients had disease confined to only one or two body parts out of four. Incidental synchronous non-lymphomatous malignancy (such as colonic or lung carcinoma) was identified in 48/1000 cases in pre-chemotherapy PET-CT. Post-chemotherapy PET-CT did not reveal any unexpected sites of lymphoma or incidental interval malignancy. Limiting PET-CT to the sites of known disease would have reduced a mean radiation dose by 3.6 mSv (24.3 %), with a mean time-saving of 16 minutes (66.6%).

### CONCLUSION

In order to assess early response to chemotherapy it may be sufficient to scan the sites of known disease. This leads to reduce the incidence of secondary cancers, particularly in the young patients experiencing multiple radiation exposure.

### CLINICAL RELEVANCE/APPLICATION

Early interval response to chemotherapy in lymphoma may be monitored with FDG-PET-CT scan limited to the original site of the disease in order to minimize the total radiation dose to the patients.

## CL-NMS-SU4A • The Significance of 18F-FDG Uptake in Neck Lymph Nodes in Pediatric Patients without Head and Neck Malignancy

**Reza Vali** MD (Presenter) ; **Amer Shamas** MD ; **Mohamad El Zein** ; **Martin Charron** MD

### PURPOSE

18F-FDG PET/CT has been widely used in oncology. Reactive neck lymph nodes (N LNs) have been reported as a cause of false positive findings on PET studies. The purpose of this study was to evaluate the frequency and the significance of N LNs uptake in patients without malignancy originating from head and neck (H and N).

### METHOD AND MATERIALS

367 patients (882 studies) who were referred for a PET/CT study from 2008 till 2011 were evaluated retrospectively. 120 patients (316 studies) were excluded from the study due to the history of a malignancy involving H and N. FDG uptake in N LNs was recorded in 247 patients (567 studies) without any malignancy originating from H and N region (130 lymphoma, 30 post transplant lymphoproliferative disease (PTLD) and 87 others) . The diagnosis of malignancy versus reactive/inflammatory process was confirmed with follow up studies or biopsy. Maximum Standardized uptake values (SUV-max) were recorded for semi-quantitative analysis.

### RESULTS

FDG uptake in N LNs was identified in 74/247 (29.9%) of the patients (83/567; 14.6% of studies). In 41 patients the N LNs with FDG uptake were proved as benign (39 on F/U evaluations and 2 with biopsy). In 8 patients the LNs were proved to be malignant (one on F/U evaluations and 7 with biopsy). In 25 patients, we were not able to confirm the final diagnosis. 7 out of the 8 malignant LNs were in patients with history of PTLN. The size of the positive LNs was less than 1 cm in 3 out of 8 positive LNs. The mean SUV-max was significantly higher in malignant lesions (5.2) compared to the benign group (2.1). 7 out of 8 malignant LNs had an SUV-max of more than 3 while only 3 out of 41 patients with non-malignant LNs had an SUV-max of more than 3.

### CONCLUSION

Mild to moderate FDG uptake in N LNs is relatively common in pediatric patients and is frequently due to reactive LNs in patients without history of H and N cancer when the SUV-max is less than 3. The frequency of malignant NLNs is higher in PTLN patients compared to other groups.

### CLINICAL RELEVANCE/APPLICATION

It is important to differentiate malignancy versus inflammation in neck lymph node with FDG uptake

## CL-NME-SU5A • Quality Improvement Initiative to Reduce Patient Pain during Preoperative Sentinel Node Localization Injections and Maintain Diagnostic Accuracy of Axillary Sentinel Node Identification for Breast Cancer

**Cindy S Lee** MD ; **Vered Stearns** MD \* ; **Jill Kessler** ; **Eman Sbaity** ; **Karineh Tarpinian** ; **David J Eisner** MD (Presenter) ; **Lisa Jacobs** MD ; **Mehran Habibi** ; **Kimberly Aguirre** ; **Amanda Blackford** MSc ; **Stacie Jeter** ; **Nagi F Khouri** MD ; **Evelyn A May** MD ; **Paul G Nagy** PhD

### PURPOSE

Preoperative sentinel node localization (SNL) is now a standard of care for patients undergoing surgical treatment for breast cancer. It requires a subareolar injection of radiotracer Tc99-sulfur colloid which often causes severe pain for a few minutes (if lidocaine is not used), but has been characterized by numerous patients as the "worst pain of my life." Subareolar administration of lidocaine in conjunction with the radiotracer injection has been demonstrated to be effective in alleviating pain during SNL. However, the use of lidocaine during SNL is not a widely adopted practice. One concern is that lidocaine use can obscure the subsequent identification of sentinel node during surgery and thereby reduce the diagnostic accuracy of SNL. This project aims to compare the diagnostic accuracy of SNL with and without lidocaine injection prior to the injection of Tc99-sulfur colloid utilizing ultrasound guidance. We hypothesize that lidocaine administration will not impact accurate identification of the axillary sentinel lymph node.

### METHODS

This study is IRB approved and HIPAA compliant. For the pre-intervention phase, we performed a retrospective analysis of surgical rates of sentinel lymph node identification from 205 women from 2005-2009 who did not receive lidocaine during preoperative SNL. For the post-intervention phase, women were enrolled from January 2011 to July 2012 and surgical identification rates were analyzed. Both groups were identified from the Johns Hopkins Breast Center and the same eligibility criteria were used. Exclusion criteria include painful cancer, lidocaine allergy, age younger than 18, lesion or microcalcifications >4cm in the upper outer breast, prior surgical interventions in upper outer breast, and history of chemotherapy and tamoxifen treatment. All of the exclusions were for the possibility of impeding lymphatic drainage to the axilla for reasons other than the additional injection of lidocaine. Patients who consented to the prospective portion were interviewed and given the McGill pain questionnaire to complete prior to and after the SNL. The diagnostic accuracy of SNL was determined by successful identification of the sentinel node during surgery based on medical record review, for both pre- and post-intervention groups. We evaluated the proportion of women with successful SNL by technetium alone and those requiring additional periareolar intraoperative injection of methylene blue dye or saline to assist in the sentinel node identification. To assess the similarity between the pre- and post intervention groups, demographic and tumor characteristics of both groups were collected and compared, including age, ethnicity, tumor type, size, grade, estrogen receptor/progesterone receptor/HER2 positivity, and status of nodal

metastasis. P values for differences between cohorts are from Wilcoxon rank sum tests comparing continuous measures and Fisher's exact test for categorical measures.

## RESULTS

The pre- and post-intervention groups have similar demographic and tumor characteristics. In the pre- intervention group, 204 patients were included; the diagnostic accuracy of SNL is 94% and 100% with the use of intraoperative methylene blue dye/saline (table). In the post-intervention group, 107 patients (80% participation rate) consented to and received the lidocaine administration prior to the radiotracer injection. The post-lidocaine diagnostic accuracy of SNL is 95% and 100% with the use of intraoperative methylene blue dye/saline (table). There is no significant difference in diagnostic accuracy of SNL pre- and post- lidocaine intervention. The reported level of pain following lidocaine injection is very low (mean = 0.481) on the McGill pain scale of 0 to 10.

## CONCLUSION

The administration of lidocaine during preoperative SNL not only reduces patient pain but also maintains diagnostic accuracy of the procedure itself. Our project validates a patient-centered approach for performing a standard-of-care procedure in breast cancer treatment. At our institution, because of the encouraging result of this project, we have changed our practice behavior to incorporate the use of lidocaine during all preoperative sentinel lymph node injections (unless there is a lidocaine allergy).

## CL-NME-SU6A • High Radiation Badge Readings among Technologists in an Outpatient PET/CT Practice: Analysis and Solution

**Josephine N Rini MD (Presenter) ; Jason J Naidich MD ; Eran Ben-Levi MD ; Cythia Kubala ; Christopher J Palestro MD ; Kenneth Nichols PhD \***

## PURPOSE

Technologists in our high volume outpatient PET/CT practice (approximately 3,500 studies/year) consistently received high radiation badge readings (>0.5 mSv/month). We undertook this investigation as part of a quality improvement project aimed at understanding and reducing technologist radiation exposure. To address these issues we (1) analyzed technologist radiation badge readings as a function of work hours; (2) determined relative radiation exposure during various segments of PET/CT workflow; (3) implemented and assessed the effectiveness of a radiopharmaceutical auto-injector for reducing technologist radiation exposure.

## METHODS

Monthly body and ring radiation badge readings and work hours were analyzed for 6 technologists performing 2-3 manual injections of 444-555 MBq 18F-FDG/shift. For 4 technologists 12 months of data were available for analysis. For the fifth and sixth technologists, nine months and five months, respectively, of data were available for analysis. Annual mean radiation dose equivalent values per hour (mSv/hr) were computed for each technologist for the manual injection technique. PET/CT workflow was divided into 3 segments: (1) preparation/injection of 18F-FDG; (2) positioning patient on scanner; and (3) removing patient from scanner. For both manual and auto-injector techniques the technologists used pocket dosimeters to determine their radiation exposure from 10 patients during each of the 3 segments of PET/CT workflow. Total radiation exposure and per cent of total radiation exposure from each workflow segment, for both injection techniques, were compared.

## RESULTS

Using the manual injection technique, mean body dose was  $0.0037 \pm 0.0012$  mSv/hr (institutional ALARA limit 0.0025 mSv/hr) and mean hand dose was  $0.0129 \pm 0.0074$  mSv/hr (institutional ALARA limit 0.025 mSv/hr). By two-way ANOVA, radiation doses per MBq of injected activity were similar among technologists for segment 1 ( $p=0.86$ ) and for the entire procedure ( $p=0.24$ ), but were significantly higher for the manual injection technique than for the auto injector ( $p=0.003$ ). For the manual injection technique, radiation doses per MBq of injected activity were significantly higher for segment 1 than for segments 2 ( $0.0084 \pm 0.0005$  versus  $0.0048 \pm 0.0022$ ,  $p=0.002$ ), and segment 3 ( $0.0084 \pm 0.0005$  versus  $0.0028 \pm 0.0012$ ,  $p=0.002$ ). Based on analysis of technologist radiation badge readings and work hours, assuming current staffing and patient volumes, technologists working full time (150 hr/month), could be expected to receive an average of 0.56 mSv/month to the body and 1.94 mSv/month to the hand, using the manual injection technique. Although well below occupational dose limits, this mean body dose exceeds institutional ALARA limits. Analysis of relative radiation exposure during each of the 3 PET/CT workflow segments showed that process improvement in the injection phase would be most beneficial for reducing technologist exposure. Re-analysis of relative radiation exposure during the 3 PET/CT workflow segments using the auto-injector technique demonstrated a 55% decrease in technologist radiation exposure during the injection phase and a 40% overall decrease in radiation exposure.

## CONCLUSION

The introduction of a radiopharmaceutical auto-injector, as our data indicate, has the potential to significantly reduce radiation exposure to technologists administering 18F-FDG.

## Nuclear Medicine - Sunday Posters and Exhibits (1:00pm - 1:30pm)

**Sunday, 01:00 PM - 01:30 PM • S503AB**



[Back to Top](#)

**CL-NMS-SUB • AMA PRA Category 1 Credit™: 0.5**

## CL-NMS-SU1B • The Value of Intratumoral Heterogeneity of FDG Uptake to Differentiate between Primary Benign and Malignant Musculoskeletal Tumors on PET/CT

**Masatoyo Nakajo MD, PhD (Presenter) ; Masayuki Nakajo PhD ; Yoshihiko Fukukura MD, PhD ; Megumi Jinguji ; Yoshiaki Nakabeppu**

## PURPOSE

To examine whether the intratumoral heterogeneity of FDG uptake on PET/CT can be helpful to discriminate between primary benign and malignant musculoskeletal (MS) tumors.

## METHOD AND MATERIALS

The study population consisted of 63 patients who underwent PET/CT examinations before therapy for primary MS tumors. The intratumoral heterogeneity was evaluated by the calculated cumulative standardized uptake value (SUV)-volume histograms which were describing % of total tumor volume above % threshold of maximum SUV (SUVmax). Percent tumor areas above a threshold from 0 to 100% of the SUVmax were plotted and the area under curve of the cumulative SUV histograms (AUC-CSH) was used as a heterogeneity index, with lower values corresponded with increased heterogeneity. The differences in the SUVmax and AUC-CSH between benign and malignant tumors were examined using the Mann-Whitney U test. To examine the applicability of SUVmax and AUC-CSH for discrimination between benign and malignant tumors, receiver operating characteristic (ROC) analyses were conducted.

## RESULTS

There were 35 benign (8 schwannomas, 5 giant cell tumors and 22 others) and 28 malignant (11 MFHs, 4 liposarcomas, 4 myxofibrosarcomas and 9 others) tumors. There was no significant difference in the SUVmax between benign and malignant tumors ( $6.9 \pm 4.4$  vs.  $9.2 \pm 6.0$ ,  $P=0.17$ ). However, the AUC-CSH was significantly lower for malignant tumors than for benign tumors ( $0.43 \pm 0.14$  vs.  $0.52 \pm 0.10$ ,  $P=0.004$ ), and malignant tumors exhibited more heterogeneous uptake than benign tumors. The optimal threshold values were  $>6.9$  for SUVmax and  $=0.42$  for AUC-CSH to diagnose malignant tumors. The sensitivity, specificity, accuracy and area under the ROC curve (AUC-ROC) were 61% (17/28), 66% (23/35), 63% (40/63) and 0.60 for SUVmax, and 61% (17/28), 89% (31/35), 76% (48/63) and 0.71 for AUC-CSH, which was superior to SUVmax in the AUC-ROC ( $P=0.018$ ).

## CONCLUSION

Primary malignant MS tumors exhibited more heterogeneous intratumoral uptake than primary benign ones. Evaluation of the intratumoral heterogeneity of FDG uptake may be more helpful than SUVmax in discrimination between primary benign and malignant MS tumors.

## CLINICAL RELEVANCE/APPLICATION

Evaluation of the intratumoral heterogeneity of FDG uptake may help in discrimination between primary benign and malignant musculoskeletal tumors.

### **CL-NMS-SU2B • The Impact of 18F-Choline PET/CT in the Staging and Restaging of Prostate Cancer. First Single Center Experience in Lebanon**

**Mohamad B Haidar MD ; Mario G Jreige MD ; Marwan Haddad MD ; Jean Abi Ghosn MD ; Feras Chehade MD, PhD ; Tatiana Khoury MD (Presenter)**

#### PURPOSE

#### METHOD AND MATERIALS

#### RESULTS

18F-Choline showed positive findings in 64/86 pts (74%).

In the staging of patients, PET/CT detected a primary lesion within the prostate in 22/23 pts (96%), locale metastatic lymph node in 3/23pts (13%) and bone metastasis in 6/23 pts (26%).

In the restaging of patients PET/CT was negative in 21/23 pts (33%); however, there was local recurrence within the prostate bed in 22/63 pts (35%), nodal metastasis in 25/63 pts (39%) and extra nodal metastatic disease in 19/63 pts (30%).

In the staging group, patients with metastatic bone deposit were treated by pelvic radiotherapy and hormonal therapy rather than surgery.

In the restaging group, patients with localized recurrent disease (prostate bed and pelvic lymph node metastasis) were treated by radiotherapy 16/63 pts (25%). As for patients with multiple metastatic sites, they were treated by hormonal therapy and/or chemotherapy.

Therefore, 18F-CHOLINE PET/CT played a major role in altering the therapeutic management.

#### CONCLUSION

F18-PET/CT was able to detect distant metastasis in the staging of newly diagnosed prostate cancer.

It was also able to identify relapse and distant metastasis in the restaging of prostate cancer. This was even noteworthy in cases where PSA level elevation was inferior to 7ng/ml.

18F-choline PET/CT altered the therapeutic management of patients by guiding physicians towards a more suitable treatment modality especially in patients with only pelvic disease.

#### CLINICAL RELEVANCE/APPLICATION

F18-PET/CT was able to detect distant metastasis in the staging and restaging of prostate cancer and altered the therapeutic management by guiding physicians towards a more suitable treatment.

### **CL-NMS-SU3B • FDG PET-CT: Patterns and Imaging Features Following Percutaneous Cryoablation Treatment for Primary Non-Small Cell Lung Cancer**

**Robert Matthews MD ; Brendan Logiurato (Presenter) ; Elham Safaie MD ; William H Moore MD \* ; Thomas Bilfinger MD ; Nand Relan ; Dinko Franceschi MD**

#### PURPOSE

The aim of this study is to understand the patterns and imaging features of fluorodeoxyglucose (FDG) positron emission tomography with computed tomography (PET-CT) in post cryoablation lung cancer patients in order differentiate benign from malignant findings.

#### METHOD AND MATERIALS

We identified 24 patients with 26 lesions treated by percutaneous cryoablation for primary non-small cell lung cancer. Two patients had metastatic lesions with different ablation dates. Two experienced nuclear radiologists blindly reviewed baseline images and follow up FDG PET-CT scans for up to 36 months with discrepancy determined by consensus. Seventeen lesions had baseline PET-CT while 9 had CT only. Follow up PET-CT studies were obtained at 6, 12, 18, 24, and 36 months with variability due to adherence to protocol.

#### RESULTS

#### CONCLUSION

Patterns and imaging features of FDG PET-CT following percutaneous cryoablation are complex. New ablation site nodules or enlargement with focal FDG uptake predicts recurrence.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the changes of FDG PET-CT imaging is critical for evaluating treatment responses after percutaneous cryoablation of primary lung cancer.

### **CL-NMS-SU4B • Posttreatment FDG PET/CT in Predicting Survival of Patients with Ovarian Carcinoma**

**Linda C Chu MD (Presenter) ; Hua-Ling Tsai ; Mehrbod Javadi MD ; Teresa Diaz-Montes ; John Crandall ; Hao Wang ; Richard L Wahl MD \***

#### PURPOSE

The purposes of this study are to evaluate the prognostic value of posttreatment PET/CT in predicting survival of patients with ovarian carcinoma and to determine the incremental value of combining posttreatment PET/CT with CA-125 in predicting patient survival.

#### METHOD AND MATERIALS

This was an IRB approved retrospective study. From July 2001 to July 2011, 48 patients (mean age 58.1 years) who completed initial therapy for ovarian carcinoma with concurrent 3 to 9 month initial posttreatment PET/CT and serum CA-125 were identified from the radiology database. PET/CT reports were systematically reviewed to determine the presence or absence of suspected disease recurrence on PET/CT. Medical records were reviewed to determine patient demographics, initial tumor stage, CA-125 values near the time of PET/CT, and mortality. The prognostic value of posttreatment PET/CT and CA-125 were determined from time-dependent receiver operator curve (ROC) analysis to evaluate accuracy of PET/CT and CA-125 in predicting survival at 12, 24, 30, and 36 month follow-up.

#### RESULTS

Time-dependent ROC showed area under the curve for PET/CT was 0.7 at 12 month, 0.73 at 24 month, 0.76 at 30 month, and 0.75 at 36 month follow-up. The addition of PET/CT to CA-125 increased the area under the curve compared to PET/CT alone or CA-125 alone across all time points. For example, at the 24 month follow-up, area under the receiver operator curve was 0.93 for combination of PET/CT and CA-125, compared with 0.73 for PET/CT alone and 0.89 for CA-125 alone. ROC at 12, 30 month, and 36 month follow-up showed similar results.

#### CONCLUSION

Posttreatment PET/CT predicts survival of patients with ovarian carcinoma. The addition of posttreatment PET/CT to the CA-125 serum biomarker further improves prognostic accuracy. Combining imaging with serum biomarker provides superior diagnostic accuracy



compared to imaging alone.

#### CLINICAL RELEVANCE/APPLICATION

Posttreatment FDG PET/CT is useful in predicting survival of patients with ovarian carcinoma and further improves risk stratification when combined with serum CA-125.

### CL-NME-SU5B • Iatrogenic and Treatment-related 18F FDG Uptake in the Breast: What the Radiologist Needs to Know

**Kelli Y Ha** (Presenter) ; **Umesh D Oza** MD

#### PURPOSE/AIM

- ◆ Illustrate iatrogenic and post-treatment etiologies for abnormal breast FDG uptake
- ◆ Emphasize the importance of obtaining relevant clinical and surgical history prior to PET-CT interpretation
- ◆ Distinguish patterns of benign vs. malignant FDG uptake using relevant clinical/surgical history
- ◆ Provide histopathologic and radiologic correlation for several case examples

#### CONTENT ORGANIZATION

Multiple benign etiologies for abnormal breast FDG uptake exist. Many conditions arise from iatrogenic sources and post-treatment related change. These include lymphedema from lymph node dissection, radiation therapy, fat necrosis, abscess formation, chemotherapy port leak, silicone implant rupture, and changes from recent/remote mastectomy and breast reconstruction. Examples will be provided with histopathologic/radiologic correlation, and emphasis on the importance of obtaining relevant history discussed. Patterns of benign FDG uptake will be distinguished from neoplastic entities, providing the radiologist with a thorough understanding of the spectrum of breast FDG-avid lesions.

#### SUMMARY

Radiologists will become familiar with multiple etiologies of benign, post-treatment and iatrogenic causes for breast hypermetabolism. These examples will aid them in accurately describing and diagnosing non-neoplastic etiologies for breast FDG avidity on PET-CT given relevant clinical/surgical history.

### CL-NME-SU6B • Current Role of Lymphoscintigraphy in Oral Squamous Cell Carcinoma with a Focus on SPECT/CT

**Brandon P Olivieri** MD (Presenter) ; **Anjeza Chukus** MD ; **Nikki Tirada** MD ; **Alexander Daoud** BS ; **Chetan D Rajadhyaksha** MD ; **Jose A Pizarro** MD

#### PURPOSE/AIM

Lymphatic metastases are an important prognostic indicator in patients with oral squamous cell carcinoma (SCC). While modified radical neck dissection has been the diagnostic procedure of choice in early oral SCC, it frequently yields negative results while putting the patient at risk for procedure-related morbidity. Although knowledge of its utility has yet to become widespread, lymphoscintigraphy in oral SCC is an excellent staging and treatment planning tool given its high specificity. Through a review of the literature and 8 years experience at our institution, our objective is to review current evidence concerning lymphoscintigraphy in oral SCC, diagnosis pearls and pitfalls, and up-to-date recommendations for its utilization.

#### CONTENT ORGANIZATION

- Review the utility of lymphoscintigraphy for detection of lymphatic metastases in oral SCC.
- The different techniques and methods of performing and optimizing intraoral lymphoscintigraphy will be described.
- Pearls and pitfalls in diagnosis of lymphoscintigraphy with sample cases and corresponding surgical and pathological findings.
- Practicality and up-to-date recommendations on lymphoscintigraphy.

#### SUMMARY

The participant will gain familiarity with the acquisition, interpretation, current evidence, and clinical values of lymphoscintigraphic images in oral SCC.

## Multi-modal Imaging Workup for Alzheimer's Disease, Parkinson's Disease, and Related Disorders: Case-based Approach

**Sunday, 02:00 PM - 03:30 PM • S505AB**



[Back to Top](#)

**RC111** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### RC111A • FDG PET-CT Findings in Differential Diagnosis of Dementia

**Alexander Drzezga** MD (Presenter) \*

#### LEARNING OBJECTIVES

1) Principle of FDG-PET imaging of cerebral glucose mechanism. 2) Physiological and pathophysiological background. 3) Methodological aspects of FDG-PET imaging in the brain. 4) Differential diagnosis of non-neurodegenerative disorders leading to cognitive impairment. 5) Differential diagnosis between different forms of neurodegenerative disorders. 6) Combination of FDG-PET with other neuroimaging procedures (multimodal imaging).

### RC111B • Amyloid PET Findings in Alzheimer's Disease and Related Disorders

**Nicholaas I Bohnen** MD (Presenter)

#### LEARNING OBJECTIVES

1) To discuss methodological aspects of fibrillary beta-amyloid PET imaging. 2) To learn about practical interpretation of fibrillary beta-amyloid PET imaging. 3) To understand the long duration of prodromal phase of amyloidopathy and its importance of correlating it with clinical symptoms when reporting on amyloid PET studies. 4) To review the presence of amyloidopathy in non-Alzheimer dementias. 5) The discuss appropriate use criteria for amyloid PET in clinical practice.

#### ABSTRACT

### RC111C • Dopamine Transporter SPECT Findings in Parkinson's Disease and Related Disorders

**Satoshi Minoshima** MD, PhD (Presenter) \*

#### LEARNING OBJECTIVES

1) To describe mechanisms of dopamine transporter SPECT imaging. 2) To explain dopamine transporter SPECT procedure. 3) To discuss dopamine transporter SPECT findings in various movement disorders.

### RC111D • MRI Findings Commonly Seen in Dementia Patients

**Yoshimi Anzai** MD (Presenter)

**RC217** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**Moderator**  
**Heike E Daldrup-Link**, MD**RC217A • Hyperpolarized 13C MR-A Complementary Method to PET for Imaging in Vivo Metabolism****Daniel M Spielman** PhD (Presenter)

## LEARNING OBJECTIVES

1) Assess the basic principles of hyperpolarized 13C MRS, including sample preparation, image acquisition, and data analysis. 2) Differentiate metabolic parameters measurable by hyperpolarized 13C MRS from those obtained with PET. 3) Compare PET versus hyperpolarized 13C MRS sensitivities, spatial resolution, and temporal resolution.

**RC217B • MR/PET, A New Perspective of Molecular Imaging****Claus D Claussen** MD (Presenter)

## LEARNING OBJECTIVES

1) To learn about the evolution of MR/PET. 2) To become familiar with current MR/PET imaging strategies. 3) To be informed about clinical applications of MR/PET.

**RC217C • The Emerging Clinical Role of Hyperpolarized <sup>13</sup>C MR in Prostate Cancer Imaging****John Kurhanewicz** PhD (Presenter) \*

## LEARNING OBJECTIVES

1) Understand the clinical need and biochemical rationale for the use of hyperpolarized [1-<sup>13</sup>C] pyruvate for prostate cancer imaging. 2) Demonstrate a multi-hyperpolarized probe approach for simultaneously measuring prostate cancer metabolism and tumor micro-environment. 3) Demonstrate the utility of hyperpolarized <sup>13</sup>C MR for measuring prostate cancer aggressiveness and response to therapy. 4) Demonstrate the safety, clinical feasibility, sensitivity and resolution, and future availability of clinical hyperpolarized <sup>13</sup>C MR.

**RC217D • Brain Dedicated PET-MRI -How Far Are We?****Zang-Hee Cho** PhD (Presenter)

## LEARNING OBJECTIVES

1) For the study of neurochemical and molecular activities in the human brain In-Vivo. 2) Roles of the ultra-high field MRI and high resolution brain PET and their fusion product.

## ABSTRACT

Last decade or so nuclear medicine or molecular imaging has progressed substantially, especially with new brain dedicated PET such as HRRT and the ultra-high field MRI such as 7.0T. Combination of the two, that is HRRT-PET and 7.0T MRI MRI, designed for the brain dedicated molecular imaging began to provide a number of markedly improved images hitherto unavailable by the conventional systems. In this talk, recent development of PET-MRI fusion imaging focused onto the study of a number deep brain structures such as the hippocampus, the thalamus and brainstem would be discussed. For instance, brainstem molecular imaging of the raphe nuclei began to show individually resolved raphe nucleus glucose and serotonin transporter activities and suggesting us the potentials of the technique for to the study of the emotional and affect related disorders.

**Nuclear Medicine Series: Assessment of Cancer Treatment Response: Updates****VSNM21** • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:3.75**Moderator**  
**Lale Kostakoglu**, MD, MPH  
**Moderator**  
**Terence Z Wong**, MD, PhD \*

## LEARNING OBJECTIVES

1) Important methods used for evaluation of treatment response. 2) Examine important findings on PET CT using FDG PET and other novel tracers to understand how to avoid potential pitfalls. 3) Interpret relevant finding with FDG PET and other PET tracer to evaluate response in tumors. 4) Compare available novel tracers for evaluation of treatment response.

## ABSTRACT

The course is designed for nuclear medicine physicians and radiologists involved in the use of PET CT. The audience will gain knowledge on various clinical applications of FDG PET for evaluation of the therapy response in tumors. The audience will become familiar with novel PET tracers and their application for evaluation of the therapy response in tumors. At the end of the course the audience should be able to apply suitable techniques of FDG PET or other novel tracers for evaluation of the therapy response in tumors.

**VSNM21-01 • Response Assessment Recommendations in Hematologic Malignancies****Lale Kostakoglu** MD, MPH (Presenter)

## LEARNING OBJECTIVES

1) Recognize the strengths of FDG PET Imaging in evaluation of therapy response in lymphoma. 2) Understand the importance of interim evaluation of therapy response. 3) Recognize the weaknesses of FDG PET Imaging in evaluation of therapy response in lymphoma.

## ABSTRACT

There remains a need for a valid means to predict the completeness of therapy response and patient outcome, ideally at baseline, or at least early during treatment, to identify a patient subset with a poor-prognosis in whom continuation of ABVD treatment would be ineffective at achieving remission. [18F]-Fluoro-2-Deoxy-D-Glucose positron emission tomography, particularly integrated with computed tomography (PET/CT) imaging yielded promising results as a surrogate for tumour chemosensitivity and response even proving to be a more accurate predictor of prognosis compared with conventional prognostic factors for lymphoma. One of the most relevant hurdles for a full integration of interim PET scan in the overall therapeutic strategy of HL treatment to harness its prognostic value in the daily clinical practice, is the lack of simple, reproducible interpretation rules shared by the medical community. This depends not only on the uncertainty of boundary definition between "weekly" and "frankly" positive scan, but also from the clinical context in which interim PET is planned: for treatment intensification or de-intensification in case of interim positive or negative scan, respectively. It is evident, in fact, that in the first case a very high PPV and specificity are needed, while in the second a very high sensitivity and NPV are essential to avoid

under treatment. Various reading schemes have been used however recently more standardized approaches have been adopted. In this session interpretation criteria developed to be used for interim PET studies and also after completion of therapy will be reviewed to emphasize the strengths and weaknesses of PET as a response surrogate.

### **VSNM21-02 • Comparative Diagnostic Performance of <sup>18</sup>F-FDG PET/CT versus Whole-body MRI for Determination of Remission Status in Multiple Myeloma after Stem Cell Transplantation**

**Christoph Weber MD (Presenter) ; Silvia Muenster ; Kersten Peldschus MD ; Peter Bannas MD ; Christian R Habermann MD ; Nikolaus Kroger MD, PhD ; Gerhard B Adam MD ; Thorsten Derlin**

#### **PURPOSE**

To compare the diagnostic performance of whole-body magnetic resonance imaging (WBMRI) versus (18)F-fluorodeoxyglucose ((18)F-FDG) positron emission tomography/computed tomography (PET/CT) for determination of remission status in patients with multiple myeloma (MM) after stem cell transplantation (SCT).

#### **METHOD AND MATERIALS**

Thirty-one patients were examined by both WBMRI and PET/CT after SCT. Imaging results and clinical remission status as determined by the clinical gold standard (Uniform Response Criteria) were compared.

#### **RESULTS**

One hundred four lesions were detected in 21 patients. PET/CT had a sensitivity of 50.0 %, a specificity of 85.7 %, a positive predictive value of 62.5 %, a negative predictive value of 78.3 %, and an overall accuracy of 74.2 % for determination of remission status. MRI had a sensitivity of 80.0 %, a specificity of 38.1 %, a positive predictive value of 38.1 %, a negative predictive value of 80 %, and an overall accuracy of 51.6 %. Concordant results were observed in only 12 (11.5 %) of the 104 lesions.

#### **CONCLUSION**

In the post-treatment setting, both FDG PET/CT and WBMRI provide information about the extent of disease, allowing for a more comprehensive evaluation of persisting or recurrent myeloma. MRI may often be false positive because of persistent non-viable lesions. Therefore, PET/CT might be more suitable than MRI for determination of remission status.

#### **CLINICAL RELEVANCE/APPLICATION**

PET/CT is the method of choice for an imaging based determination of the remission status in multiple myeloma after stem cell transplantation.

### **VSNM21-03 • The PERCIST Assessment of Response to Radioimmunotherapy in Patients with Lymphoma by Measuring a Single, 5 and all Tumor Lesions**

**Joo Hyun O MD (Presenter) ; Heather Jacene MD ; Jeffrey P Leal BA ; Richard L Wahl MD \***

#### **PURPOSE**

To determine how well the different PET metrics in PET response criteria in solid tumor (PERCIST) correlate to each other for measuring fractional change before and after radioimmunotherapy.

#### **METHOD AND MATERIALS**

Patients with refractory or relapsed non-Hodgkin's lymphoma received Bexxar (n=35) or Zevalin (n=14) therapy. FDG PET/CT studies were obtained before the radioimmunotherapy and 12 weeks after single dose of radioimmunotherapy. Three different PERCIST metrics were measured from the baseline and the post therapy FDG PET studies: 1.) the peak standard uptake value corrected for lean body mass (SULpeak) of the single hottest tumor, 2.) the sum of up to the 5 hottest SULpeaks, and 3.) the total lesion glycolysis (TLG) of the entire tumor burden. The three PET metrics represent measurement of a single, up to the 5 hottest lesions, or the entire tumor burden. The fractional change for each PET metric was computed. (Percent change=[baseline measurement - follow-up measurement] ÷ baseline measurement.)

#### **RESULTS**

For patients treated with Bexxar, the percent change in a single SULpeak correlated with the change of up to 5 SULpeaks (r=0.932, p

#### **CONCLUSION**

Tracking the single hottest SULpeak before and after radioimmunotherapy shows high correlation with both the analysis of up to the 5 hottest lesions and the entire tumor TLG, both for Bexxar and Zevalin.

#### **CLINICAL RELEVANCE/APPLICATION**

Measuring just the one hottest SULpeak may adequately represent the entire tumor burden, saving the time and effort that goes into measuring multiple lesions.

### **VSNM21-04 • Role of <sup>18</sup>F NaF PET-CT in Tumor Response Assessment of Skeletal Metastasis from Prostate Cancer: A Preliminary Analysis**

**Bhushan Desai MD (Presenter) ; Evan Allgood ; Steven Cen PhD ; Hossein Jadvar MD, PhD**

#### **PURPOSE**

Conventional morphologic (CT) and functional (99m Tc-MDP bone scintigraphy) imaging methods for qualitative treatment response assessment of bone metastases have been inaccurate and poses a challenge in routine oncological practice and clinical trials. We hypothesize that bone-specific imaging with <sup>18</sup>F NaF PET-CT might address an urgent need to develop an objective method for assessing tumor response in bone lesions which can clinically help physicians determine the effectiveness of systemic therapy.

#### **METHOD AND MATERIALS**

Our preliminary analysis included 21 prostate cancer patients who underwent a baseline and a follow-up <sup>18</sup>F NaF PET-CT scan. Clinical (treatment), biochemical (PSA) and quantitative imaging (SUVmax) parameters were collected on these patients. Response was assessed using operational Imaging and PSA based treatment response criteria. Percentage change in AVG of SUVmax of all lesions for each patient was compared to changes in PSA and treatment, to assess if these changes correlated and accurately predicted treatment response. Patients were categorized as Progressors (P) vs. Non-Progressors (NP); Responders (R) vs. Non-Responders (NP) and cross-tabulation was done comparing Imaging and PSA-based response criteria.

#### **RESULTS**

R vs. NR: 14 of the 21 patients showed concordant response (66.67%). Of the 7 cases which were discordant: 3 were NR by Imaging but R by PSA with a change in treatment after the scan and 4 were R by Imaging but NR by PSA with only 1 patient undergoing change in treatment after the scan. P vs. NP: 7 of the 21 patients showed concordant response (33.34%). Of the 13 cases which were discordant: 5 showed P by Imaging but NP by PSA with a change in treatment after the scan and 8 were NP by Imaging but P by PSA with a change in treatment for only 2 patients.

#### **CONCLUSION**

Imaging based criteria captured progressors earlier than PSA and this was well correlated with the corresponding change in therapy post scan. Results of our preliminary analysis demonstrate that semi-quantitative analysis of <sup>18</sup>F NaF PET/CT might serve as an important imaging tool for monitoring tumor response in bone lesions. These preliminary findings need to be validated on a larger cohort of subjects and assessed in a variety of tumor types as it might have a major implication in patient management.

#### **CLINICAL RELEVANCE/APPLICATION**

<sup>18</sup>F NaF PET/CT might serve as an important imaging tool for monitoring tumor response in bone lesions.

## VSNM21-05 • Response Assessment Recommendations in Solid Tumors: RECIST vs PERCIST

**Heather Jacene MD (Presenter)**

### LEARNING OBJECTIVES

1) To compare anatomic and metabolic imaging for response assessment in solid tumors. 2) To discuss limitations of current, widely used criteria for assessing response in solid tumors. 3) To discuss the benefits and limitations of metabolic imaging for response assessment in solid tumors.

## VSNM21-06 • RECIST 1.0, PERCIST 1.0 and PSA Treatment Response Criteria in Metastatic Castrate-resistant Prostate Cancer

**Hossein Jadvar MD, PhD (Presenter) ; Bhushan Desai MD ; Lingyun Ji MS ; Susan Groshen PhD ; Chung Y Yu BS ; Tanya Dorff MD ; Jacek Pinski MD, PhD ; Peter S Conti MD, PhD ; David I Quinn MD, PhD**

### PURPOSE

Many novel therapies are under active evaluation for the treatment of men with metastatic castrate-resistant prostate cancer (CRPC). Anatomic (RECIST1.0), metabolic (PERCIST1.0) and PSA-based (PCWG2) criteria have been proposed for assessing treatment response in this clinical setting. We compared these guidelines in assessment of response to treatment and in relationship to overall survival in men with CRPC.

### METHOD AND MATERIALS

47 men with metastatic CRPC underwent FDG PET-CT before and 4-mo after start of new systemic therapy. Baseline and 4-mo data were compared using published operational RECIST 1.0, PERCIST 1.0 and PCWG2 definitions with some modifications. Patients were categorized as Responders (R) vs. Non-Responders (NR) and cross-tabulation was done comparing any 2 response criteria eliminating patients who were not evaluable based on either of 2 criteria in each combination. Association between overall survival and a specific response criteria status was calculated using the Kaplan-Meier method.

### RESULTS

Not all 47 patients were evaluable by all 3 criteria. RECIST 1.0 vs. PERCIST 1.0: 28 of 37 evaluable by both with 75.7% concordance and 9 cases discordant; 6 were NR by RECIST 1.0 but R by PERCIST 1.0 with 3 alive and 3 dead after 22 mo; 3 cases were R by RECIST 1.0 but NR by PERCIST 1.0, 2 died within 1.9 mo post 4-mo scan and 1 was alive at 18.1 mo. PCWG2 vs. RECIST1.0: 23 of 39 evaluable by both with 58.9% concordance and 16 cases discordant; 14 were R by PCWG2 but NR by RECIST 1.0 with 9 dead and 5 alive; 2 were NR by PCWG2 but R by RECIST 1.0 and both died within 1.9 m after 4-mo scan. PCWG2 vs. PERCIST 1.0: 31 of 43 evaluable by both PCWG2 and PERCIST 1.0 with 72.1% concordance and 12 cases discordant; 10 were R by PCWG2 but NR by PERCIST 1.0, 6 died and 4 were lost to follow-up, 2 were NR by PCWG2 but R by PERCIST 1.0, 1 died and 1 was alive at last follow-up.

### CONCLUSION

PERCIST 1.0 was more concordant than RECIST 1.0 with the PCWG2 response criteria and tended to be better associated with overall survival. PERCIST 1.0 may have a competitive advantage over RECIST 1.0 in the assessment of treatment response in metastatic CRPC (Supported by NIH grants R01-111613 and P30-CA014089; Clinical Trial Registration number NCT00282906)

### CLINICAL RELEVANCE/APPLICATION

Use of an appropriate treatment response criteria is pivotal for comparative effectiveness of various current and novel therapies in metastatic prostate cancer.

## VSNM21-07 • FDG PET/CT for Early Response Assessment in Patients (pts) with Advanced Melanoma (MEL) Receiving Immune Checkpoint Blockade

**Steve Cho MD (Presenter) \* ; Evan J Lipson MD ; Alin Chirindel MD ; Suzanne Topalian MD \* ; Drew M Pardoll MD, PhD ; Richard L Wahl MD \***

### PURPOSE

Immune checkpoint blockade with anti-CTLA-4 (ipilimumab) prolongs survival in ~20% of pts with advanced MEL, and blockade of the PD-1/PD-L1 pathway induces objective responses in some pts with MEL and other cancers. Traditional CT-based response criteria can be insufficient to measure the activity of these therapies, which can produce delayed or mixed tumor regressions preceded by apparent progressive disease (PD). In MEL pts receiving immune checkpoint inhibitors, we compared the ability of FDG PET and CT at 4 and 12 weeks of therapy to predict and evaluate clinical response.

### METHOD AND MATERIALS

Ten pts with MEL scheduled for treatment with ipilimumab (8 pts) or anti-PD-L1 (2 pts; BMS-936559) were enrolled. FDG PET/CT was performed at baseline (day -28 to 0) (PET1), and 4 wks (PET2) and 12 wks (PET3) after treatment initiation. The CT portion of the PET/CT was used for conventional restaging with RECIST 1.1 (REC) and WHO criteria. FDG PET was used for quantitative assessment with PERCIST 1.0 (PER). One pt was not able to receive PET3 due to rapid PD.

### RESULTS

At PET3, 9/10 pts demonstrated PD by all criteria; one pt with lymph node < 1.5 cm in short axis was not evaluable by REC, but had stable disease (SD) by WHO and complete response (CR) by PER. However, when evaluating only index lesions and excluding new lesions as PD, the response for these cohort of patients showed varying clinical benefit by REC (4 SD), WHO (3 SD, 1 partial response (PR)), or PER (1 CR, 1 PR, 2 SD). 8/9 pts had increased tumor FDG uptake at PET2 (7.8% to 211% increase from baseline) of whom 2 had CR or PR on PET3 (100% and 49% decrease from baseline). 1/9 pts had decreased tumor FDG uptake at PET2 (28% decrease from baseline). We observed a pattern of increased tumor FDG uptake and dimensions at PET2 with subsequent improvement by PET3, suggesting the presence of tumor inflammation (anti-tumor immune response) on PET2.

### CONCLUSION

Increased tumor FDG uptake at 4 weeks (PET2) may indicate inflammation preceding lesional response, or actual tumor progression. These preliminary data suggest that early increased FDG uptake may be necessary but not sufficient for tumor regression in pts receiving immune checkpoint blockade, requiring validation in larger trials.

### CLINICAL RELEVANCE/APPLICATION

Combined FDG PET/CT using an early 4 week and standard 16 week time-point may be used predict melanoma response assessment to immune checkpoint blockade therapy.

## VSNM21-08 • The Clinical Value of FDG PET/CT in Assessing Therapeutic Efficacy of Non-surgical Ablation Therapy for Radioiodine-negative Recurrent or Metastatic Thyroid Cancer

**Kunihiro Nakada (Presenter) ; Hiroki Sugie MD ; Keiichi Kamijo MD, PhD ; Masayuki Sakurai**

### PURPOSE

Percutaneous ethanol injection (PEI) and radiofrequency ablation (RFA) serve as feasible options for local control of radioiodine-ineffective thyroid cancer after surgery. The purpose of the study was to determine clinical value of PET/CT using F-18 fluorodeoxyglucose (FDG) in assessing therapeutic efficacy of PEI or RFA for radioiodine-negative metastatic thyroid cancer.

### METHOD AND MATERIALS

The study consists of 108 metastatic tumors from thyroid cancer (100 metastatic nodes in the neck or mediastinum and 8 metastatic bone tumors) in 76 patients (PCA/FCA 68/8) who had underwent total thyroidectomy and radioiodine ablation. All patients received high dose I-131 therapy. However, I-131 uptake in the metastatic tumor on the post-therapy scan was no or equivocal. Additionally, patients had reluctance to further surgery or were at high risk for surgery due to other complications. Patients underwent FDG PET/CT within

2mos. prior to and between 1 and 2 mos. post completion of ablation therapy. FDG uptake in the tumor was visually assessed as positive or negative. Patients were followed up for 14-66mos. (median 31) to investigate clinical course of the treated tumors. Efficacy of PEI or RFA was determined based upon RECIST 1.1. Achievement of CR or PR was considered as successful.

## RESULTS

On the pre-treatment PET/CT, all 109 tumors were FDG positive. Then 99 were treated by PEI while 9 were treated by RFA. On the post-treatment PET/CT, FDG uptake was negative in 76 (70%) and was persistently positive in the remaining 33 (30%). In the FDG negative tumors, CR and PR were observed in 55 and 20, respectively. Regrowth of the tumor was seen in 8 (11%). In the FDG positive tumors, PR were seen in 13 while remaining 20 showed SD. Regrowth of the tumor was seen in 15 (45%). The PPV, NPV and accuracy of FDG PET/CT for successful outcome of ablative therapy were 99%,61% and 88%.

## CONCLUSION

Almost all tumors with negative FDG uptake after treatment showed good response. In contrast, tumors with persistent FDG uptake were associated with poorer response and the risk of tumor regrowth was 4 times higher than that in FDG negative tumors. FDG PET seems valuable in assessing efficacy of non-surgical ablation therapy for metastatic thyroid cancer.

## CLINICAL RELEVANCE/APPLICATION

Application of FDG PET/CT may enhance clinical value of non-surgical ablation therapy and may improve management of radioiodine-negative metastatic thyroid cancer.

### VSNM21-09 • Response Assessment Recommendations after Radiation Therapy

**Terence Z Wong** MD, PhD (Presenter) \*

#### LEARNING OBJECTIVES

1) Understand the physiology of normal tissue response to radiation therapy. 2) Understand potential limitations of PET/CT imaging following radiation therapy. 3) Suggest potential strategies for evaluating patients following radiation therapy.

#### ABSTRACT

FDG-PET/CT imaging following radiation therapy can be complicated, due to the resulting inflammatory response. These post-radiation effects can mimic residual or recurrent tumor, and may preclude accurate determination of response to therapy. The extent to which radiation therapy effects influences interpretation of PET/CT scans is highly dependent on the organ site and time-dependent normal tissue response. Armed with this knowledge, it is often possible to distinguish radiation changes from tumor. Several strategies are available to improve accuracy of post-treatment PET/CT. Waiting for several months following radiation therapy allows the inflammatory response to subside. Alternatively, imaging early in the course of radiation therapy may allow response to be evaluated before the inflammatory response occurs. Alternative PET tracers, such as F-18 fluorothymidine as a marker of cell proliferation, may be less affected by the inflammatory reaction. Therapeutic strategies can be designed to minimize the impact of radiation effects; for example chemotherapy can be initiated prior to combined chemoradiation, allowing PET/CT to measure the response to the chemotherapy prior to starting radiation therapy.

### VSNM21-10 • Early Assessment of Therapeutic Response of Radioimmunotherapy (RIT) in Non-Hodgkin Lymphoma: Comparing Tumor Volume Reduction and Metabolic PET Measurements in Prediction of Progression Free Survival (PFS)

**Ehab H Youssef** MD, FRCR (Presenter) ; **Yuni K Dewaraja** PhD ; **Hatice Savas** MD ; **Matthew Schipper** ; **Shen Jincheng** ; **Mark S Kaminski** \* ; **Anca Avram** MD

#### PURPOSE

To evaluate if initial tumor volume reduction and metabolic response predicts progression free survival (PFS) in patients with advanced follicular non-Hodgkin lymphoma (NHL) receiving 131-I Tositumomab therapeutic regimen. Tumor volumes were measured on CT component of SPECT/CT (at 6 days and 2 weeks), and of PET/CT at 2 months post-RIT; qualitative metabolic response (defined as positive or negative ♦complete metabolic response♦ for disease) was assessed on PET/CT at 2 months post-RIT. Clinical and imaging follow-up was continued for all patients until they progress 1-51.5 months (average 9.3).

#### METHOD AND MATERIALS

A group of 53 patients (37 males, 16 females), with advanced (stage III or stage IV) chemotherapy-refractory follicular B-cell lymphoma, aged 33-81 years (median age 54) received 131-I Tositumomab therapy based on whole body dosimetry calculations with the goal of delivering 75 cGy whole body radiation absorbed dose for patients with platelets > 150,000/mL, or 65Gy for patients with platelets

#### RESULTS

51 patients (96%) had tumor shrinkage, 26 of them (49%) had =30% shrinkage in 2 weeks, and 25 (47%) had = 73% shrinkage at 2 months.

Statistically significant correlation between progression free survival (PFS) and tumor volume reduction of =30% on CT portion of SPECT-CT (at 2 weeks) and = 73% on PET-CT (at 2 months) was observed (p= 0.0013), and (p< 0.0001) respectively.

Statistically significant correlation between PFS and complete metabolic tumor response on post-therapy PET-CT (2 months) (p< 0.0001) was observed.

#### CONCLUSION

Initial tumor volume reduction and complete metabolic response (in PET) can be used to predict PFS, hence can potentially be used to customize future treatment protocols for NHL patients.

#### CLINICAL RELEVANCE/APPLICATION

Initial tumor volume reduction and complete metabolic response (in PET) can be used to predict PFS, hence can potentially be used to customize future treatment protocols for NHL patients.

### VSNM21-11 • 18F-fluorodeoxyglucose Positron Emission Tomography (PET) Response to Stereotactic Body Radiotherapy (SBRT) in Metastatic Melanoma

**Miran J Blanchard** MD (Presenter) ; **Zachary C Wilson** MD ; **Brandon M Barney** MD ; **Gregory Wiseman** ; **Kenneth R Olivier** MD ; **Sean S Park** MD, PhD ; **Svetomir Markovic** MD, PhD

#### PURPOSE

We report our SBRT experience for extracranial melanoma metastases to objectively characterize the PET metabolic response.

#### METHOD AND MATERIALS

32 metastatic melanoma patients (pts) treated with SBRT with baseline and post-SBRT PETs were identified in our prospectively maintained database from 2008 to August 2011. PET metabolic response was evaluated per PERCIST 1.0 criteria: Complete response (CR) was a decrease in the maximum standard uptake value corrected for lean body mass (SUL) to 1.5 times the liver mean + 2 standard deviations, partial response (PR) was a 30% decrease in SUL, progressive disease (PD) was > 30% increase in SUL and stable disease (SD) was any lesion not fitting these criteria. Local control (LC) included CR, PR, and SD.

#### RESULTS

57 lesions treated with SBRT and 174 pre- and post-SBRT PET scans were analyzed. Median follow-up (f/u) was 1.6 years. Sites of treated lesions were: 15 musculoskeletal, 14 liver, 14 lung, 12 abdominal, 2 extra abdominal lymph nodes. Median single-fraction equivalent dose (SFED) was 43 Gy (range 18-56 Gy). A median of 5 PET scans (range 2-6) were evaluated for each lesion. LC was 92% and 87% and overall survival was 59% and 29% at 1.5 and 3 years, respectively. Median time to CR was 2.8 months (0.7-15 months). CR was achieved in 49 lesions (86%), and 44 lesions maintained CR at last f/u. Median f/u for lesions in continuous CR was 18 months (0.9-36.5). PR, SD, and PD were 9%, 4%, and 10%, respectively. SFED = 24 Gy correlated with PD (HR 17, p=0.01). At initial f/u (median 2 months), CR was 60%, and 9 lesions (16%) had increased SUL. These 9 lesions resolved to 6 CR, 1 SD, and 2 PD with

subsequent f/u. One patient is alive with no evidence of disease (NED) and one patient with NED died of other causes. Three patients had NED on PET and died suddenly of CNS metastasis. 28% developed CNS metastases at a median of 5 months (0.2-32 months) after SBRT.

#### CONCLUSION

SBRT is highly effective in inducing a complete metabolic response in melanoma. A SFED of > 24 Gy has been validated as a predictor of lesion control. 16% of lesions had a SUL rise at initial f/u with the majority subsequently achieving CR with no additional local therapy. Three pts with NED on PET died suddenly of brain metastases. Screening brain MRI prior to SBRT for oligometastatic melanoma should be considered.

#### CLINICAL RELEVANCE/APPLICATION

SBRT leads to a high rate of complete metabolic response in metastatic melanoma.

### **VSNM21-12 • Cu-ATSM Uptake May Predict Prognosis after Treatment in Advanced Head-and-Neck Cancers: Evaluation of Resistant Hypoxic Tissue with Tumor-to-Muscle Ratio**

**Yoshitaka Sato MD ; Myungmi Oh MD, PhD ; Tetsuya Mori PhD ; Yasushi Kiyono PhD ; Shigeharu Fujieda MD, PhD ; Hidehiko Okazawa MD, PhD (Presenter)**

#### PURPOSE

To delineate hypoxic tissue in head-neck cancers, [<sup>62</sup>Cu]diacetyl-bis(N<sup>4</sup>-methylthiosemicarbazone) (Cu-ATSM) PET was employed and tracer distribution was compared with [<sup>18</sup>F]fluorodeoxyglucose (FDG). Predictability of effectiveness of tumor treatment was compared between the 2 tracers.

#### METHOD AND MATERIALS

Thirty patients with head-and-neck cancer (mean age: 67 ± 13 y.o.) underwent Cu-ATSM-PET and FDG-PET/CT within a week interval. For Cu-ATSM PET images, 20-min dynamic data acquisition was performed after 600-800 MBq tracer injection, and 10 to 20 min data were used for analysis. After co-registration of Cu-ATSM-PET and FDG-PET/CT images, region of interest (ROI) was placed on the tumour mass using the threshold of 40% of maximum value for each PET image to obtain standardized uptake values (SUV) and maximum SUV (SUV<sub>max</sub>) of each tumour. SUV values of the muscles in the head-and-neck region were also obtained and tumour-to-muscle (T/M) ratio for each tracer was calculated. Patients were followed up at least 6 months after the treatment by using CT, MRI or FDG-PET/CT, and progression-free survival (PFS) period was compared using Kaplan-Meier Logrank analysis. The end-point of the follow-up for PFS was set at the time of recurrence or metastasis of the cancer. Relationships between PET parameters and PFS period were analyzed to assess which was the most appropriate parameter to predict prognosis of head-and-neck cancers.

#### RESULTS

Twenty-eight of the patients received chemoradiation therapy and 2 underwent surgical treatment only. The mean PFS period was 12.6 ± 9.5 months, and 14 patients showed recurrence or metastasis. Patients were divided into 2 groups of higher and lower uptake of tracers using SUV<sub>max</sub> and T/M ratio. Threshold was determined by ROC analysis for each PET parameter, and PFS was compared between the 2 groups. The patient groups determined by the T/M ratio of Cu-ATSM showed significantly different PFS; i.e. higher T/M ratio showed poor PFS compared with the lower T/M ratio group. Other PET parameters did not show significant difference in PFS.

#### CONCLUSION

The high Cu-ATSM T/M ratios predicted the poor prognosis after treatment in patients with head-and-neck cancer. SUV<sub>max</sub> and FDG-T/M ratio were not good indicators of prognosis after the cancer treatment.

#### CLINICAL RELEVANCE/APPLICATION

Cu-ATSM PET is expected to be useful for detection of resistant malignant tumours.

## **Nuclear Medicine - Monday Posters and Exhibits (12:15pm - 12:45pm)**

**Monday, 12:15 PM - 12:45 PM • S503AB**



[Back to Top](#)

**CL-NMS-MOA • AMA PRA Category 1 Credit™:0.5**

**Host**

**Amir H Khandani , MD**

**CL-NME-MO1A • Three-dimensional Reformatted PET/CT for Assessing Therapy Response in Lung Cancer**

**Seoung-Oh Yang MD, PhD (Presenter) ; Hong Je Lee MD ; Sang Ho Lee**

#### PURPOSE/AIM

Three-dimensional (3-D) displays for medical imaging are now emerging field and very promising tools for diagnosis, therapeutic response monitoring and detection of tumor recurrence. Morphological criteria for defining therapy response (CR, PR, SD, PD) have been established with RECIST (Response evaluation criteria in solid tumors). Furthermore, 3-D imaging taken from PET/CT can be an excellent approach to assess the tumor response after appropriate therapy. In this educational presentation, we will discuss the TrueD application of F-18-FDG PET/CT for both initial staging and post-therapeutic follow-up in patients with lung cancers.

#### CONTENT ORGANIZATION

Over five hundred lung cancer patients with more than two PET/CT images enrolled in this study. A. Methods of producing 3-D PET/CT images using TrueD software with appropriate palettes. B. Among many galleries, the most optimal palette will be recommended according to various metastatic lesions. C. Monitoring of tumor response to therapy was assessed using these 3-D PET/CT images.

#### SUMMARY

The development of three- and four-dimensional image processing will lead medical imaging to full definition volumetric display for clinician as well as patients themselves. VOIs (volume of interests) of 2 or 3 time points display can be saved and exported as a comprehensive images through the PACS systems.

**CL-NMS-MO2A • Scintigraphic Assessments of Reparative Process in Osteonecrosis of the Femoral Head Using Bone SPECT/CT Fused Imaging**

**Goro Motomura (Presenter) ; Takuaki Yamamoto MD, PhD ; Koichiro Abe MD ; Yasuharu Nakashima ; Masanobu Ohishi ; Satoshi Hamai ; Hiroshi Honda MD ; Yukihide Iwamoto**

#### PURPOSE

The purpose of this study was to assess the fused imaging of SPECT/CT with 99mTc-HMDP in early-stage osteonecrosis of the femoral head for the better understanding of the reparative process of the disease.

#### METHOD AND MATERIALS

We retrospectively evaluated the SPECT/CT imaging, which were performed after femoral osteotomy to confirm the viability of the proximal bone fragment. Consecutive 23 hips with untreated osteonecrosis of the femoral head contralateral to the osteotomized hips were the subjects of this study. Patients included 16 males and seven females with a mean age of 40.4 years. According to the classification system, 12 hips were classified as stage1 (defined as no radiographic abnormality), six hips were stage2 (demarcating sclerosis is seen



without femoral head collapse), and five hips were stage 3A (less than 3mm femoral head collapse). All SPECT/CT images were processed on a workstation and analyzed by a single experienced nuclear medicine physician, who was blind to all patients' information including staging. The lesion which shows the highest uptake count within the femoral head on SPECT/CT imaging was recorded. The degree of uptake in each case was assessed by the count ratio, which was defined as the highest count within the femoral head divided by the average uptake count of ipsilateral femur at the level of the distal end of lesser trochanter.

#### RESULTS

In stage-1 hips, the highest uptake count tended to be seen at the anterior region of the femoral head (11 of 12 hips). Meanwhile, in both stage-2 and 3A hips, the highest uptake count was more likely to be observed at the lateral region of the femoral head (five of six hips and all five hips, respectively). The count ratios of stage-2 and 3A were significantly higher than those of stage-1. Based on the analysis of Spearman rank correlation coefficient, a count ratio was positively correlated with progression of the ONFH stages.

#### CONCLUSION

The current study indicated that, during the time before collapse, there may be a gradual increase in osteoblastic activity around the necrotic lesion, shifting the main region from anteriorly to laterally. SPECT/CT imaging will be helpful for the better understanding of the repair mechanisms as well as the pathophysiology of ONFH.

#### CLINICAL RELEVANCE/APPLICATION

SPECT/CT clearly demonstrated the osteoblastic activity in the early stages of osteonecrosis of the femoral head.

### CL-NMS-MO3A • The Role of 99mTc-MDP Bone Scintigraphy in the Workup of Patients with Hepatocellular Carcinoma

**Khun Visith Keu MD, FRCPC (Presenter) ; Glen Lutchman ; Andrew Quon MD ; Erik S Mittra MD, PhD ; Andrei Iagaru MD \***

#### PURPOSE

Bone scintigraphy (BS) is part of the standard of care staging workup of patients with hepatocellular carcinoma (HCC) considered for liver transplantation. The UCSF criteria for liver transplantation are less stringent than the Milan criteria and the value of BS has not been tested in this setting. Therefore, we retrospectively analyzed the value of BS in patients evaluated under UCSF criteria, a group with potentially higher risk for bone metastases.

#### METHOD AND MATERIALS

We retrospectively reviewed all HCC patients evaluated for liver transplantation who had BS at our institution from January 2008 to April 2012. Patients without BS performed within 3 months of routine clinical workup were excluded. BS results were catalogued as malignant, indeterminate or benign based on the original image interpretation. Findings were correlated with other imaging procedures (including subsequent BS), biopsies and/or clinical follow-up. The cohort was then divided into 3 groups: Milan +, Milan -/UCSF + and UCSF -.

#### RESULTS

A total of 785 patients were evaluated for liver transplantation: 592 patients did not have a BS and 31 did not have a scan performed within 3 months from the initial visit. Therefore, only 162 patients (114 male; 38 female) with an average age ( $\pm$ SD) of 58.9 year-old ( $\pm$  7.2) were eligible. The majority of patients (92%, N=149) had negative BS, but 8 (4.9%) had indeterminate and 5 (3.1%) had positive BS for metastases. In the Milan + group (N = 103), there were 98 negative BS, 4 indeterminate BS and 1 positive BS. The Milan -/UCSF + group (N = 22) had 18 negative BS, 2 indeterminate BS and 2 positive BS. Lastly, the UCSF  $\diamond$  group (N = 37) had 33 negative BS, 2 indeterminate BS and 2 positive BS. On follow-up, only 2 patients were diagnosed with bone metastasis.

#### CONCLUSION

Abnormal BS findings (indeterminate and positive cases) were more frequent in the Milan -/UCSF + group than the Milan + or UCSF  $\diamond$  groups. However, true positive bone metastases were rare. The impact of BS in the workup of HCC patients considered for liver transplantation should be re-evaluated from a healthcare cost analysis perspective.

#### CLINICAL RELEVANCE/APPLICATION

Bone metastases are rare in HCC patients considered for liver transplantation: a bone scintigraphy should not be performed routinely.

### CL-NMS-MO4A • Tc99m Labeled WBC SPECT/CT is Not Inferior to MRI for Diagnosis of Biopsy Proven Diabetic Foot Osteomyelitis

**Francisco J Lazaga MD (Presenter) ; Kavita Bhavan MD ; Kenrick Lam BS ; Lawrence Lavery DPM ; Javier La Fontaine DPM ; Orhan K Oz MD, PhD ; William A Erdman MD**

#### PURPOSE

MRI is the recommended diagnostic imaging test for diabetic foot osteomyelitis (DFO) with a reported 79% accuracy (Dinh et al, 2008). The accepted standard for diagnosing osteomyelitis in the clinical infectious diseases literature is the presence of abnormal bone culture or histopathology findings from bone biopsy studies (Lipsky et al, 2012). Our purpose is to assess the accuracy of hybrid image Tc99m labeled WBC SPECT/CT for diagnosis of diabetic foot osteomyelitis as determined by bone biopsy results in comparison to MRI.

#### METHOD AND MATERIALS

We performed a retrospective chart review of 71 patients who underwent Tc99m labeled WBC SPECT/CT and bone biopsy between 2011 to 2013 to confirm the diagnosis of diabetic foot osteomyelitis. Twenty five of the 71 patients had MRI in addition to SPECT/CT. Patients whose scan(s) was not within a clinically relevant timeframe of biopsy, determined to be eight weeks, were excluded.

#### RESULTS

Forty three of 71 SPECT/CT patients met our inclusion criteria. The sensitivity, specificity, PPV, NPV and accuracy of SPECT/CT were 0.91, 0.25, 0.84, 0.4 and 0.79 respectively. Fifteen of 25 MRI patients met our inclusion criteria and the corresponding values for MRI were 0.67, 0.67, 0.89, 0.33 and 0.67 respectively. Nine patients had both MRI and SPECT/CT within 8 weeks of bone biopsy. Three of the 9 patients had discordant results between the MRI and SPECT/CT. SPECT/CT gave the correct diagnosis for 2/3 patients while MRI was correct for 1/3 patients.

#### CONCLUSION

Our data suggests that SPECT/CT is not inferior to MRI in the diagnosis of diabetic foot osteomyelitis. Furthermore SPECT/CT results correlate well with the bone biopsy results.

#### CLINICAL RELEVANCE/APPLICATION

Currently MRI is the gold standard in the radiologic diagnosis of diabetic foot osteomyelitis. This study suggests that Tc99m labeled WBC SPECT/CT is a suitable substitute.

### CL-NMS-MO5A • Impact and Correction of Erroneous Lung Segmentation in PET/MR Using a Three-segment Model Attenuation Correction Based on a 3D Multi-station T1-weighted Spoiled Gradient Echo Sequence

**Christian Rubbert MD (Presenter) \* ; Andres Kohan MD \* ; Jose L Vercher-Conejero MD \* ; Sasan Partovi BS \* ; Peter F Faulhaber MD \* ; Raymond Muzic PhD \* ; Karin A Herrmann MD**

#### PURPOSE

To assess the impact of erroneous lung segmentation in PET/MR on the quantification of FDG-avid lesions in the chest, and to propose methods to correct for these errors. Quantification depends on accurate MR attenuation correction (MRAC) maps, which, in turn, depend on correct segmentation of the MR image volume. Mis-segmentation may occur in the presence of metallic implants or artifactually increased signal in the lungs.

#### METHOD AND MATERIALS

3D T1w spoiled gradient echo images are segmented to identify air, lung, and soft tissue. In the lung, region growing is seeded by

histogram analysis and borders are extended to lung/soft tissue interfaces. Images from 100 patients enrolled in a PET/CT and sequential PET/MR double-scanning protocol were reviewed to identify cases in which large portions of the lungs were misidentified. Mis-segmentation was corrected by filling in metal voids in the T1w image volume, which caused 3D growing to fail, or by depressing spurious pixel values in the lungs. The modified T1w image volumes were segmented for MRAC.  $SUV_{max}$  and  $SUV_{mean}$  of VOIs of corresponding chest lesions were recorded in PET/CT and PET/MR in both failed and corrected datasets. Bland-Altman analysis was performed to assess agreement between modalities.

#### RESULTS

PET/CT was acquired 70.9±12.1 min after FDG injection and PET/MR 31.5±22.1 min after PET/CT. Lung segmentation failed in 14 cases. Each correction method was applied in 6 cases, respectively. 2 could not be corrected. 40 lesions were identified within the chest in 7 subjects. Mean  $SUV_{max}$  differences, PET/MR minus PET/CT, and (limits of agreements) for all lesions were 2.10 (-2.10 to 6.32) with failed segmentation and 0.88 (-0.50 to 2.27) with corrected segmentation. The corresponding values for the  $SUV_{mean}$  were 0.72 (-0.62 to 2.05) and 0.19 (-0.46 to 0.84). The mean differences decreased and the limits of agreement were narrower with the corrected segmentation in all anatomical sub-regions.

#### CONCLUSION

The critical impact of mis-segmentation of the lungs is demonstrated by wide limits of agreement and mean SUV overestimation. Correction is feasible and resulted in improved mean differences and narrower limits of agreement in all cases.

#### CLINICAL RELEVANCE/APPLICATION

Failed lung segmentation in PET/MR affects and overestimates the SUV, which, in turn, may have critical impact on a patient's therapy. Screening and correction of mis-segmentation is recommended.

### **CL-NMS-MO6A • Evaluation of Staging and Response to Chemotherapy with Whole-body Diffusion-weighted Magnetic Resonance Imaging in Malignant Lymphoma Patients: A Comparison with FDG-PET**

**Kazunobu Tsuji ; Tatsuro Tsuchida MD, PhD ; Shinji Kishi ; Hidehiko Okazawa MD, PhD ; Hirohiko Kimura MD, PhD**  
(Presenter)

#### PURPOSE

The purpose of this study was to examine the utility of diffusion-weighted magnetic resonance imaging (DW-MRI) for staging and evaluation of response to chemotherapy in patients with malignant lymphoma in comparison to fluorodeoxyglucose positron emission tomography (FDG-PET).

#### METHOD AND MATERIALS

Participants comprised 28 patients with histologically confirmed malignant lymphoma (diffuse large B-cell lymphoma, n = 17; follicular lymphoma, n = 11). All patients underwent both magnetic resonance imaging and FDG-PET before (pre-treatment) and after 2 courses of chemotherapy (mid-treatment). Staging with MRI (DW-MRI only and with T2-weighted imaging) and FDG-PET were compared visually and the concordance rate (kappa value; ?) was calculated. To evaluate response to chemotherapy, patients were divided into 2 groups based on response evaluation criteria: complete remission (CR) or non-CR. Progression-free survival (PFS) and overall survival (OS) were compared between groups using the Kaplan-Meier method.

#### RESULTS

Stage diagnosed by DWI alone and by FDG-PET was concordant in 19 patients (? = 0.67, p < 0.05), and addition of T2-WI increased the number of concordant patients to 23 (? = 0.89, p < 0.05). On mid-treatment imaging, 19 patients were diagnosed as CR from both images. PFS differed significantly between CR and non-CR on both DW-MRI (p = 0.0013) and FDG-PET (p = 0.037). However, OS did not differ significantly between DW-MRI (p = 0.452) and FDG-PET (p = 0.452).

#### CONCLUSION

DW-MRI appears to be a promising tool for staging and evaluation of response to chemotherapy in patients with malignant lymphoma.

#### CLINICAL RELEVANCE/APPLICATION

DW-MRI and FDG-PET could be used depending on the availability of equipment within an institution, or could be chosen depending on the advantages, drawbacks and contraindications of each modality.

## **Nuclear Medicine - Monday Posters and Exhibits (12:45pm - 1:15pm)**

### **Monday, 12:45 PM - 01:15 PM • S503AB**



[Back to Top](#)

#### **CL-NMS-MOB • AMA PRA Category 1 Credit™:0.5**

### **CL-NMS-MO1B • Comparison of 99M-TC-MDP Bone Scintigraphy and 18F-FDG-PET/CT for the Detection of Skeletal Metastases**

**Connie Y Chang MD (Presenter) ; Corey Gill ; Frank J Simeone MD ; Atul K Taneja MD ; Martin Torriani MD ; Miriam A Bredella MD**

#### PURPOSE

To compare the accuracy of fluorine-18-fluorodeoxyglucose positron emission tomography/computed tomography (PET/CT) with technetium-99m-bone scintigraphy (bone scan) for the detection of skeletal metastases.

#### METHOD AND MATERIALS

The study group comprised 202 adult cancer patients who underwent both PET/CT and bone scan within 31 days for staging. Bone scans and PET/CT were evaluated by two musculoskeletal radiologists in consensus for the presence and location of skeletal metastatic disease. In cases of discordance between the two modalities, confirmation of the final diagnosis was based on the CT or MR appearance, follow-up imaging or histology.

#### RESULTS

The sensitivity, specificity, and accuracy of PET/CT were 97%, 98%, and 98% respectively, and the sensitivity, specificity, and accuracy of bone scan were 83%, 98%, and 93%, respectively. The lesions that bone scan most commonly missed were located in the pelvis, spine, and sacrum. PET/CT missed mostly lesions that were outside of the field of view, but in all of these cases the patient had additional sites of skeletal metastatic disease. Bone scan falsely identified 6 metastatic lesions (spine, pelvis, and humerus) and PET/CT falsely identified 3 metastatic lesions (spine, pelvis, and clavicle).

#### CONCLUSION

PET/CT is an accurate technique for detection of skeletal metastases, and is superior to bone scan, especially in the spine and pelvis.

#### CLINICAL RELEVANCE/APPLICATION

PET/CT and bone scan are performed concurrently for skeletal metastases, resulting in increased patient radiation dose and health care dollars spent; we show that PET/CT alone may be sufficient.

### **CL-NMS-MO2B • Osteochondral Talar Lesions: SPECT-CT Contribution to MRI**

**Ignacio Lopez-Vidaur Franco (Presenter) ; Adolfo Gomez Grande ; Beatriz Alvarez De Sierra Garcia MD ; Luis Banuelos**

## Andrio

### PURPOSE

The osteochondral lesion in the dome of the talus is one of the most frequent treatable causes of chronic inexplicable pain. SPECT-CT, whose impact in the treatment of this kind of lesion is not well known, can supply additional information to the MRI findings. The objective of the present research is to assess the utility of SPECT-CT in detecting and localizing osteochondral lesions in the talar dome analyzing the additional information to the MRI findings and its impact in the taking of therapeutic decisions.

### METHOD AND MATERIALS

From October 2011 to January 2012 we conducted three-phase scintigraphy Tc99m-DPD/MPD and SPETC-CT studies to 10 patients with osteochondral talar dome lesion in the MRI. We analysed the matching between the focal uptake and degree of osteochondral lesion, its exact location and the correlation in the MRI image of the additional findings of SPECT-CT. We consulted to the responsible physician about the influence of SPECT-CT in the diagnosis and management (surgical / conservative).

### RESULTS

We analyzed 10 patients with talar osteochondral lesion. In 2 absence active osteoblastic reaction was observed. In the remaining 8 studies where osteochondral lesion with osteoblastic activity was observed in 4 of them the SPECT-CT showed additional findings (1 reflex sympathetic dystrophy, 2 similar injury contralateral ankle, 1 intense uptake in tibiofibular syndesmosis). And the remaining 4 SPECT-CT studies showed a single focal uptake coincident with MRI. Surgical treatment was indicated in 3 of them. In studies with multifocal deposits (4) or osteochondral lesion without osteoblastic activity (2), the SPECT-CT supported a conservative approach.

### CONCLUSION

SPECT-CT provides additional useful information to MRI, suggesting other possible causes of pain and helping to decide a conservative management when the osteochondral lesion of the talus shows no osteoblastic activity.

### CLINICAL RELEVANCE/APPLICATION

Adding SPECT-CT to MRI can help to prevent unnecessary surgeries depending on the results.

## CL-NMS-MO3B • Role of 18F-FDG-PET/CT in the Follow Up of Bone Lesions Treated with Thermal Ablation

**Desiree Deandreis MD (Presenter) ; Frederic Deschamps ; Camila Nascimento ; Sophie Leboulleux ; Jean Lumbruso MD ; Clarisse Dromain MD ; Caroline Caramella ; Martin Schlumberger ; Thierry Debaere**

### PURPOSE

to evaluate the interest of FDG-PET/CT in the assessment of bone thermal ablation -radiofrequency ablation (RFA) or cryoablation (CRY)- efficacy in case of inconclusive morphological imaging.

### METHOD AND MATERIALS

Ten patients (4M, 6F; mean age: 54 ys) treated with curative intent by thermal ablation for painful bone metastases and studied by FDG PET/CT before and within 6 months after treatment were retrospectively evaluated. In all patients post-treatment morphological imaging (CT scan and/or MRI) were inconclusive. A visual and semi-quantitative analysis (SUVmax) of PET images was performed. A significant persistent uptake after treatment was considered when superior to background (normal bone uptake). A decrease of at least 90% of SUV max value was considered as complete response. Gold standard for response was clinical follow up.

### RESULTS

A total of 20 metastatic bone lesions treated by RFA (n=10), CRY (n=7) or thermal ablation (2 RFA and 1 CRY) combined with cementoplasty were analysed. Bone lesions were localised in the pelvis (n=12), in the spine (n=7) and in the rib (n=1). They were respectively lytic (n=12), blastic (n=5) or mixed (n=3) lesions. Median size was 25 mm (8-43). At final follow up (10 months, 5-24) 18 and 2 lesions were considered respectively completely and incompletely treated. At PET/CT, 15 completely treated lesions showed a ring shape homogeneous peripheral mild FDG uptake and a pre-ablation and post-treatment median SUVmax of 3.9 (1.5-16.4) and 2.2 (0.6-5.3) respectively. The remaining 3 cases were lesions treated by ablation and cementoplasty and showed persistent FDG uptake on PET images due to overcorrection artefact. One case of incompletely treated lesion appeared as persistent focal and intense uptake with SUVmax increase from 6.7 to 22 within 2 months after treatment. The second case showed a significant SUVmax decrease but heterogeneous patchy uptake. Disease relapse was detected after 11 months of follow up.

### CONCLUSION

These preliminary data show that FDG PET/CT can be a useful tool for the assessment of ablation efficacy in bone lesions. Persistent not tumoral FDG uptake in case of cementoplasty may occur.

### CLINICAL RELEVANCE/APPLICATION

FDG PET/CT can be a useful tool for the evaluation of bone lesions ablation efficacy in case of inconclusive morphological imaging.

## CL-NMS-MO4B • PET Threshold for Target Volume Delineation in Cervical Cancer Using an Integrated PET/MR

**Shaomin Zhang (Presenter) ; Jun Xin MD ; Hongzan Sun ; Yueyue Lu ; Qiyong Guo MD**

### PURPOSE

To determine the maximum standardized uptake value (SUVmax) optimal threshold for PET-defined gross tumor volume (PET-GTV) based on PET/MR in patients with cervical cancer. And to compare the difference in target volume delineation between MRI-defined gross tumor volume (MR-GTV) and PET-GTV defined by the optimal threshold.

### METHOD AND MATERIALS

Twenty-four patients with biopsy-proven squamous cell carcinomas were enrolled in this study. All patients underwent Philips Ingenuity TF 18F-FDG PET/MR pelvic examination before radiotherapy. MR-GTV was manually outlined by consensus of two experienced radiologists on sagittal T2-weighted MR images as the gold standard. PET-GTVs were auto-contoured on the PET images using 15%~90% SUVmax thresholds. Pearson analysis was used to calculate the correlation between different PET-GTVs and MR-GTV. The difference between MR-GTV and PET-GTV defined by the optimal threshold was used to compare the discrepancies in target volume delineation.

### RESULTS

The mean±SD SUVmax of the tumors was 13.2±5.3, and the mean±SD MR-GTV was 41.0±28.6cc. The mean MR-GTV correlated significantly (P < 0.0001) with 40% of SUVmax values with best correlation according to the Pearson bivariate correlation. The mean±SD difference between MR-GTV and PET-GTV at the 40% threshold was 12.0±16.2cc. The PET-GTV at the 40% thresholds overestimated the MR-GTV for 7 of 24 lesions, and underestimated the MR-GTV for 17 lesions. Patients were divided into three groups based upon MR-GTV due to their prognostic significance. The optimal thresholds of PET-GTV were 80%, 55% and 35% SUVmax for MR-GTV measuring less than 14cc, 14~16cc, and greater than 62cc. For the

### CONCLUSION

The present study will provide new guidelines on the ability of integrated PET/MR to determine SUVmax threshold in target volume delineation for cervical cancer.

### CLINICAL RELEVANCE/APPLICATION

This study demonstrates an added value of PET/MR for definition of PET-GTV for RT planning of cervical cancer.

## CL-NMS-MO5B • Correlation of Preoperative Clinical, PET and CT Parameters with Histologic Grading of Residual Tumor after Neoadjuvant Chemoradiotherapy in Pancreatic Adenocarcinoma

**Makoto Sakane MD (Presenter) ; Mitsuaki Tatsumi MD, PhD ; Tonsok Kim MD ; Masatoshi Hori MD ; Jun Hatazawa MD, PhD ; Noriyuki Tomiyama MD, PhD ; Hiromitsu Onishi MD ; Atsushi Nakamoto MD ; Eku Shimosegawa**

#### PURPOSE

The purpose of this study is to investigate the correlation of histological effect of chemoradiotherapy (CRT) to pancreatic adenocarcinoma with preoperative clinical, PET and CT parameters, and to evaluate prognostic significance of those grading and parameters.

#### METHOD AND MATERIALS

This study included 25 patients diagnosed as pancreatic carcinoma by radical surgery after Gemcitabine and S-1 based preoperative-CRT from 2009 to 2012. The extent of residual tumor was graded using the Evans grading systems by a pathologist. Clinical values of CA 19-9 and prognosis of the patients were derived from medical records. A radiologist evaluated radiographic features of pre- and post-CRT contrast-enhanced dynamic CT and PET-CT, including size of tumors, peak standardized uptake value normalized for lean body mass (SUL<sub>peak</sub>) and metabolic tumor volume with a threshold of SUV<sub>max</sub> 2.0 (MTV<sub>2.0</sub>). These values were statistically compared by commercial software.

#### RESULTS

Among the 25 patients, 8 patients (32%) showed pathologic poor response (Evans grade I), 12 cases (48%) had mild response (Evans grade IIa), 5 cases (20%) had moderate response (Evans grade IIb), and no case showed complete response or minimal residual tumor (Evans grade III or IV). Mean reduction rate was 35%, 44% and 37% in CA19-9, 10%, 11% and 22% in tumor size, and 32%, 34% and 43% in SUL<sub>peak</sub>, respectively for Evans grade I, IIa and IIb. Post-chemoradiation MTV<sub>2.0</sub> were 0 cm<sup>3</sup> for all 5 cases of Evans grade IIb, and were 2.4 and 3.5 cm<sup>3</sup> for Evans grade I and IIa. Median disease free survival time for patients with negative post-chemoradiation MTV<sub>2.0</sub> were longer than patients with positive values (883 and 433 days, respectively (p = 0.28)).

#### CONCLUSION

The reduction rate of tumor size and SUL<sub>peak</sub> showed mild tendency to represent histological effect of CRT evaluated by Evans grade. Negative MTV<sub>2.0</sub> on PET-CT after CRT may indicate better histologic response and prognosis in pancreatic adenocarcinoma, although further studies are obviously required.

#### CLINICAL RELEVANCE/APPLICATION

- Tumor size, SUL<sub>peak</sub>, and MTV<sub>2.0</sub> were correlated with histological grading.
- Negative post-CRT MTV<sub>2.0</sub> may indicate better histological effect and prognosis.

### CL-NMS-MO6B • Evaluation of Software Based Analysis of V/P SPECT/CT in Patients with Pulmonary Emphysema

**Nils F Schreiter (Presenter) ; Felix Doellinger ; Alexander Poellinger MD ; Ralf-Harto Huebner ; Ralph Buchert ; Thomas J Kroencke MD ; Bernd K Hamm MD \* ; Winfried Brenner \* ; Vera Froeling MD**

#### PURPOSE

New software based analyzing system (SBAS) is available for ventilation / perfusion (V/P) SPECT/CT. Purpose of this study was to evaluate reproducibility of SBAS for V/P SPECT/CT in patients with pulmonary emphysema (PE) and to compare it to visual interpretation (VI) of V/P SPECT/CT

#### METHOD AND MATERIALS

Twenty-one patients (12 female, 9 male; median age: 69) with clinically confirmed PE and COPD (GOLD IV) were scanned with V/P SPECT/CT (Tracer: T99m MAA and Tc99m Technegas). Data was analyzed by two independent observers using SBAS and VI. SBAS was used to assess counts per lung lobe (CpL) and volume per lung lobe (VpL). Counts density per lobe (CDpL=CpL/VpL) and a ratio CpL/counts per lung (RCDpL) were calculated. VI was performed using a 100 point scale to assess mean counts per lung lobe. Interobserver variability and association for SBAS and VI were analyzed using Spearman's Rho correlation coefficient. Analysis was performed lobe based and descriptive parameters are given as mean (range).

#### RESULTS

SBAS yielded excellent lobe based correlation between both observers (all; p < 0.05): CpL [perfusion: 0.96 (0.91 - 0.99); ventilation: 0.03 (0.73 - 0.99)], CDpL [perfusion: 0.96 (0.87 - 0.99); ventilation: 0.92 (0.72 - 0.99)]; RCDpL [perfusion: 0.97 (0.93 - 0.995); ventilation: 0.91 (0.74 - 0.99)].

Correlation of VI was modest to good and correlated in 5/5 lobes 0.66 (0.47 ♦ 0.78) in perfusion and in 3/5 lobes 0.49 (0.36 ♦ 0.58) in ventilation significantly (p < 0.05).

For observer I correlation of SBAS and VI was 0.41 (0.11 - 0.63) which was significant (p < 0.05) for 3/5 lobes in perfusion and 2/5 lobes in ventilation.

For observer II correlation of SBAS and VI was 0.44 (0.15 - 0.71) that was significant (p < 0.05) with SBAS for 2/5 lobes in perfusion and 3/5 lobes in ventilation. Mean time of SBAS analyses was 45 min compared to 5 min for VI per patient.

#### CONCLUSION

Software based analysis offers more reproducible parameters in functional lung imaging by V/P SPECT/CT in patients with pulmonary emphysema than visual interpretation.

#### CLINICAL RELEVANCE/APPLICATION

Software based analysis is an excellent tool for V/P SPECT/CT in an experimental setting, but has limitations in daily practice due to the time needed for analysis.

### ISP: Gastrointestinal (Oncology: Staging and Distant Metastases)

Monday, 03:00 PM - 04:00 PM • E353C

[OI](#) [NM](#) [MR](#) [CT](#) [GI](#)

[Back to Top](#)

**SSE08 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1**

**Moderator**

**Tracy A Jaffe, MD**

**Moderator**

**Brian C Lucey, MBBS**

**SSE08-01 • Gastrointestinal Keynote Speaker: Imaging and Cancer Staging-Present and Future**

**Tracy A Jaffe MD (Presenter)**

**SSE08-03 • Integrated Whole Body PET/MR for Evaluation of Abdominal Malignancies: Does It Really Add Clinical Value Compared with Contrast-enhanced Body CT Scans?**

**Beomsik Kang (Presenter) ; Jeong-Min Lee MD \* ; Yong Sub Song MD ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD \***

#### PURPOSE

To evaluate the added value of combined positron emission tomography (PET) and magnetic resonance (MR) imaging (PET/MR) in diagnostic performance in patients with abdominal malignancy compared to that of conventional contrast-enhanced body CT examinations.

#### METHOD AND MATERIALS

Between October 2012 and March 2013, 77 patients who had history of abdominal malignancy underwent 18-FDG PET/MR and conventional body CT in our institution. Imaging analysis was performed to verify added values of PET/MR compared to conventional body CT for detection and characterization of abdominal tumors as well as staging. Added value of PET/MR was defined as follows: 1. Further characterization of the lesion which had been found on CT image; 2. Added detection of distant metastasis or lymph node metastasis which had not been detected on CT image; 3. Change of preoperative staging of disease. In addition, quality of image registration was subjectively assessed in a three point scale: 1: poor; 2: average; and 3: excellent. In 10 patients, patients already had their PET/CT scan performed immediately before undergoing the PET/MR examination.

#### RESULTS

In all patients, PET/MR examinations from head to proximal thigh were obtained within 25-35 minutes and additional dedicated MR examinations including dynamic MR imaging and diffusion weighted imaging took additional 20 minutes. In all patients except 1 patient (98.7%), quality of image registration was excellent or at least average. Overall added values of PET/MR were observed in 24 patients (31.2%). In detail, added values of MRI were observed at 13 patients (16.9%) and added values of PET were observed at 21 patients (27.3%). Further characterization of CT-detected lesions were made in 15 patients (19.5%), detection of new lesions in 5 patients (6.5%) and change of stage in 4 patients (5.2%). SUV values of the malignant tumors and the major organs on PET/MR were slightly lower than those on PET/CT.

#### CONCLUSION

Compared to conventional body CT, PET/MR imaging provides added value in further characterization of the lesions, detection of distant metastasis or lymph node metastasis and staging of malignancy at abdominal malignancy patients.

#### CLINICAL RELEVANCE/APPLICATION

PET/MR could be obtained within 1 hour, maximize diagnostic information and provide additional value for characterization and detection of abdominal malignancies, and staging compared to body CT scan.

### **SSE08-04 • Colorectal Cancer Staging: Comparison of Whole-body Hybrid MR/PET and PET/CT Imaging**

**Onofrio A Catalano MD (Presenter) ; Dushyant V Sahani MD ; Francesco Crafa MD ; Carlo Iannace MD ; Peter F Hahn MD, PhD \* ; Alexander R Guimaraes MD, PhD \* ; Bruce R Rosen MD, PhD \* ; Mark Vangel PhD ; Marco Catalano ; Elisa Varriale ; Ignazio Maria Francesco Sordelli ; Anna Ferrante ; Emanuele Nicolai ; Andrea Soricelli MD ; Marco Salvatore MD**

#### PURPOSE

To compare the lesion detection performance and SUV measurement accuracy of whole-body hybrid MR/ PET with PET/CT in patients with colorectal cancer (CRC).

#### METHOD AND MATERIALS

In this prospective IRB approved study, 15 consecutive patients with CRC underwent whole-body hybrid FDG PET/CT (Gemini TF, Philips) and same day MR/PET (Biograph mMR, Siemens). PET/CT and MR/PET studies were independently evaluated by two readers. Attenuation correction of MR/PET images was performed with Dixon sequences. The tumor with the highest FDG uptake (primary cancer or metastases) -to-liver SUV ratios were calculated and compared between PET/CT and MR/PET.

#### RESULTS

#### CONCLUSION

Hybrid MR/PET imaging provides all the diagnostic benefits in the assessment of the CRC patients with the benefits of superior local staging, nodal staging and accuracy in comparison to PET/CT.

#### CLINICAL RELEVANCE/APPLICATION

MR/PET might represent a very promising and innovative technique for accurate staging of CRC patients.

### **SSE08-05 • Comparison between MRI, CT and PET-CT for Lymph Node Staging in Patients with Squamous Cell Carcinoma of Anorectum and Anal Verge**

**Michael R Torkzad MD, PhD (Presenter) \* ; Hakan Ahlstrom ; Jens Sorensen ; Peter Nygren**

#### PURPOSE

To compare T2 weighted imaging on MRI with contrast-enhanced CT with PET-CT and biopsy for lymph node staging in squamous cell carcinoma of anorectum and anal verge

#### METHOD AND MATERIALS

35 patients with histologically confirmed squamous cell carcinoma of anorectum and anal verge with available MRI and contrast-enhanced CT prior to PET-CT and biopsy were identified from the database.

10 lymph node stations were identified: inguinal (x2), internal iliac (x2), external iliac (x2), common iliac (x2), perirectal (x1) and paraaortic (x1). Based on signal characteristics on T2 weighted images of lymph node stations and the primary tumor and lymph node size node were classified into malignant and benign with different sets of criteria. Similarly, nodal stations were staged on contrast-enhanced pelvic CT based on size and different density criteria.

Reference test comprised of histopathology whenever available, otherwise FDG-PET/CT with Max SUV = 2.5.

#### RESULTS

The best set of criteria for assessment of lymph node staging was obtained by CT based on any of the following criteria:

1. Lymph short axis diameter = 2 times the largest reported normal size
2. Clear sign of necrosis
3. Density of the node = the primary tumor.

With these criteria a sensitivity and specificity of 100% was achieved on CT. Non-enhanced MRI achieved significantly less promising results than CT (p < 0.01).

#### CONCLUSION

Contrast-enhanced CT can identify all pelvic nodes that are deemed malignant on FDG-PET/CT in patients with squamous cell carcinoma of anorectum and anal verge. This might reflect increased flow seen in metabolically active tumors as seen on PET/CT. Non-enhanced MRI cannot achieve the same good results.

#### CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced CT is sufficient for lymph node staging in squamous cell carcinoma of anorectum and anal verge, decreasing the need for biopsy and PET/CT while MRI without contrast is insufficient.

### **SSE08-06 • Does PET/CT Derived Tumor Heterogeneity and Glucose Uptake Predict Survival in Primary Colorectal Cancer Patients?**

**Ming Young S Wan MBBChir ; Balaji Ganeshan PhD (Presenter) \* ; Alec Engledow ; Daren Francis ; Nick Reay-Jones ; Manuel Rodriguez-Justo ; Vicky J Goh MBBCh \* ; Marie Meagher ; Jacquie Peck ; Kim Jaggs ; Jackie Hayward ; Helen Whiteway ; Zia Saad ; Faira Rizal ; Jakub Nalepa \* ; Michael Hayball \* ; Robert Kozarski ; Peter J Ell MD \* ; Stuart A Taylor MBBS ; Steve Halligan MD ; Kenneth Miles \* ; Ashley M Groves MBBS \***

#### PURPOSE

To investigate the prognostic value of FDG PET and CT textural analysis (CTTA) in determining overall survival in primary colorectal

cancer.

## METHOD AND MATERIALS

## RESULTS

3 patients were lost to follow up leaving 126 for analysis (79-males; 47-females; mean-age 62.6±10.6y). 39 (31.0%) patients died during follow-up. Univariate analysis revealed that textural heterogeneity (p=0.012) and tumor clinical stage (p=0.003) predicted survival but SUVmax or size did not. Using multivariable analysis, tumor computed tomography textural heterogeneity (p=0.026) and stage (p independent survival predictors).

## CONCLUSION

Using a cross validation model, tumor heterogeneity as measured on CT is shown to be a survival factor for patients with primary colorectal cancer, independent of clinical stage.

## CLINICAL RELEVANCE/APPLICATION

Given that performing textural analysis is simple and could be easily adopted into clinical workflow, it would have potential management implications for primary colorectal cancer patients.

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## Nuclear Medicine (Quantitative Imaging)

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Monday, 03:00 PM - 04:00 PM • S504CD

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[NM](#) [CT](#) [BQ](#)

[Back to Top](#)

**SSE19** • *AMA PRA Category 1 Credit*™:1 • *ARRT Category A+* Credit:1

**Moderator**

**Andrew Quon**, MD

**Moderator**

**Amir H Khandani**, MD

### **SSE19-01 • Integration of Automated Quality Control Using Image Classification into a CAD System for Bone Scan Lesion Detection**

**Keith W Henkel** MS, BEng (Presenter) \* ; **Matthew S Brown** PhD \* ; **Jonathan G Goldin** MBChB, PhD ; **Grace Kim** MD ; **Katherine Yang** \* ; **Bharath Ramakrishna** ; **Greg Chu** ; **Richard Pais**

#### PURPOSE

The aim of this research is to develop an automated bone scan image classifier for quality control as a pre-processing step prior to application of a CAD lesion detection system. As quantitative image analysis of bone scans becomes increasingly useful in clinical trials, so does the need to define quality bone scans in such a way that it predicts images' usability for an automated lesion detection system.

#### RESULTS

Based on review of the CAD segmentation, 35.5% of the 833 images were usable. In the test data set, images were split by those performed on ADAC machines (n=30), and those performed on other machines (n=803). To confirm the algorithm identified in the training set, its sensitivity and specificity were compared against the usability predictive power of the individual parameters. Overall, the manufacturer (ADAC vs. not ADAC) appeared to have a low classification accuracy, but there was not enough data in the ADAC dataset reach a firm conclusion. In the other machine group, pixel spacing also showed a low classification accuracy (sensitivity of 0.889, specificity of 0.702). The image type most commonly associated with usable images (ORIGINAL / PRIMARY / WHOLE BODY / EMISSION) had a very high classification accuracy with a sensitivity of 0.918 and a perfect specificity (no false negatives) of 1.000. Image Type is defined in DICOM Part 3: Information Object Definitions, and had a perfect specificity. Image size (256 by 1024 pixels as usable, others as requiring manual review) had a sensitivity of 0.968 and specificity of 0.985 in predicting image usability, the largest individual parameter sensitivity.

The combination of manufacturer, image type, and image size provide the best criteria for identifying quality bone scans: a sensitivity of 0.973 and a perfect specificity of 1.000. Further classification of images by pixel spacing (the last step of the algorithm identified in the training data set) actually had no further effect on the sensitivity and specificity. Images incorrectly identified as usable (n=7) were not usable due to extravasation hindering anatomic segmentation or due to missing anatomy with two notable exceptions: a pair of blood pool NM images. Including all images performed on ADAC scanners, for which the sample size was too small to identify an association, 56 of 833 images (6.7%) would require review via a non-automated process to determine usability of an image.

#### CONCLUSION

The question of how to approach quality control of medical images for use in automated systems appears to have an answer in traditional image classification. Close regulation of consistent scanner use, delay times from injection of radiotracer to acquisition of image, and varying doses received across time points, though not completely irrelevant, are not as significant factors in identifying quality images as simple DICOM header values like image type, image size, and manufacturer. Based on the inefficacy of including pixel spacing as a step in classifying the images of the test set, further evidence will be sought to determine if including the parameter is redundant or not.

#### METHODS

Acceptable bone scan image quality was defined in terms of usability for processing by an CAD lesion detection system currently in use in clinical trials (see Brown et al. Computer-aided quantitative bone scan assessment of prostate cancer treatment response. Nuclear Medicine Communications. 33(4):384-394, April 2012.). The CAD system atlas-based segmentation of anatomic landmarks and normal bone has been observed to fail when non-standard and/or non whole-body DICOM images are acquired, i.e., for secondary screen captures, spot views, tomos, key images, etc. Such images are unusable by CAD processing required in clinical trials and are thus considered of unacceptable quality.

From a training set of over 3,000 images (Phase 2 multi-center clinical trial of VEGFR-2 inhibitor in prostate cancer), four technical imaging parameters from the DICOM header were identified as features to classify image quality as acceptable or not: (1) image size, (2) image type, (3) pixel spacing, and (4) manufacturer. In the training data set, the best correlations with usability were found by differentiating by manufacturer first, then by a combination of image type, image size, and pixel spacing. While additional factors such as radiotracer dosage and timing may affect the quality of a bone scan, they are not consistently available within the DICOM header and are prone to manual entry error, and therefore have been excluded from analysis.

To test the imaging parameter features, 833 images from 25 patients across 23 sites were analyzed from a different multi-center Phase 2 prostate cancer clinical trial. Each of the images was processed by the CAD lesion detection system, and usability was determined as defined above. Statistically, sensitivity and specificity are reported to test the association between classified image quality and CAD usability.

### **SSE19-02 • QIBA2 FDG PET Reading Study: Variability of Liver FDG Uptake Measurements across Different Sites**

**Joo Hyun O** MD (Presenter) ; **Edward A Eikman** MD ; **Jaime L Montilla-Soler** ; **Paul E Kinahan** PhD \* ; **James M Mountz** MD, PhD ; **Eric Perlman** ; **John Sunderland** PhD ; **Heather Jacene** MD ; **Nathan C Hall** MD, PhD \* ; **Michael V Knopp** MD, PhD ; **Abdel K Tahari** MD, PhD ; **Ronald Boellaard** PhD ; **Otto S Hoekstra** MD ; **Li Huo** ; **Hye Ok Kim** ; **Sun Young Chae** ; **Sae Jung Na** ; **Sung Hoon Kim** ; **Mike Sathekge** ; **Moses Modiselle** ; **Sally Barrington** ; **Andrew M Scott** ; **Sam Berlangieri** ; **Andrew Quon** MD ; **Jeffrey P Leal** BA ; **Muhammad A Chaudhry** MD, MBBS ; **Richard L Wahl** MD \*

#### PURPOSE



To determine the variability in measurement of FDG uptake in normal liver background in identical human PET studies analyzed by differing readers, software and performance sites.

#### METHOD AND MATERIALS

Baseline and post-therapy FDG PET/CT images of a single patient were distributed digitally to 15 sites in North America, Europe, Africa, Asia and Australia in an IRB approved study. Readers at each site measured the background activity by placing a 3 cm diameter spherical volume of interest (VOI) in right side of the liver. Workstation software from 8 different vendors were used for the quantification. The standard uptake value (SUV) and SUV corrected for lean body mass (SUL) were measured using local standard approaches.

#### RESULTS

The liver background SUV ranged from 1.47 to 2.19 at baseline with standard deviation (SD) of 0.16; and ranged from 1.80 to 2.96 (SD 0.26) at follow-up. The liver SUL measurements ranged from 0.91 to 1.56 (SD 0.12) at baseline; and from 1.20 to 2.02 (SD 0.17) at follow-up.

#### CONCLUSION

SUV and SUL measurements of the normal liver derived from the same set of FDG PET/CT images showed generally similar, but not consistently the same, values. The cause of the variance of liver measurements is likely due to both human VOI selection methods and software differences.

#### CLINICAL RELEVANCE/APPLICATION

These results indicate that varying quantitative results can be extracted from identical PET/CT images and suggest the need to more fully standardize the PET analytic process.

### **SSE19-03 • Impact of 4D PET-CT on SUV Quantification in Lung Tumors: How Many Phase-bins?**

**Carlo Cavedon** DPhil (Presenter) ; **Emanuele Zivelonghi** ; **Stefania Guariglia** ; **Maria Grazia Giri** ; **Daniela Grigolato** ; **Michele Zuffante** ; **Marina Cucca** ; **Marco Ferdeghini** MD

#### PURPOSE

To find the optimal number of phase bins in respiratory-gated PET-CT (4D PET-CT) in order to improve SUV quantification in lung tumors while preserving signal-to-noise ratio.

#### METHOD AND MATERIALS

28 patients with lung tumors were studied with 18F-FDG 4D PET-CT. Only patients that showed respiratory-induced tumor motion greater than 5 mm were enrolled. 4D PET-CT was performed by means of a Philips Gemini BigBore TOF scanner and the Varian RPM respiratory gating system. 3.0 MBq/kg, 2 min/bed and retrospective-mode for both PET and CT modalities were used. Images were reconstructed using 1 (no sorting) up to 10 phase bins. SUVmax values within the lesion were studied as a function of the number of phase-bins. The lower number of phase bins that allowed SUV quantification no smaller than 90% compared to the gold standard (10 phases) was considered as optimal. Lesion volumes were estimated by three different segmentation methods: fixed SUV=2.2 threshold, 40% of SUV<sub>max</sub> isocontour and gradient-based method. These volumes were also studied as a function of the number of phase bins.

#### RESULTS

SUV<sub>max</sub> measured at max exp was on average 63.2% higher in the gated acquisition (10 phases) compared to the non-gated case (range 11.5%-328.3%). The underestimation of SUV in non-gated PET-CT was strongly dependent on lesion volume and location, small lesions in the lower lung region being the most affected. When comparing 4D PET-CT in 4 and 10 phases, the underestimation reduced to 12.3% (range 2.0%-37.7%). The corresponding value for 6 and 10 phase bins was 6.9% (range 0.0%-23.3%). Volumes estimated by the fixed-threshold method increased with the number of phase bins, SUV<sub>max</sub> percentage-based volumes decreased and gradient-based volumes did not show a unique trend.

#### CONCLUSION

4D PET-CT offers an advantage in 18F-FDG SUV quantification for tumors that move with respiration. The balance between acquisition/reconstruction time, SNR and accuracy of SUV estimation seems to be achievable using 4 to 6 phase bins, depending on lesion volume and location. SUV-based volume quantification obtained by multiple segmentation methods is less prone to inconsistent results when respiratory gating is used.

#### CLINICAL RELEVANCE/APPLICATION

4D PET-CT can improve SUV quantification in tumors that move with respiration. This might be especially useful when metabolic data are used to help delineate reference volumes in Radiation Oncology.

### **SSE19-04 • Impact of a New Respiratory Amplitude-based Gating Technique (HD-Chest) in Evaluation of Subdiaphragmatic PET Lesions**

**Axel Van Der Gucht** (Presenter) ; **Benjamin Serrano** ; **Florent Hugonnet** ; **Benoit Paulmier** ; **Nicolas Garnier** ; **Marc Faraggi**

\*

#### PURPOSE

PET acquisition requires several minutes which can lead to respiratory motion blurring, partial volume effect and SUV under-estimation. To avoid these artifacts, conventional 10-minute Phase-Based Respiratory Gating (PBRG) can be performed but is time-consuming and difficult with a non-compliant patient. HD-Chest is an amplitude-based gating method which keeps 35% of the counts at the end of expiration to minimize respiratory motion. We estimated the impact of HD-Chest on subdiaphragmatic lesion detectability and quantification.

#### METHOD AND MATERIALS

Our study consisted of 30 patients for a total of 76 hepatic and 26 perihepatic lesions. Each patient underwent 3 acquisitions on a Siemens Biograph mCT (4 rings and time-of-flight): a Standard free breathing Whole Body (SWB, 5 to 7 steps / 2.5 min per step, 3.3 ± 0.4 MBq/Kq of 18F-FDG), a 10-min PBRG with six bins and a 5-min HD-Chest. All gated acquisitions were performed with an ANZAI respiratory gating system. SUVmax and Target to Background Ratio (TBR, expressed as SUVmax of lesions / SUVmean in healthy liver) were compared.

#### RESULTS

All 93 lesions in SWB images were detected in the gated images. PBRG and HD-Chest respectively revealed 5 and 9 new lesions and relocated 7 and 8 lesions. Localization remained uncertain for 2 lesions in both gated methods. Four lesions revealed by HD-Chest were missed by PBRG in 3 non-compliant patients. Compared to SWB, TBR but not SUVmax increased significantly with PBRG (respectively 40 ± 62%, p

#### CONCLUSION

A better detection rate, a better coregistration, a higher contrast, a reduction of the acquisition time by up to 50% compared to PBRG make of HD-Chest the first choice respiratory-gated PET protocols in the evaluation of subdiaphragmatic lesions.

#### CLINICAL RELEVANCE/APPLICATION

Compared to phase-based respiratory gating, HD-Chest enhances detectability, image quality and reduces acquisition time without compromising quantification in evaluation of subdiaphragmatic lesions.

### **SSE19-05 • Quantification of Treated Volumes and Correlation with Functional and Morphologic Target Volume Estimation in SIRT of the Liver**

**Michael P Wissmeyer** MD (Presenter) ; **Valentina Garibotto** ; **Pietro Mjano** MD ; **Romain Breguet** MD ; **Christoph D Becker** MD ; **Osman Ratib** MD, PhD \* ; **Sylvain Terraz** MD

#### PURPOSE

To quantify treated volumes and compare them with morphologic and functional target volume estimation algorithms in patients undergoing SIRT.

#### METHOD AND MATERIALS

We evaluated 28 consecutive patients scheduled for SIRT due to hepatocellular carcinoma or liver metastases from other tumors into this pilot study. Treated liver volumes were calculated using a threshold based semi-automatic delineation technique on post-interventional Y-90 SPECT-CT. The pre-interventional target volumes and Y-90 activities were estimated by manual delineation on contrast enhanced CT and on pre-therapeutic Tc-99m-MAA SPECT-CT by two experienced observers. Additionally, the expected lung dose was determined on the base of the lung shunt fraction as derived from planar whole-body MAA-images. Treated and target volumes, Y-90 activities and lung doses were compared using correlation coefficients (cc) and a paired two sided t-test.

#### RESULTS

7 patients were excluded because of too high hepato-pulmonary shunt fractions. In 7 other patients with bilobar treatment, functional target volumes could not be drawn on the MAA-SPECT/CT due to technical reasons. In the remaining 14 patients, estimated mean±SD treated liver volume was 1247±533ml using a threshold of 24.2±9.1% of maximum counts for semi-automatic volume estimation. Absolute counts were not useful for threshold selection. Estimated target volumes (ml), calculated Y-90 activities (GBq), and lung doses (Gy) were 1344±524, 3.62±1.37, and 13.03±8.35 for CT, compared to 1352±664, 3.62±1.69, and 12.35±7.54 for MAA-SPECT-CT. Overall, morphologic (cc=0.88; p= 0.185) and functional (cc=0.92; p=0.177) target volumes correlated well with treated volumes, with a slight but not statistically significant advantage for the functional approach (p=0.125).

#### CONCLUSION

Treated liver volumes can be quantified easily on the post-interventional Y-90 SPECT-CT using a threshold based semi-automatic approach. Functional and morphologic pre-therapeutic target volume estimation correlates well with the treated volumes, with a slight advantage of the functional technique, most probably due to patients presenting with perfusion patterns differing from the expected vascular anatomy.

#### CLINICAL RELEVANCE/APPLICATION

Functional target volume estimation correlates slightly better with treated liver volumes in SIRT than the morphologic approach and is an important adjunct to depict unexpected liver perfusion patterns

### SSE19-06 • Integrated PET/CT Color Scale Response Assessment Workflow

**Joseph Colao** BS (Presenter) ; **Alin Chirindel** MD ; **Joo Hyun O** MD ; **Steve Cho** MD \*

#### PURPOSE

Assessment of tumor response to therapy by FDG PET/CT image sets from various time points can be often tedious and time consuming, especially in complex patients with multiple lesions or subtle changes. We developed and applied an integrated color-coded PET/CT image visualization workflow incorporating the tumor uptake at two time points to allow the reader to efficiently and accurately assess the relative PET tumor response to therapy.

#### METHOD AND MATERIALS

Using MIM 5 imaging software (MIM Software™), we analyzed FDG PET/CT image sets from two time points for 6 melanoma and 6 lymphoma cases. With technical support from MIM, we created a workflow that deformed the baseline PET and CT to the follow-up images. The SUV in each voxel of the deformed baseline PET was subtracted from each voxel's SUV in the follow-up PET. Each PET voxel was assigned a color based on its subtraction value, and the colored images were fused with the follow-up CT image set to create an anatomical view of the relative SUV changes. The colors corresponding to each subtraction value were based on a 20-color scale for positive and negative absolute and percent SUV change from baseline to follow-up. Two readers with third reader adjudication reviewed all 12 cases to determine if the response of the lesions with the greatest SUV values from baseline (max of 2 per organ) were accurately depicted by the color scale by comparing it to traditional gray-scale PET/CT visualization and ROI SUV values.

#### RESULTS

The number of lesions analyzed per patient ranged from 1 to 5 for each based on the state of the patient's disease. The readers found that integrated PET/CT color scale images accurately depicted the approximate SUV changes for 26 of the 28 index lesions. The less clear color scale representations occurred because of small errors in the deformable registration in a lung nodule and with development of tumor necrosis.

#### CONCLUSION

The integrated color scale PET/CT tumor response image sets provides an efficient and reliable method of determining the approximate tumor SUV changes associated with disease progression or treatment response for the major index lesions in our pilot study of metastatic melanoma or lymphoma patients.

#### CLINICAL RELEVANCE/APPLICATION

Integrated color scale PET/CT representation can be a helpful aid to quickly judge and approximately quantify tumor response to therapy, especially in cases difficult to assess by current methods.

### Nuclear Medicine (SPECT/CT)

**Monday, 03:00 PM - 04:00 PM • S505AB**

**NM** **CT**

[Back to Top](#)

**SSE20 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1**

**Moderator**

**M. Elizabeth Oates**, MD

**Moderator**

**Terence Z Wong**, MD, PhD \*

### SSE20-01 • Sentinel Lymph Node Mapping in Patients with Vulvar Cancer: Comparison between Conventional Planar Lymphoscintigraphy and SPECT/CT

**Christoph Weber** MD (Presenter) ; **Peter Bannas** MD ; **Susanne Klutmann** ; **Gerhard B Adam** MD ; **Thorsten Derlin**

#### PURPOSE

To compare the relative performance of conventional lymphoscintigraphy and SPECT/CT in sentinel lymph node mapping in vulvar cancer, and to create a surgical roadmap by evaluating the relative frequencies of SLNs according to regional lymph node stations in the groin.

#### METHOD AND MATERIALS

25 consecutive patients (59.1 ± 16.3 years, range 32-88) suffering from vulvar cancer were examined by both conventional lymphoscintigraphy and subsequent SPECT/CT. After injection of four peritumoral subcutaneous deposits, anterior and lateral static views were obtained for planar lymphoscintigraphy, followed by a SPECT/CT scan without reinjection of the radiopharmaceutical. The presence of sentinel lymph nodes and additional downstream lymph nodes on conventional lymphoscintigraphy and on SPECT/CT was analyzed qualitatively, and compared. All sentinel lymph nodes were mapped to obtain a relative distribution pattern for lymph nodes in vulvar cancer.

## RESULTS

Conventional planar imaging suggested 46 sentinel nodes in the studied 25 patients. SPECT/CT visualized these lymph nodes, and 12 additional sentinel lymph nodes in eleven patients. The mean number of visualized sentinel nodes was  $1.8 \pm 0.5$  (range, 1-3) for conventional technique, and  $2.4 \pm 0.7$  (range, 1-4) for SPECT/CT. Conventional scintigraphy detected 19 downstream lymph nodes in all patients, but correct localization was challenging from planar views. The mean number of visualized downstream lymph nodes was  $0.8 \pm 0.9$  (range, 0-2) for conventional technique. SPECT/CT detected 66 downstream lymph nodes in all patients. The mean number of visualized downstream lymph nodes was  $2.6 \pm 2.1$  (range, 1-7) for SPECT/CT. SPECT/CT depicted additional sentinel nodes in 44% of the patients, and additional downstream lymph nodes in 76% of the subjects. The detected sentinel nodes were predominantly NII. inguinales superiores mediales, followed by NII. inguinales superiores inferiores.

## CONCLUSION

SPECT/CT is superior to conventional planar lymphoscintigraphy in the detection of both sentinel lymph nodes and downstream lymph nodes in vulvar cancer.

## CLINICAL RELEVANCE/APPLICATION

SPECT/CT may contribute to a more comprehensive lymph node mapping in vulvar cancer and might facilitate surgical exploration in difficult cases.

### **SSE20-02 • SPECT/CT and Freehand-SPECT 3D-imaging Can Localize Sentinel Nodes in the Operating Room Using Mixed-reality Navigation**

**Gijs Kleinjan MD ; Nynke S Van Den Berg MSc ; Oscar Brouwer ; Simon Horenblas MD, PhD ; Henk G Van Der Poel ; Omgo Nieweg ; Thomas Wendler ; Fijfs Van Leeuwen (Presenter) ; Renato Valdes Olmos**

## PURPOSE

By providing anatomical landmarks, SPECT/CT has improved the sentinel node (SN) localization in different types of cancer. The introduction of mixed-reality protocols makes it possible to incorporate the SPECT/CT information into the patient environment during the operation. The Declipse<sup>®</sup> SPECT-system (SurgicEye, Munich, Germany) uses 3D SPECT/CT mixed-reality for intraoperative navigation. The device is also equipped with a Freehand-SPECT (FHS) probe that generates 3D imaging to be real-time merged with the patient environment (augmented-reality). The aim of the study was to determine the feasibility of the navigation system to localize SNs.

## METHOD AND MATERIALS

The hybrid tracer Indocyanine green (ICG)-99mTc-nanocolloid is fluorescent and radioactive. For inguinal SNs the tracer was injected around the primary lesion in 10 penile cancer patients and 5 patients with melanoma of the leg. A reference tracker (ReT) was placed on the patient during preoperative SPECT/CT to upload SPECT/CT images into the Declipse<sup>®</sup> system. In the operating room, a sterile ReT allowed incorporation of SPECT/CT images onto the patient. A gamma probe with a second sterile ReT was used to navigate towards the SN. The fluorescence of the hybrid tracer confirmed the SN location. FHS was evaluated for pelvic SNs in 4 prostate cancer patients. Based on pre-operative SPECT/CT, the area of interest was scanned with a laparoscopic probe. A Sterile ReT was placed on the patient and on the laparoscopic probe, to match the information of FHS-scanning of the radioactive signal in the SN. SN imaging was generated and used in an augmented-reality-based 3D navigation protocol.

## RESULTS

In the groin SN location indicated by mixed-reality based navigation deviated on average 4.5mm (range 0-10 mm) from the actual location; this was confirmed by its fluorescence signal. FHS-based augmented-reality navigation allowed the identification of 4 pelvic SNs in 4 patients.

## CONCLUSION

The 3D SPECT/CT-mixed-reality based SN navigation is feasible for groin and pelvis, and has the potential to guide SN localization in areas of complex anatomy. FHS real-time generated 3D imaging may complement navigation.

## CLINICAL RELEVANCE/APPLICATION

An accurate localization of the SNs could be of clinical relevance by lowering the false negative rate in SN detection in different types of cancer with lymphatic drainage to complex anatomical areas.

### **SSE20-03 • Impact of SPECT/CT on Interpretation of Bone Scans in a Supra-regional Oncology Centre**

**Umme Sara Zishan MBBS (Presenter) ; Hamish Richardson MSc ; Zubair Khan MBBS, FRCR**

## PURPOSE

To evaluate impact of single photon emission computed tomography/computed tomography (SPECT/CT) in assessment of indeterminate uptake on planar bone scans compared with prior practice.

## METHOD AND MATERIALS

Retrospective comparative study. Data was collected from reports available on radiology information system. First data set included bone scans from June 2009- June 2010 when planar whole-body images were referenced to other available structural imaging. After installing hybrid scanners in late 2010, SPECT/CT was used as a problem solving tool in patients with indeterminate/ suspicious lesions on planar imaging. The second set of data included bone scans(with added SPECT/CT if required) from June 2011-June 2012. The reports were analysed and categorised into these six categories: Normal, bony metastatic disease, degenerative changes, fractures/trauma, incidental findings, in-conclusive requiring further investigation.

## RESULTS

First data set from 2009/10 included 1422 reports, while 1617 reports were included in the second data set. The latter also included 737 reports with added SPECT/CT.

In 2009/10, 16.5 % (234/1422) of the scans showed bony metastatic disease, 8.8 % (125/1422) were indeterminate requiring further investigations and 1.8% (26/1422) showed incidental findings.

In 2011/12, 23% (372/ 1617) of overall bone scans showed bony metastatic disease. There was reduction in the number of referrals for further investigations to 7.8% (126/ 1617). There was increased pick up of incidental findings both benign and malignant conditions to 13.5% (219/1617).

Specifically looking at bone scans with added SPECT/CT for indeterminate lesion/s (i.e. not clearly malignant and no recent structural imaging for that lesion) the sensitivity for diagnosis of metastatic disease was 30.1 % (222/737). Pick up of incidental findings was 27.13% (200/737), there were 207 benign and 67 malignant lesions. 10.2% patients (75/737) were referred for further investigations, most of them to assess the incidental findings.

## CONCLUSION

SPECT/CT had a significant impact with improved detection of bony metastatic disease, better characterisation and reduction in onward referrals. There was increased detection of incidental pathology (benign and malignant), some of these required further investigation.

## CLINICAL RELEVANCE/APPLICATION

SPECT/ CT is a powerful cost effective tool providing accurate diagnosis of indeterminate uptake on planar bone scan.

### **SSE20-04 • Feasibility of 90Y Bremstrahlung Scan to Determine SIRT Patient Dose**

**Chor-Yi S Ng PhD (Presenter) ; Martin W Law PhD ; Victor H Lee MD, MBBS ; W. H. Ma MBBCh ; T. W. Leung MD, MBBS**

## PURPOSE

We reported the use of  $^{90}\text{Y}$  PET/CT imaging for patient dose computation of the SIRT procedure. Other than  $^{90}\text{Y}$  PET/CT,  $^{90}\text{Y}$  Bremstrahlung SPECT/CT scan can also be used to evaluate the distribution of  $^{90}\text{Y}$  microspheres after SIRT. This work aimed to evaluate the feasibility of using  $^{90}\text{Y}$  SPECT/CT scan as a tool for patient dose evaluation. We compared and contrasted its performance for dose determination with  $^{90}\text{Y}$  PET/CT scan.

#### METHOD AND MATERIALS

PET/CT and SPECT/CT were done for a rectangular phantom with 4 spherical inserts containing  $^{90}\text{Y}$  solution in a cold background. The volume of the inserts ranged from 0.38 to 57.79  $\text{cm}^3$ . To determine the absorbed dose, the PET and SPECT images were convolved with the  $^{90}\text{Y}$  voxel dose kernel and the results presented as DICOM-RT dose files. Dose volume histogram was computed for each insert and compared with the actual dose based on total energy deposited by  $^{90}\text{Y}$ . A patient's  $^{90}\text{Y}$  Bremstrahlung SPECT/CT image was used to compute the 3D dose distribution from SIRT. The computed physical dose was converted to biologically effective dose then to dose equivalent to 2 Gy/fraction delivery to assess the clinical efficacy and toxicity.

#### RESULTS

All 4 inserts were visible on the PET images while the 0.38  $\text{cm}^3$  sphere was not detected on the SPECT images. The SPECT images showed significant scatter, with average background to target ratio equal to 5.4% compared to 0.2% for PET. The SPECT scatter was partially corrected by deducting a constant value from the pixel counts on the images, then absorbed dose was computed. For The SPECT images, the computed dose volume extended beyond the inserts' boundary into the cold background. This could result from inadequate scatter correction. The partial volume effect was also more marked for SPECT with a large reduction in observed count rate as the volume of the object decreased. For the insert of volume 4.06  $\text{cm}^3$ , the dose dropped to 23% of the actual value for SPECT compared to 57% for PET. Based on the SPECT images, the patient's 2 Gy/fraction equivalent dose to tumor, liver and lung were 106.5 Gy, 24.8 Gy and 1.5 Gy respectively.

#### CONCLUSION

Improved correction methods for partial volume effect and scatter are needed for accurate dose calculation for SIRT based on SPECT/CT imaging.

#### CLINICAL RELEVANCE/APPLICATION

SPECT/CT could be a tool for in vivo dose determination for the SIRT procedure which will help to assess treatment efficacy and toxicity of SIRT.

### **SSE20-05 • Localization of Parathyroid Adenomas by Tc99m Sestamibi SPECT-CT, Contrast-enhanced Multi-phase CT (4D-CT) and Combination of SPECT-CT and 4D-CT**

**Franklin C Wong** MD, PhD (Presenter) ; **Thinh H Vu** MD ; **Stephen T Wong** PhD ; **Dawid Schellingerhout** MD ; **Hubert H Chuang** MD, PhD ; **Nandita Guha-Thakurta** MD ; **Edmund E Kim** MD ; **Srinivas C Kappadath** PhD \* ; **Nancy Perrier** MD ; **Eric M Rohren** MD, PhD \*

#### PURPOSE

This study is designed to compare the abilities of Tc99m Sestamibi (MIBI) SPECT-CT, dynamic contrast enhanced CT (4D CT) and combination of both modalities to identify parathyroid adenomas

#### METHOD AND MATERIALS

A retrospective study was conducted under an IRB-approved chart review for patients undergoing parathyroid adenoma resection in Jan 2010-June 2010. Parathyroid SPECT-CT was conducted after the patient received 20 mCi of Tc99m MIBI, 4D CT was conducted within 2 days from MIBI. All images were displayed in planar digital displays. Three teams of nuclear physicians and radiologists were assigned to interpret anonymized imaging studies without clinical or pathologic information. The surgical pathology is used as the gold standard. An A-F type location scheme was applied to identify the location of the lesions.

#### RESULTS

A total of 41 evaluable patients were collected. Histopathology reported 46 lesions with 21 in the left and 25 in the right size. SPECT-CT correctly lateralized 36 lesions and identified 21 correct surgical types; 4D CT also lateralized 36 lesions but correctly identified 18 lesion types while combination of both correctly lateralized 37 lesions and identified 24 lesion types.

#### CONCLUSION

The combination of 4D CT and MIBI SPECT CT may have additional diagnostic values for identification of parathyroid adenomas.

#### CLINICAL RELEVANCE/APPLICATION

The use of combination of 4D CT and MIBI SPECT-CT may enhance the accuracy of pre-surgical identification of lesions for treatment planning

### **SSE20-06 • The Value of Routinely Post Radioiodine Therapy Scintigraphy with SPECT CT Imaging Diagnosis in Clinic**

**Yu Wen Chen** MD, MA (Presenter) ; **Pi Jung Hsio** MD ; **Yung Chang Lai**

#### PURPOSE

The fusion imaging of SPECTCT will improve diagnostic quality. In here, we collect thyroid cancer patients with high dose radioiodine therapy and post therapy scintigraphy with SPECTCT diagnosis during prior one year. The value of SPECTCT in imaging diagnosis will be disclosed in this article.

#### METHOD AND MATERIALS

During prior one year (Aug, 2011 to Aug 2012), we collect sixty-five patients received high dose radioiodine therapy and post radioiodine scintigraphy with SPECTCT imaging. Forty patients who were newly diagnosed as advanced differentiated thyroid cancer (DTC) and received bilateral total thyroidectomy with central nodal dissection. The other twenty five patients were diagnosed as recurrence during follow-up. The mean age of patients is 51.2 year-old (19 to 76) and ratio of female to male is 54 to 11. After high dose radioiodine administration, the imaging was performed at the following 5th and 8th day respectively. The imaging protocols were including whole body scintigraphy (WBS) and SPECTCT (Philips, Bright view XCT). The acquisition of SPECTCT was including SPECT protocol with 32 frames/ 30 sec per frame and cone-beam CT with 30mA/ 120 kV parameters. The field of view included hard palate to diaphragm, as three beds routinely. The imaging reconstruction was based on iterative algorithm. The interpretation of imaging was performed by two nuclear medicine physicians.

#### RESULTS

Among newly diagnosed forty DTC patients, almost remnants are detectable, except one patient. Based on SPECTCT localization, pyramidal and contralateral tubercle are the most common sites of remnant exist. Twelve patients (30%) are demonstrated as N1b after post radioiodine therapy SPECTCT diagnosis. There is no detectable distal lung or bone metastasis among this group of patients. The SPECTCT imaging provides differential diagnosis for low grade of radioiodine avid pulmonary nodule in an old lady with tuberculosis history. For the twenty five patients with recurrent thyroid cancer, remnants are near not detectable, except two young age females (8%). Five patients (25%) are demonstrated as N1b nodal involvement on SPECTCT. Three patients are diagnosed as lung metastasis on WBS and SPECTCT imaging. The SPECTCT provides pulmonary nodular pattern in the two patients.

#### CONCLUSION

Routinely post radioiodine therapy scintigraphy with SPECTCT imaging provides exact nodal stage and remnant distribution.

#### CLINICAL RELEVANCE/APPLICATION

none

## Case-based Review of Nuclear Medicine: PET/CT Workshop-Head and Neck Cancers (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, 08:30 AM - 10:00 AM • S406A

[NM](#) [CT](#) [NR](#) [HN](#)

[Back to Top](#)

**MSCC31** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### Director

**John A Parker**, MD, PhD

**Rathan M Subramaniam**, MD, PhD \*

### LEARNING OBJECTIVES

1) To understand what the surgeon, radiation oncologist and oncologist want from a head and neck PET/CT. 2) To understand the normal variant FDG uptake in Head and Neck. 3) To understand the neck spaces, tumor spread and value of PET/CT in staging. 4) To understand the value of PET/CT in post therapy assessment of head and neck oncology.

### ABSTRACT

This lecture will cover the essential information that allows a surgeon, radiation oncologist and oncologist to care for head and neck cancer patients in a multidisciplinary settings. It will emphasise the PET/CT clinical paradigms, normal variants of FDG uptake, neck spaces and tumor spread, and value and pitfalls of PET/CT in therapy assessment and follow up of head and neck cancer patients.

## Medical Physics 2.0: Nuclear Imaging

Tuesday, 08:30 AM - 10:00 AM • S102D

[PH](#) [NM](#)

[Back to Top](#)

**RC321** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### Co-Director

**Ehsan Samei**, PhD \*

### Co-Director

**Douglas E Pfeiffer**, MS \*

### RC321A • Nuclear Imaging Perspective

**Douglas E Pfeiffer** MS (Presenter) \*

### LEARNING OBJECTIVES

1) Understand the history and development of nuclear imaging. 2) Become introduced to the advances of hybrid imaging. 3) Understand the impact of equipment development on medical physics support.

### ABSTRACT

Nuclear imaging has not received the attention or development enjoyed by other imaging modalities. Nevertheless, our understanding of nuclear imaging and development of protocols and hybrid systems has led to new requirements for testing and other medical physics support. This presentation will discuss these developments and the impact they have had on the medical physics support needed by nuclear imaging departments.

### RC321B • Nuclear Imaging 1.0

**Osama R Mawlawi** PhD (Presenter)

### LEARNING OBJECTIVES

1) Learn acceptance testing and commissioning of gamma cameras/SPECT / and PET-CT systems. 2) Describe routine quality control procedures and their frequencies. 3) Become familiar with ACR accreditation of planar, SPECT, and PET systems. 4) Learn about various potential image artifacts of gamma camera, SPECT and PET systems.

### ABSTRACT

The aim of this lecture is to provide the audience with an overview of the current medical physics testing procedures that are performed on gamma cameras, SPECT and PET systems. The lecture will be divided into 3 main parts; the first part will describe the tests performed for acceptance testing of these systems while the second part will describe the routine quality control and assurance tests and their frequencies. The last part of the lecture will focus on the ACR accreditation process and the necessary phantom imaging for gamma cameras, SPECT and PET systems. Throughout the lecture, examples of potential image artifacts will be presented.

### RC321C • Nuclear Imaging 2.0

**Jeffrey Nelson** (Presenter)

### LEARNING OBJECTIVES

1) Become familiar with new physics metric and analytics in nuclear imaging. 2) Determine testing implication of emerging technologies in nuclear imaging. 3) Envision the clinical implementation of new physics metrics and analytics.

### ABSTRACT

## CT/PET in the Abdomen and Pelvis: How and When (How-to Workshop) (An Interactive Session)

Tuesday, 08:30 AM - 10:00 AM • E353C

[NM](#) [CT](#) [GU](#) [GI](#)

[Back to Top](#)

**RC351** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### RC351A • CT/PET: Value of Iodinated Contrast

**Erik K Paulson** MD (Presenter)

### LEARNING OBJECTIVES

1) Discuss the role of iodinated contrast as a complement to FDG-PET/CT. 2) Discuss appropriate/efficient utilization of PET/CT relative to routine CT or MR.

### RC351B • CT/PET: Metabolic Assessment in Reporting

**Eric M Rohren** MD, PhD (Presenter) \*

### LEARNING OBJECTIVES

1) Discuss the role of metabolic parameters in response assessment using FDG-PET/CT. 2) Compare the use of anatomic and metabolic response evaluation systems in the evaluation of patients with malignancy.

### RC351C • Artifacts/Pitfalls/Incidentals

**Terence Z Wong** MD, PhD (Presenter) \*

#### LEARNING OBJECTIVES

1) Recognize and address common benign findings on FDG-PET / CT scans that can simulate malignancy. 2) Understand technical factors that can influence interpretation and quantification of FDG-PET studies.

#### ABSTRACT

Diagnostic accuracy of FDG-PET/CT scans can be degraded by potential technical artifacts during imaging acquisition as well as interpretive pitfalls encountered when evaluating regions of tracer accumulation. Technical artifacts occur relatively frequently due to the complexity of the PET and CT image acquisition and reconstruction; examples of important artifacts will be presented, along with potential solutions. Thoughtful design of PET/CT imaging protocols and attention to detail during image acquisition can reduce the incidence of artifacts. In addition, interpretive pitfalls due to false positive and false negative FDG accumulation is a major source of angst in interpreting oncologic PET/CT studies. Examples of common interpretive pitfalls will be presented along with approaches to distinguish malignant from benign FDG accumulation.

### RC351D • Select Issues in Abdominal and Pelvic CT/PET

**Andrea G Rockall** MRCP, FRCR (Presenter) \*

#### LEARNING OBJECTIVES

1) To know the indications for PET/CT in pelvic malignancy. 2) To recognize the typical findings on FDG-PET/CT in pelvic malignancies, including gynaecologic and urologic cancers. 3) To be aware of some new tracers that are being used in pelvic malignancy.

## Nuclear Medicine Series: Non-FDG PET Radiotracers in Oncology

Tuesday, 08:30 AM - 12:00 PM • S505AB



[Back to Top](#)

**VSNM31** • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:4

#### Moderator

**Jonathan E McConathy**, MD, PhD \*

#### Moderator

**Hossein Jadvar**, MD, PhD

### VSNM31-01 • Proliferation Imaging: FLT/PET in Oncology

**David A Mankoff** MD, PhD (Presenter)

#### LEARNING OBJECTIVES

1) Describe the kinetics of thymidine relevant to FLT PET imaging. 2) Discuss approaches to FLT image interpretation. 3) Describe studies that have tested FLT PET as a marker cancer response to treatment.

### VSNM31-02 • Quantitative Study of 18F-fluorodeoxyglucose and 18F-fluorothymidine PET Characteristics in Esophageal Squamous Cell Carcinoma Staging

**Changsheng Ma** MS (Presenter) ; **Yong Yin**

#### PURPOSE

To quantitatively evaluate the value of diagnostic information provided by both 18F-FDG and 18F-FLT PET and quantitatively investigated whether 18F-FLT PET had a better performance compared with 18F-FDG PET in esophageal squamous cell carcinoma (ESCC) staging and delineation.

#### METHOD AND MATERIALS

26 patients with newly diagnosed ESCC and underwent pretreatment 18F-FDG and 18F-FLT PET were included in this study. The indices such as the standardized uptake value (SUV), gross tumor length and extracted texture parameters between 18F-FDG and 18F-FLT PET were compared, respectively. Moreover, the indices relationship between 18F-FDG and 18F-FLT PET mentioned above, were analyzed using Spearman's correlation coefficient and Paired T-test. Subsequently all patients received esophagectomy and the extracted PET indices capability in ESCC pathological staging were assessed by Kruskal-Wallis test and Mann-Whitney test. In addition, tumor delineation length on 18F-FDG (SUV threshold 2.5) and 18F-FLT (SUV threshold 1.4) PET were validated by pathologic gross tumor length.

#### RESULTS

#### CONCLUSION

The 18F-FDG and 18F-FLT PET scans have their own advantages in ESCC staging and tumors were well identified as the nonphysiologic distribution of radiotracers intensity typically higher than normal tissues on either PET scans. Delineation on the two types of PET with proper threshold can both provide accuracy estimation of pathologic tumor length. Those different indices extracted from PET scans can be potentially employed to differentiate AJCC and TNM in ESCC stage.

#### CLINICAL RELEVANCE/APPLICATION

No

### VSNM31-03 • Diagnostic and Prognostic Value of Nodal Staging by 4'-[Methyl-11C]-Thiothymidine (4DST) PET/CT in Non Small Cell Lung Cancer

**Ryogo Minamimoto** MD, PhD (Presenter) ; **Jun Toyohara** ; **Miyako Morooka** MD ; **Yoko Miyata** ; **Momoko Okazaki** ; **Kazuhiko Nakajima** ; **Kiichi Ishiwata** ; **Kazuo Kubota** MD

#### PURPOSE

4'-[methyl-11C]-thiothymidine (4DST) is a novel PET tracer available for evaluating proliferation of malignancy. We prospectively compared the diagnostic ability of 4DST PET/CT and FDG PET/CT for detection of regional lymph node metastasis of non-small cell lung cancer (NSCLC). In addition, we surveyed the relation between these PET results and prognosis of NSCLC patients.

#### METHOD AND MATERIALS

A total of 31 patients with NSCLC underwent 4DST PET/CT and FDG-PET/CT. PET imaging was obtained from 40 min for 4DST and 60 min for FDG after injection. The PET/CT images were evaluated qualitatively and quantitatively for focal uptake of each PET tracers, according to American Joint Committee on Cancer staging system. Surgical and histologic results were regarded as reference standards. Patients were followed up 2 years after surgery for survey of recurrence. A multivariate analysis was performed to assess the prognostic significance of T stage, N stage and maximum SUV of 4DST and FDG for primary lung tumor.



## RESULTS

Four patients were inoperable by being proved dissemination during surgery. In 27 patients with 156 resected lymph nodes, metastasis was pathologically proved in 9 patients with 17 lesions. On a per-lesion basis, sensitivity, specificity, positive predictive value, negative predictive value and accuracy for lymph node staging were 82, 73, 33, 96 and 74 % respectively for 4DST, 29, 86, 25, 88 and 78% respectively for FDG. Statistical significant difference was confirmed in the sensitivity between 4DST and FDG. The cases with positive nodal findings by 4DST showed higher rate (91%) of lesion extent or recurrence within 2 years, compared to FDG (45%). Multivariate analysis showed that N stage by 4DST was most influential prognostic factor for recurrence or lesion extent.

## CONCLUSION

4DST PET/CT showed high sensitivity for the detection of lymph node metastasis, and it was independent prognostic value for recurrence or lesion extent in NSCLC.

## CLINICAL RELEVANCE/APPLICATION

4DST PET/CT can contribute to detect lymph node metastasis, and 4DST PET/CT can predict prognosis for recurrence or lesion extent in NSCLC.

### VSNM31-04 • Bone PET Imaging: NaF PET in Oncology

**Baris Turkbey MD (Presenter)**

#### LEARNING OBJECTIVES

1) To identify the advantages of F-18 NaF PET/CT imaging in oncology. 2) To understand the importance of a standardized imaging protocol. 3) To become comfortable differentiating benign from malignant lesions on F-18 NaF PET/CT.

#### ABSTRACT

F-18 NaF PET/CT has been shown to have higher sensitivity and specificity than planar <sup>99m</sup>Tc MDP bone scanning in several small studies. The concomitant acquisition of anatomic images permits immediate correlation of any abnormal findings. Additionally, F-18 NaF PET/CT bone imaging can be quantitated, allowing bone disease to be  $\diamond$ measureable $\diamond$ , increasing its utility therapy monitoring. When a consistent F-18 NaF uptake period is used, the SUV values are highly reproducible, and due to the high extraction fraction, high quality images can be obtained with a radiation dose exposure similar to that of Tc-99m MDP (including the low dose CT scan). This presentation will discuss the benefits and challenges of F-18 NaF PET/CT in oncology.

### VSNM31-05 • Prospective Evaluation of Planar Bone Scintigraphy, SPECT/CT, <sup>18</sup>F NaF PET/CT and Whole Body 1.5T MRI for Detection of Bone Metastases in High Risk Breast and Prostate Cancer Patients

**Ivan Jambor MD (Presenter) ; Anna Kuisma ; Riikka Huovinen ; Minna Sandell ; Joakim Auren ; Sami A Kajander MD ; Jukka Kempainen ; Jani Saunavaara ; Tommi Noponen ; Heikki R Minn MD, PhD \* ; Hannu J Aronen MD, PhD ; Marko Seppanen**

#### PURPOSE

The aim of the study was to compare the diagnostic accuracy of <sup>99m</sup>Tc methylene-diphosphonate planar bone scintigraphy (<sup>99m</sup>Tc-MDP BS), <sup>99m</sup>Tc methylene-diphosphonate single photon emission tomography/computed tomography (<sup>99m</sup>Tc-MDP SPECT/CT), <sup>18</sup>F NaF PET/CT and whole body 1.5 Tesla MRI (wbMRI) for the detection of bone metastases in high risk breast cancer and prostate cancer patients.

#### METHOD AND MATERIALS

Twenty-five breast cancer and twenty-six prostate cancer patients at high risk of bone metastases prospectively underwent <sup>99m</sup>Tc-MDP BS, <sup>99m</sup>Tc-MDP SPECT/CT, <sup>18</sup>F NaF PET/CT and wbMRI. Coronal T1-weighted, T2-weighted STIR, axial diffusion weighted images (b-values: 0, 150, 1000 s/mm<sup>2</sup>) covering whole body were acquired. Four independent reviewers interpreted each individual modality, grading lesions as suspicious, equivocal and benign, without the knowledge of other imaging findings. The final metastatic status was based on the consensus reading of all imaging modalities. The bone findings were compared on patient and region basis. In the region based analysis, the skeleton was divided into five regions.

#### RESULTS

Based on the consensus reading, 18 (35%) patients and 54 (21%) regions had presence of bone metastases while 33 patients and 201 regions were free of bone metastases. <sup>99m</sup>Tc-MDP BS was false negative in 4 patients. In the region based analysis, the sensitivity for <sup>99m</sup>Tc-MDP BS, <sup>99m</sup>Tc-MDP SPECT/CT, <sup>18</sup>F NaF PET/CT and wbMRI was 70%, 87%, 98% and 90%, respectively. The number of equivocal findings for <sup>99m</sup>Tc-MDP BS, <sup>99m</sup>Tc-MDP SPECT/CT, <sup>18</sup>F NaF PET/CT and wbMRI was 30, 6, 8, 2, respectively. wbMRI provided clinically useful information concerning soft tissues in 6 patients while CT in 4 patients.

#### CONCLUSION

Whole body 1.5T MRI, including diffusion weighted imaging, had similar diagnostic accuracy for detecting bone metastases in high risk breast and prostate cancer patients as <sup>99m</sup>Tc-MDP SPECT/CT, <sup>18</sup>F NaF PET/CT. These modalities were significantly more sensitive in region based analysis than <sup>99m</sup>Tc-MDP BS and provided increased diagnostic confidence. Additional soft tissues information provided by whole body 1.5T MRI has potential to affect the patient management.

#### CLINICAL RELEVANCE/APPLICATION

Whole body MRI showed similar sensitivity for detecting bone metastases in high risk breast and prostate cancer patients as <sup>99m</sup>Tc-MDP SPECT/CT, <sup>18</sup>F NaF PET/CT and was superior to bone scintigraphy.

### VSNM31-06 • Quantitative Imaging Biomarkers in Whole Body <sup>18</sup>F-Sodium Fluoride (<sup>18</sup>F-NaF) PET-MRI to Evaluate Prostate Cancer Bone Metastases

**Luis S Beltran MD (Presenter) ; Christopher Glielmi PhD \* ; Fabio Ponzo MD ; Andrew B Rosenkrantz MD ; Rajan Rakheja ; Anna Ferrari MD ; Marc H Schiffman MD ; Scott Tagawa MD ; David Nanus MD ; Himisha Beltran MD ; Michael P Recht MD**

#### PURPOSE

To correlate quantitative PET and MR diffusion weighted imaging parameters in prostate cancer (PC) bone metastases utilizing whole body <sup>18</sup>F-Sodium Fluoride (<sup>18</sup>F-NaF) PET-MRI

#### METHOD AND MATERIALS

6 men (median age 73, range 63-83) with advanced PC and known bone metastases underwent whole body PET-MRI (Siemens Biograph mMR) 45 minutes after the intravenous administration of 9 mCi of <sup>18</sup>F-Sodium Fluoride (<sup>18</sup>F-NaF). The maximum Standardized Uptake Value (SUVmax), mean Apparent Diffusion Coefficient (ADCmean), and Intravoxel Incoherent Motion (IVIM) parameters including fast component of diffusion (Dfast), slow component of diffusion (Dslow), and Perfusion Fraction (PF) from multi-b value diffusion weighted imaging were calculated in dominant bone lesions (diameter > 1.5 cm). Correlation between SUVmax and ADCmean, Dfast, Dslow, and PF were evaluated using Spearman rank correlation (r). Two patients underwent biopsy of metastatic lesions.

#### RESULTS

15 metastatic bone lesions were evaluated. The average value for SUVmax was 28.6 (5.9-61.7, SD 27). The average value (10<sup>-3</sup> mm<sup>2</sup>/sec) for ADCmean was 0.93 (0.47-1.8, SD 0.38), for Dfast was 18.2 (11-28, SD 4.5), and for Dslow was 0.98 (0.4-1.7, SD 0.39). The average PF (%) was 10.3 (3.2-18.5, SD 5.1). There was a significant negative correlation between SUVmax and ADCmean (r=-0.75; p=0.001). There were weak to moderate negative correlations between SUVmax and IVIM parameters (p>0.14): Dfast: r=-0.11; Dslow: r=-0.38; PF: r=-0.17. In both patients who had biopsies of metastatic lesions, the biopsy site was determined after reviewing the PET-MRI images. One patient had a biopsy of a bone lesion with a high SUVmax of 48.9 in the L5 vertebral body. Another patient had a biopsy of a metastatic supraclavicular lymph node rather than a bone lesion due to a low SUVmax value of 5.9 of the dominant bone

lesion. Both patients with biopsies of metastatic lesions, were positive for metastatic PC.

#### CONCLUSION

ADCmean and SUVmax show a significant negative correlation in 18F-NaF PET-MRI. IVIM parameters showed weak to moderate negative correlations with SUVmax and may provide complementary information to ADC and SUV, thus warranting further attention in future larger studies.

#### CLINICAL RELEVANCE/APPLICATION

Our pilot data shows feasibility of 18F-NaF PET-MRI in providing quantitative metrics (SUV,ADC,IVIM) of PC bone metastases, which warrant study as biomarkers for biopsy planning and treatment response

### **VSNM31-07 • Prostate Cancer Choline PET Imaging and Other PET Tracers**

**Hossein Jadvar MD, PhD (Presenter)**

#### LEARNING OBJECTIVES

1) Review the major biological targets that may be useful for imaging in prostate cancer. 2) Understand the need for tailoring the imaging technique to the particular clinical phase of disease. 3) Analyze the current evidence with the potential utility of PET with various radiotracers in the imaging evaluation of prostate cancer.

#### ABSTRACT

Recent advances in the fundamental understanding of the complex biology of prostate cancer have provided increasing number of potential targets for imaging and treatment. In this presentation, I review the experience with a number of major PET radiotracers for potential use in the imaging evaluation of men with prostate cancer.

### **VSNM31-08 • [Cu-62]-ATSM PET-CT Study as Hypoxic Imaging in Patients with Gliomas: Comparison with Multitracer Approach Using [F-18]-FDG and [C-11]-Methionine**

**Ukihide Tateishi MD, PhD (Presenter) ; Kensuke Tateishi ; Ayako Shishikura ; Tomohiro Yoneyama ; Ikuo Torii ; Tomio Inoue MD, PhD ; Nobutaka Kawahara**

#### PURPOSE

The purpose of study was to investigate multitracer approach by [Cu-62]-diacetyl bis (N4-methylthiosemicarbazone) ([Cu-62]-ATSM) PET-CT as hypoxic imaging comparing with [F-18]-FDG PET-CT and [C-11]-Methionine PET-CT for differentiation of tumor grade in patients with glioma.

#### METHOD AND MATERIALS

Multitracer PET-CT studies using [Cu-62]-ATSM, [F-18]-FDG and [C-11]-Methionine were performed in 32 patients with glioma prior to surgery. The maximum standardized uptake value (SUV max), tumor/ background ratio (TBR), and volumetric analysis were quantitatively assessed. Distribution of trace uptake was qualitatively evaluated in comparison with MR images. To confirm tissue hypoxia, the transcription factor hypoxia inducible factor-1alpha (HIF-1alpha) utilized as a hypoxic marker was also assessed.

#### RESULTS

There were 17 glioblastoma multiformes (GBM) and 15 grade II or grade III gliomas. Of these, 19 (59.4%) patients were newly diagnosed. The SUVmax and TBR of [Cu-62]-ATSM were significantly higher in GBM than in non-GBM gliomas (p = 0.003 and 0.0001, respectively); however, there were no significant differences when assessed by [F-18]-FDG and [C-11]-Methionine. At a TBR cutoff threshold of 1.9, [Cu-62]-ATSM was the most predictive of GBM, with 94.1% sensitivity and 80.0% specificity. The mean TBR was significantly higher in HIF-1alpha positive tumors than those with HIF-1? negative tumors (p

#### CONCLUSION

Our results demonstrated that [Cu-62]-ATSM PET-CT provides the valuable information to discriminate GBM. [Cu-62]-ATSM appears to be a suitable tracer establishing attractive therapeutic strategies for hypoxic imaging in GBM.

#### CLINICAL RELEVANCE/APPLICATION

[Cu-62]-ATSM is a suitable biomarker establishing attractive therapeutic strategies for hypoxic imaging in GBM.

### **VSNM31-09 • Diagnostic Performance of Synthetic Amino Acid Anti-3-[18F] FACBC PET in Recurrent Prostate Carcinoma Detection**

**Oluwaseun Odewole MBBS, MPH (Presenter) ; Pooneh Taleghani MD ; Ashesh B Jani MD ; Bitai Savir-Baruch MD ; Leah M Bellamy ; Adeboye Osunkoya MD ; Weiping Yu PhD ; Raghuvveer K Halkar MD \* ; Peter Nieh MD ; Viraj Master MD ; Mark M Goodman PhD \* ; David M Schuster MD**

#### PURPOSE

anti-3-[18F] FACBC is a synthetic amino acid PET radiotracer with utility in detection of prostate cancer (Radiology 2011; 259:852). Following full accrual in a clinical trial, we investigate the diagnostic performance of anti-3-[18F] FACBC PET/CT in the detection of both prostatic and extraprostatic recurrence of prostate cancer.

#### METHOD AND MATERIALS

115 patients with suspected recurrent prostate carcinoma after definitive therapy for localized disease and negative bone scan underwent anti-3-[18F] FACBC. Studies were interpreted blindly to other imaging using established dual time point criteria. Correlation was made to histology and clinical followup by a multidisciplinary board.

#### RESULTS

109 out of 115 patients and 86 out of 115 patients had a reference standard sufficient to determine the presence of prostatic or extraprostatic disease respectively. Mean PSA ( $\pm$ SD) was 7.1( $\pm$ 7.7) ng/ml. Average follow-up after imaging was 41.5( $\pm$ 13.4) months. 94 of 115 (81.7%) examinations were positive. In the prostate bed, anti-3-[18F] FACBC had a sensitivity of 89.0%, specificity of 35.1%, accuracy of 70.6%, positive predictive value of 72.7% and a negative predictive value of 61.9% while for extra-prostatic disease detection, anti-3-[18F] FACBC had a sensitivity of 58.3%, specificity of 94.7%, accuracy of 74.4% positive predictive value of 93.3%, and a negative predictive value of 64.3%. All prostatic true positive lesions (100%) on FACBC and 89.3% of extra-prostatic lesions had histological confirmation of disease. On a whole body basis, true positive lesion detection rate was 16.7, 72.7, 85.2 and 84.3 at PSA (ng/ml) of 0-1, 1.1-2, 2.1-5 and >5.1 respectively.

#### CONCLUSION

anti-3-[18F] FACBC has favorable diagnostic performance in the detection of recurrent prostate cancer and can delineate prostatic from extra-prostatic recurrence.

#### CLINICAL RELEVANCE/APPLICATION

anti-3-[18F] FACBC is useful for restaging of patients with suspected prostate cancer recurrence.

### **VSNM31-10 • Hypoxia Imaging: FMISO PET Imaging in Oncology**

**Joseph G Rajendran MBBS (Presenter)**

#### LEARNING OBJECTIVES

1) Understand the evolution of tumor hypoxia and its biological implications. 2) Identify the mechanistic changes in tumor biology that will result in tumor resistance and poor patient outcome. 3) Learn novel ways to image tumor hypoxia with focus on FMISO PET imaging. 4) Understand the potential approaches to overcoming the negative impact of hypoxia.

## ABSTRACT

The physiological microenvironment for a tumor is largely dictated by abnormal vasculature and metabolism. Many solid tumors develop areas of hypoxia during their evolution caused by unregulated cellular growth, resulting in greater demand on oxygen for energy metabolism. Hypoxia induces a cascade of changes that reflects the homeostatic attempts (highly conserved evolutionally) to maintain adequate oxygenation that may result in tumor cells to adapt by developing more aggressive survival traits; mediated by Hypoxia Inducible Factor (HIF1a) part of the cellular oxygen sensing mechanism. Hypoxic tumors are not effectively eradicated with conventional doses of radiation and show resistance to several chemotherapy drugs. Hypoxia may also result in angiogenesis (itself a marker of tumor aggressiveness) mediated by Vascular endothelial growth factor (VEGF). While angiogenesis is a frequent consequence of hypoxia, some tumors develop extensive angiogenesis without the presence of hypoxia and vice versa. Advances in PET imaging instrumentation, coupled with the development of an increasing array of novel molecular probes, provide opportunities for imaging and selection of appropriate therapies to overcome the cure limiting effects of these two fundamental aspects of tumor microenvironment. The biology of tumor microenvironment related to hypoxia and its effect on patient outcome and developments in imaging technology and novel radiotracers for hypoxia imaging with a focus on F-18 FMISO would be reviewed. Challenges and novel treatments to overcome the cure limiting ability of hypoxia will be discussed.

### **VSNM31-11 • Correlation of F-18 Fluoromisonidazole PET Findings with HIF-1A and p53 Expressions in Head and Neck Cancer: Comparison with F-18 FDG PET**

**Takashi Norikane** (Presenter) ; **Yuka Yamamoto** MD, PhD ; **Yukito Maeda** ; **Nobuyuki Kudomi** ; **Yoshihiro Nishiyama** MD

#### PURPOSE

We evaluated tumor hypoxia using F-18 fluoromisonidazole (FMISO) positron emission tomography (PET) in relation to the expression of hypoxia-inducible factor-1? (HIF-1?) and p53 in patients with head and neck cancer and compared with 2-deoxy-2-F-18-fluoro-D-glucose (FDG) PET.

#### METHOD AND MATERIALS

A total of 28 tumors (23 primary tumors and 5 metastatic lymph nodes) from 24 patients with newly diagnosed head and neck cancer were examined with FMISO PET and FDG PET. The FMISO PET images were scaled to the venous blood concentration of FMISO activity to produce tumor-to-blood (T/B) values. Hypoxia was defined as a region with a T/B ratio of  $\geq 1.2$ . The maximum T/B ( $T/B_{max}$ ) and hypoxic volume were calculated by region-of-interest (ROI) analysis. For FDG PET, the maximum standardized uptake value ( $SUV_{max}$ ) and hypermetabolic volume were calculated by ROI analysis. The expressions of HIF-1? and p53 using immunohistochemistry were estimated in tumor tissue samples.

#### RESULTS

There was a significant correlation between hypoxic volume and  $T/B_{max}$  ( $r=0.53$ ,  $P=0.003$ ) using FMISO PET and between hypermetabolic volume and  $SUV_{max}$  ( $r=0.38$ ,  $P=0.046$ ) using FDG PET. The hypoxic volume using FMISO PET and hypermetabolic volume using FDG PET also showed a significant correlation ( $r=0.44$ ,  $P=0.020$ ). The values of FMISO hypoxic volume was significantly correlated with HIF-1? ( $r=0.40$ ,  $P=0.037$ ) and p53 ( $r=0.47$ ,  $P=0.012$ ) obtained on immunohistochemical examination.

#### CONCLUSION

These preliminary results suggest that hypoxic volume measured by FMISO PET may be a potential noninvasive biomarker for predicting tissue hypoxia in patients with head and neck cancer.

#### CLINICAL RELEVANCE/APPLICATION

Hypoxic volume measured by FMISO PET may be a potential noninvasive biomarker for predicting tissue hypoxia in patients with head and neck cancer.

### **VSNM31-12 • 18F-fluoroethylcholine (18F-Cho) PET/MRI Functional Parameters in Paediatric Brain Tumors**

**Francesco Fraioli** MD (Presenter) ; **Ashley M Groves** MBBS \* ; **Jamshed Bomanji** ; **Rizwan Syed** MBBS, FRCR ; **Asim Afaq** FRCR

#### PURPOSE

This study tested the principle that simultaneous 18F-fluoroethylcholine PET/MRI along with functional parameters ( $SUV_{max}/mean$  and  $ADC_{mean}$ ) is a valuable option for diagnosis, and response assessment, in children and adolescents with histological confirmed gliomas and intra-cranial germ cell tumors.

#### METHOD AND MATERIALS

18F-Cho PET MRI scans were performed in 10 children with biopsy proven intra-cranial tumours detected on MRI imaging. Five patients also underwent a second PET MR scan after chemotherapy. PET data were acquired simultaneously with the MR sequences. The standardized uptake values (SUVs) ratios between the lesion and normal brain tissue greater than background was indicative of a positive scan. Maximal Standardized Uptake Value ( $SUV_{max}$ ) and mean SUV ( $SUV_{mean}$ ) and apparent diffusion coefficient (ADC) Mean of the whole tumor ROI were recorded. For all tumors the association between the ADC mean and to SUV mean and max was assessed using the non-parametric Spearman correlation coefficient

#### RESULTS

In all the patients the ratio between 18F-cho lesion and normal brain tissue were significantly elevated and were shown to be independent predictors of the presence of gliomas. The areas of 18F-Cho uptake matched to areas of contrast enhancement and of restricted diffusion.

There was a negative correlation between  $SUV_{max}$  and  $ADC_{mean}$ .

Five patients had response assessment scans 6 weeks after chemo-radiotherapy; in four patients there was an agreement between volume changes, 18F-Cho and ADC values. In one patient there was a minimal reduction of  $SUV_{max}$  and mean and  $ADC_{mean}$ . In this patient the tumor volumetric dimensions were stable.

#### CONCLUSION

PET MR allows simultaneous acquisition of morphological and molecular images. ADC maps may provide additional information in staging and follow up brain tumors.

#### CLINICAL RELEVANCE/APPLICATION

PET MR allows simultaneous acquisition of morphological and molecular images. ADC maps may provide additional information in staging and follow up brain tumors.

### **Case-based Review of Nuclear Medicine: PET/CT Workshop-Cancers of the Abdomen and Pelvis (In Conjunction with SNMMI) (An Interactive Session)**

**Tuesday, 10:30 AM - 12:00 PM • S406A**

**OI** **NM** **CT** **GU** **GI**

[Back to Top](#)

**MSCC32 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Director**

**John A Parker**, MD, PhD

**Jacqueline C Brunetti**, MD

## LEARNING OBJECTIVES

1) Demonstrate an understanding of normal distribution of FDG PET in the abdomen and pelvis and possible pitfalls in interpretation of PET/CT scans of the abdomen and pelvis. 2) Understand the variability of FDG PET metabolic activity in specific abdominal and pelvic malignancies and apply this knowledge to optimally utilize this modality for the most efficient and accurate patient care. 3) Understand the current accepted indications of FDG PET/CT in diagnosis, staging and restaging in neoplasms of the abdomen and pelvis.

## ABSTRACT

FDG PET/CT has evolved into a routine tool in the diagnosis, staging and restaging of cancer patients. The accuracy and clinical benefit of the technique, however, are dependent on the glycolytic activity of the specific neoplasm, the background activity and the pattern of spread of metastatic disease. As the healthcare system is increasingly stressed by decreasing reimbursements and increasing regulations, it is critical for the Radiologist to have a clear concept of the value of FDG PET/CT for each tumor type. Acting in the role as consultant, the Radiologist can steer the referring physician to the most cost efficient approach that will yield the most beneficial and appropriate treatment choice. This course will present a case-based review of abdominal and pelvic malignancies, highlighting the benefits, pitfalls and best indications for FDG PET/CT in tumors of the hepatic, gastrointestinal, gynecologic and urologic neoplasms.

## ISP: Breast Imaging (Nuclear/Molecular Imaging)

Tuesday, 10:30 AM - 12:00 PM • E451A



[Back to Top](#)

**SSG01** • *AMA PRA Category 1 Credit*™:1.5 • *ARRT Category A+* Credit:1.5

### Moderator

**David A Mankoff**, MD, PhD

### Moderator

**D. David Dershaw**, MD

## SSG01-01 • Breast Imaging Keynote Speaker: Molecular Imaging of Breast Cancer-Clinical and Biological Considerations

**David A Mankoff** MD, PhD (Presenter)

## SSG01-03 • Comparison of FDG-PET/CT and FDG-PET/MRI for Local Staging of Breast Cancer

**Johannes Grueneisen** (Presenter) ; **James Nagarajah** ; **Sonja Liebeskind** ; **Kai Nassenstein** ; **Sonja Kinner** MD

### PURPOSE

To compare the diagnostic potential of FDG-PET/MRI mammography and FDG-PET/CT for local staging in breast cancer patients.

### METHOD AND MATERIALS

43 Patients with biopsy-proven invasive breast cancer were included in our study. In addition to a clinically indicated FDG-PET/CT all patients subsequently underwent contrast enhanced FDG-PET/MR mammography (Biograph mMR, Siemens) using a 16-channel breast coil. Two readers evaluated separately both imaging methods concerning lesion detection and size measurement of the primary tumor as well as detection of multifocality / multicentricity and bilateral lesions. All patients underwent surgery; histopathology examination served as a reference of standard.

### RESULTS

A total of 52 lesions, including 49 primary tumor lesions and three contralateral lesions were detected. While PET/CT allowed for identification of 46/52 cases (88,5%), PET/MRI offered correct identification of 50/52 (96,2%) breast cancer lesions. PET/MRI enabled a correct assessment of the T stage in 44/52 cases (84,6%); compared to PET/CT (31/52; 59,6%). In five cases the same lesion at T2 stage was falsely diagnosed as T1 stage by both diagnostic modalities.

### CONCLUSION

The results demonstrate the superiority of PET/MRI in detecting malignant lesions and in its size estimation compared to PET/CT while both diagnostic methods reveal the tendency to underestimate the tumor size.

### CLINICAL RELEVANCE/APPLICATION

PET/MRI seems to be a powerful tool in detecting and rating primary breast cancer lesions as well as accessory lesions and should be diagnostic modality of choice for staging primary breast cancer.

## SSG01-04 • Meta-analysis of Molecular Breast Imaging (MBI) Studies

**James W Hugg** PhD (Presenter) \*

### PURPOSE

Molecular Breast Imaging (MBI) uses planar imaging of single gamma photon emission from intravenous injection of Tc99m-sestamibi or tetrofosmin to visualize breast cancers that are often occult on mammography in the 40-50% of women with radiographically dense breasts. Clinical results published since 2002 support a meta-analysis of the MBI studies in three clinical applications: diagnostic workup, extent of disease, and high-risk screening.

### METHOD AND MATERIALS

MBI consists of a pair of opposed semiconductor (CZT) gamma photon cameras. Breast-Specific Gamma Imaging (BSGI) consists of a single scintillator (NaI or CsI with PS-PMT or photodiode) gamma camera and a compression paddle. In both MBI and BSGI the breast is mildly compressed in standard planar mammographic views. We culled the literature until we had 19 studies and 4948 patients for diagnostic workup, 8 studies and 1507 patients for extent of disease, and 5 studies and 3013 patients for dense-breast screening. The analysis pools studies performed by BSGI (Dilon) and MBI (Gamma Medica or GE Healthcare).

### RESULTS

Patient injected doses were 8-20 mCi for MBI and 20-44 mCi for BSGI, with a general reduction in dose over time. The diagnostic workup studies, including primarily women with suspicious lesions on screening mammography, had a sensitivity of 94% for the detection of 1652 cancers and a specificity of 85%. The extent of disease studies in women with biopsy-proven cancer yielded additional cancers in 8% of women, changing clinical treatment in many cases. The high dense-breast screening studies detected a prevalence of 12.9 cancers per 1000 asymptomatic women screened by MBI or BSGI, compared to an incidence of 3.0 per 1000 for annual screening mammography.

### CONCLUSION

MBI and BSGI are more sensitive and specific than mammography, especially in dense breasts, and should be considered as an adjunct diagnostic and screening tool in breast cancer. Efforts to improve the technology and reduce the patient dose will further encourage the adoption of this new breast imaging modality.

### CLINICAL RELEVANCE/APPLICATION

MBI and BSGI are more sensitive and specific than mammography, especially in dense breasts, and should be considered as an adjunct diagnostic and screening tool in breast cancer.

## SSG01-05 • Correlation between Quantitative 18F-FDG Uptake on PET/CT with Prognostic Factors in Triple-negative Breast Cancers

**Hye Ryoung Koo** MD ; **Woo Kyung Moon** ; **Nariya Cho** MD ; **Jung Min Chang** MD ; **Mirinae Seo** MD ; **Hye Mi Gweon** MD (Presenter) ; **Keon Wook Kang**

## PURPOSE

We aimed to investigate whether a correlation exists between quantitative 18F-FDG uptake on PET/CT and prognostic factors in triple-negative breast cancer

## METHOD AND MATERIALS

Between January 2009 and December 2012, 1109 patients with newly diagnosed breast cancer underwent 18F-FDG PET/CT for initial staging followed by surgical treatment. This retrospective study involved 112 triple-negative invasive ductal cancers (mean tumor size 2.64cm, range 1 to 6.5cm) in 112 patients (mean age, 50.04 years; range, 28-77 years). Correlations between quantitative 18F-FDG uptake on PET/CT, expressed as maximum standardized uptake value (SUVmax), and prognostic factors including tumor size, axillary lymph node involvement status, histologic grade, nuclear grade, expression of Ki-67, p53, bcl-2, EGFR, CK5/6 were analyzed. Triple-negative breast cancer was defined as estrogen receptor (ER)-negative, progesterone receptor (PR)-negative, and human epidermal growth factor 2 (HER2)-negative.

## RESULTS

The mean SUVmax value of the 112 tumors was  $10.05 \pm 5.8$  (range: 1.4-32.8). Tumors with high nuclear grade (mean SUVmax  $10.39 \pm 5.75$ , n=106) showed higher FDG uptake than tumors with low nuclear grade (mean SUVmax  $3.96 \pm 2.31$ , n=6). There was a positive correlation between 18F-FDG uptake and tumor size (Spearman's correlation coefficient = 0.38) as well as Ki-67 (Spearman's correlation coefficient = 0.22), whereas this relationship was not observed among the axillary lymph node involvement status, histologic grade, p53, bcl-2, EGFR, and CK5/6. In a multivariate logistic regression analysis, tumor size (P

## CONCLUSION

Increased FDG uptake on PET/CT correlates with tumor size, nuclear grade, and Ki-67 proliferation index in triple-negative breast cancer.

## CLINICAL RELEVANCE/APPLICATION

FDG uptake relates to biologically important prognostic factors in triple-negative breast cancer. FDG uptake on PET/CT might be a useful tool to define the heterogeneity of triple-negative breast cancer

## **SSG01-06 • Molecular Breast Imaging: The Sensitivity of Breast-specific Gamma Imaging (BSGI) as a Diagnostic Adjunct to Mammography and Ultrasound in a Triple Assessment Protocol**

**Jean M Weigert MD (Presenter) \* ; Douglas A Kieper BS \* ; Marcela Bohm-Velez MD**

## PURPOSE

BSGI is a diagnostic breast imaging procedure becoming more common in clinical breast practice. The goal of this work is to quantify its performance as an addition to mammography and ultrasound in detection of breast carcinoma when used in the community breast center setting.

## METHOD AND MATERIALS

A multi-center patient registry was maintained for all patients routinely sent to BSGI as part of their diagnostic work up. From the registry data, patients who had a mammogram followed by ultrasound and BSGI were selected for evaluation. The BIRADS rating schematic was used for mammography and sonography and a similar category system was used for the BSGI images. For each modality, the reports were classified as positive (categories 4 - 6) or Negative (categories 0 - 3). Needle and/or surgical biopsy were conducted as deemed clinically necessary and all patients who had a malignant diagnosis by pathology were entered into this analysis.

## RESULTS

731 patients had all three imaging modalities as part of their diagnostic work up resulting in 180 malignancies confirmed by pathology: 29 ductal carcinoma in-situ, 110 infiltrating ductal carcinoma, 11 infiltrating lobular carcinoma, 9 papillary carcinoma and 21 mixed component malignancies. Mammography was positive in 130 (sensitivity = 72%) while ultrasound was positive in 114 (sensitivity = 63%) and BSGI was positive in 147 (sensitivity = 82%). Mammography and ultrasound were positive in 163 cases (sensitivity = 90%). BSGI provided positive findings for 177 malignancies resulting in a sensitivity of 98%. A breast MRI detected one lesion missed by the three modalities while two lesions were found by pathology alone

## CONCLUSION

Of the three imaging modalities, BSGI provided the highest independent sensitivity and when added to the diagnostic workup, BSGI detected an additional 14 malignancies, increasing the sensitivity from 90% to 98%. Although it is beyond the scope of this work, it is interesting to note that the cost of the BSGI procedure is relatively low, about \$320, and that in this population the BSGI specificity was 74%. In summary, when added to the diagnostic work up of patients in the community breast cancer, BSGI can improve the detection of breast malignancy when compared to mammography and ultrasound alone.

## CLINICAL RELEVANCE/APPLICATION

BSGI can improve the detection of breast malignancy when compared to mammography and ultrasound alone.

## **SSG01-07 • False Positive Findings on Adjunct Screening Molecular Breast Imaging with Tc-99m Sestamibi**

**Carrie B Hruska PhD (Presenter) \* ; Amy L Connors MD ; Katie N Jones MD ; Michael K O'Connor PhD \* ; Deborah J Rhodes MD**

## PURPOSE

To determine the rates and histopathologic subtypes of false positive imaging findings and benign biopsies generated from adjunct screening with molecular breast imaging (MBI).

## METHOD AND MATERIALS

Screening MBI was performed in asymptomatic women presenting for screening mammography who had dense breasts (>50% fibroglandular) on past prior mammogram. Intravenous injection of 8 mCi Tc-99m sestamibi was administered; bilateral 2-view MBI was performed using a dual-head CZT-based gamma camera. MBI studies were interpreted with access to the current screening mammogram and assigned an assessment of 1-5 that parallels BI-RADS. Assessment of 3 or higher was considered test positive. Participants with negative reference standard (benign biopsy result or negative/benign imaging at one year) were analyzed.

## RESULTS

Of 1638 eligible participants, 1578 (96%) had complete reference standard, of which 1557 had no diagnosis of cancer. In 1557 participants with negative reference standard, 105 (6.7%) had test positive screening MBI and were recalled for diagnostic workup. Of these 105, 70 (67%) were resolved with benign findings on immediate diagnostic mammogram/ultrasound and follow-up MBI at 6 months. Final impressions included: stable background uptake (24) or resolved focal uptake (16); appearance of fibrocystic change (14), fibroadenoma (5), lymph node (3), post-operative change (4), or stable mass (2); and previously biopsied papilloma (2). The remaining 35 of 105 (33%) underwent biopsy: ultrasound-guided in 26, magnetic resonance imaging-guided in 7, and stereotactic in 2. Pathologic findings included fibroadenoma (11), benign breast parenchyma (6), fibrocystic change (5), papilloma (4), radial scar (3), stromal fibrosis (2), pseudoangiomatous stromal hyperplasia (2), atypical ductal hyperplasia (2).

## CONCLUSION

For non-cancer cases, adjunct MBI had a recall rate of 6.7% and benign biopsy rate of 2.3%. The most common false positive imaging finding was benign background uptake of Tc-99m sestamibi in fibroglandular tissue; the most common biopsied benign lesion was fibroadenoma.

## CLINICAL RELEVANCE/APPLICATION

MBI demonstrated a relatively low additional false positive rate compared to that reported for other modalities under consideration for supplemental screening in the dense breast.

## SSG01-08 • Improved Diagnostic Yield in Dense Breasts with Supplemental Screening Molecular Breast Imaging

Deborah J Rhodes MD (Presenter) ; Carrie B Hruska PhD \* ; Amy L Conners MD ; Katie N Jones MD ; Michael K O'Connor PhD \*

### PURPOSE

We previously demonstrated that addition of Molecular Breast Imaging (MBI) using 20 mCi Tc-99m sestamibi to screening mammography (SM) increased diagnostic yield for breast cancer in dense breasts (supplemental yield of 7.5/1000 screened). After implementing radiation dose reduction techniques, we are comparing performance of incident SM and prevalent screen MBI in women with dense breasts.

### METHOD AND MATERIALS

Women presenting for SM with heterogeneously or extremely dense breasts on past prior SM were enrolled and underwent digital SM and MBI. MBI was performed with 8 mCi Tc-99m sestamibi and dual-head cadmium zinc telluride detectors. SMs were read independently; MBIs were read in comparison with SM. MBIs were assigned an assessment score of 1-5 which parallels BI-RADS; scores of 3-5 on MBI were considered positive.

### RESULTS

In 1651 women enrolled, 1578 (96%) completed imaging and had reference standard of pathology findings within 365 days or negative imaging at >300 days. In 1578 analyzable participants, 21 had breast cancer diagnosed. Sensitivity was 5/21 (24%) for SM alone and 19/21 (91%) for the combination of SM and MBI. Diagnostic yield was 3.2 for SM and 12.0 for the combination ( $p = 0.0001$ ). Diagnostic evaluation was prompted by SM alone in 174 (11%) patients and by the combination in 280 (18%). Biopsy was prompted by SM in 21 (1.3%) patients and by the combination in 67 (4.3%). The number of breast cancers diagnosed per number of biopsies (PPV) was 24% for SM and 28% for combination. Specificity was 88% for SM alone and 82% for the combination ( $p = 0.0001$ ). Fourteen patients had cancer detected only on MBI: 4 ductal carcinoma in situ (DCIS); 8 invasive ductal carcinoma (IDC); and 2 invasive lobular carcinoma (ILC); median pathologic tumor size was 12 mm; range 4-62 mm. Three of 14 were node positive. The 4 MBI occult cancers were node negative and included 1 DCIS, 1 IDC, and 2 ILC; median pathologic tumor size was 6 mm, range 3-7 mm. Two patients had cancers detected on neither modality, including a 6 mm ILC detected on MRI and a 7 mm ILC detected on prophylactic mastectomy.

### CONCLUSION

Low dose MBI as an adjunct to SM in women with dense breasts provided a supplemental yield of 8.8 per 1000 with a modest decline in specificity.

### CLINICAL RELEVANCE/APPLICATION

The supplemental yield of adding screening MBI to SM in women with dense breasts is preserved at a lower administered dose of 8 mCi Tc-99m sestamibi.

## SSG01-09 • Background Parenchymal Uptake of Tc-99m Sestamibi on Molecular Breast Imaging in Mammographically Dense Breasts

Carrie B Hruska PhD (Presenter) \* ; Amy L Conners MD ; Katie N Jones MD ; Deborah J Rhodes MD ; Michael K O'Connor PhD \* ; Celine M Vachon \*

### PURPOSE

Background parenchymal uptake (BPU), or uptake of Tc-99m sestamibi in normal fibroglandular tissue (FT), has been observed on molecular breast imaging (MBI). We describe categories of BPU and examine associated factors, including mammographic density.

### METHOD AND MATERIALS

Screening MBI exams between April 2010-March 2012 from women with BI-RADS D3/D4 density on last mammogram were reviewed. Participants with breast implants or cancer diagnosed at screening were excluded. BPU intensity was subjectively categorized by two radiologists as photopenic (uptake in FT < subcutaneous fat), mild (uptake in FT = fat), moderate (uptake in FT up to 2x fat), or marked (uptake in FT > 2x fat). Association of BPU with age, current BI-RADS mammographic density, menopausal status, and use of hormonal medications was examined.

### RESULTS

In 1274 screening MBI exams, BPU was photopenic in 273 (21%), mild in 826 (65%), moderate in 136 (11%), and marked in 39 (3%). Moderate/marked BPU occurred in 31% (99/315) of women age 40-49 compared to 8% (76/959) of women age 50 and older ( $p$

### CONCLUSION

Moderate/marked BPU occurred more often in denser breasts and in women who were younger, pre- or perimenopausal, or on exogenous hormones. In each density category, substantial proportions of both moderate/marked and photopenic BPU were observed, establishing that similar-appearing FT on mammography can demonstrate considerable differences in BPU on MBI.

### CLINICAL RELEVANCE/APPLICATION

BPU may reflect underlying functional activity of mammographically dense tissue. Additional studies are needed to determine if BPU can help predict an individual's density-related breast cancer risk.

## Nuclear Medicine - Tuesday Posters and Exhibits (12:15pm - 12:45pm)

Tuesday, 12:15 PM - 12:45 PM • S503AB



[Back to Top](#)

CL-NMS-TUA • AMA PRA Category 1 Credit™: 0.5

Host  
Amir H Khandani, MD

CL-NMS-TU1A • Comparison of Intratumoral 18FDG and 18FAZA Distribution in Non-small Cell Lung Cancer Using Deformable Image Registration

Kenta Miwa RT (Presenter) ; Hidenobu Tachibana PhD ; Masayuki Inubushi ; Tsuneo Saga MD ; Kei Wagatsuma ; Taisuke Murata ; Mitsuru Koizumi ; Masayuki Sasaki

### PURPOSE

This study compares the intratumoral distribution of fluorodeoxyglucose (18FDG) and fluoroazomycin arabinoside (18FAZA) by registering tumor locations in two PET/CT studies using deformable image registration (DIR).

### METHOD AND MATERIALS

We retrospectively analyzed data acquired within one week from 18FDG- and 18FAZA-PET/CT images of 18 patients with non-small cell lung cancer. The general external shape of the lung fields was determined by global registration in DIR using a block-matching algorithm, and the interiors of lung field regions were matched by local registration using a free-form deformation algorithm. The amount of displacement between the two types of images was calculated using DIR vector fields and applied to the deformation of two concomitant PET images. The accuracy of registration was evaluated using a Dice coefficient (DC) of consistency between the reference and deformed CT images. Uptake areas, heterogeneity and maximum standardized uptake values (SUVmax) were compared with the distribution of 18FDG and 18FAZA within the tumors.



## RESULTS

The reference and deformed CT images of the tumors were very consistent, with DC values of 0.85-0.95. The area of distribution within tumors was narrower for 18FAZA than for 18FDG, and tended to be heterogeneous. Although the correlation between 18FDG and 18FAZA uptake was slightly lower ( $r = 0.60$ ), the two PET/CT images provided quite different types of information.

## CONCLUSION

We accurately registered two separate PET/CT image sets and compared the intratumoral distribution of 18FDG and 18FAZA.

## CLINICAL RELEVANCE/APPLICATION

This new method will gain insight into the biological mechanism underlying hypoxia-related tumor resistance to radiotherapy by determining the intratumoral distribution of 18FDG and 18FAZA.

## CL-NMS-TU2A • Scintigraphic Hypofunctioning Thyroid Nodules in Patients (pts) with Hyperthyroidism: Findings Predictive of Malignancy in Correlation with Ultrasonography

**Nam Ju Lee MD (Presenter) ; David A Mankoff MD, PhD ; Bongju Lee PhD ; Daniel Pryma MD \***

## PURPOSE

We evaluated hyperthyroid pts found to have hypofunctioning thyroid nodules on scintigraphy and correlated with ultrasonographic findings and the likelihood of malignancy.

## METHOD AND MATERIALS

We reviewed 3,298 thyroid scintigraphs done between 1/1991 and 10/2012. Of these, 1,506 were done for hyperthyroidism and 61 pts were found to have hypofunctioning nodules. Of these, 50 pts underwent US within 6 months. We excluded 6 pts with clinically transient hyperthyroidism and 4 pts without tissue confirmation or follow up studies to support benign nature. Finally, we collected 40 pts; age 18-79, median age 53 (F:37, M:3). Biopsy was performed on 22 pts. Seven pts had both biopsy and surgery. Three pts had surgery only. Four pts were stable on follow up US (25months-10yrs, median: 68months). Ablation therapy was done for 2 pts. Corresponding US was evaluated for multiplicity (single vs. multiple), meeting the currently recommended biopsy criteria, composition (solid vs. mixed), microcalcifications, coarse calcifications, and interval growth. For multiple nodules, we evaluated a dominant nodule. SAS version 9.3 was used for statistical analysis.

## RESULTS

Twenty three out of 40 nodules were solitary on scintigraphy and 5 out of 23 were solitary on US. Nine pts did not show corresponding nodules on US (22.5%). Surgery proved 6 cancers (15%); 3 were proven on biopsy prior to the surgery and 3 were occult cancers found surgically. Five out of 6 cancer pts had a single nodule on scintigraphy. Of 31 pts with a sonographic nodule, 18 nodules met the sonographic biopsy criteria and 3 out of 18 nodules had cancer on biopsy (OR 6.1, 95 % CI 0.3-129.0). Malignancy was proven in 2 of 5 sonographic solitary nodules (OR 16.7, 95 % CI 1.1-243.7) and 3 of 9 solid nodules (OR 24.2, 95 % CI 1.1-532.0) on biopsy. There was a statistically significant relationship between cancer and both solid composition ( $G^2=8.25$ ,  $p=4.50$ ,  $p$

## CONCLUSION

In hyperthyroid pts, scintigraphic hypofunctioning nodules need tissue confirmation when the nodule meets the biopsy criteria on US. Our study also revealed a significant correlation between ultrasonographic solid or solitary nodule and malignancy in the setting of hyperthyroidism.

## CLINICAL RELEVANCE/APPLICATION

Tissue confirmation is recommended to exclude malignancy when the scintigraphic hypofunctioning thyroid nodules are single, solid, or meeting biopsy criteria on US.

## CL-NMS-TU3A • 4'-[methyl-11C] Thiothymidine (4DST) PET for Proliferation Imaging in Brain Tumors: Comparison with 18F-FLT PET

**Yuka Yamamoto MD, PhD (Presenter) ; Yukito Maeda ; Nobuyuki Kawai MD ; Yoshihiro Nishiyama MD**

## PURPOSE

Although 3'-deoxy-3'-18F-fluorothymidine (FLT) has been used for imaging cell proliferation with PET, it is not incorporated into DNA. A new tracer, 4'-[methyl-11C]-thiothymidine (4DST), has been developed as an in vivo cell proliferation marker based on the DNA incorporation method. The purpose of this study was to investigate the feasibility of 4DST PET, compared with FLT PET, for the detection of brain tumors.

## METHOD AND MATERIALS

Thirteen patients with various malignant brain tumors were examined with both 4DST PET and FLT PET. Tumor lesions were identified as areas of focally increased uptake, exceeding that of background uptake. PET results were evaluated by visual and semi-quantitative analyses. For semi-quantitative analysis, the standardized uptake value (SUV) and tumor to contralateral normal brain tissue (T/N) ratio were determined by region-of-interest analysis.

## RESULTS

Although both 4DST and FLT showed little uptake in the normal brain, 4DST uptake was somewhat higher than FLT uptake in the normal brain. Both 4DST PET and FLT PET detected all brain tumors. The mean ( $\pm$ SD) value of SUV in the tumor on 4DST PET ( $3.37\pm 1.93$ ) was significantly higher than that on FLT PET ( $2.29\pm 2.96$ ) ( $p$

## CONCLUSION

These preliminary results indicate that 4DST PET is a potentially useful tracer for proliferation imaging in brain tumors.

## CLINICAL RELEVANCE/APPLICATION

4DST PET may be a potentially useful tracer for proliferation imaging in brain tumors.

## CL-NMS-TU4A • Identification and Lateralization of Diseased Parathyroid Glands in Complicated Patients: Preoperative Dual-tracer Scintigraphy (SC) Compared to Intraoperative Gamma Probe

**Aurela Clark MD (Presenter) ; Courtney Y Lee MD ; Partha Sinha MBBS ; Gary R Conrad MD ; M. Elizabeth Oates MD**

## PURPOSE

To compare the performance of dual tracer scintigraphy (SC) to intraoperative gamma probe (IGP) in identifying and lateralizing diseased parathyroid glands (DPG) in complicated patients with primary hyperparathyroidism (PHPT).

## METHOD AND MATERIALS

Medical records were retrospectively reviewed for 18 patients (17F:1M, average age 58 years) with PHPT complicated by one or more of the following: concomitant thyroid disease in 14 (11 nodular goiter, 3 hypothyroidism), multiglandular parathyroid disease (MGD) in 6, recurrent PHPT in 3. All patients had routine preoperative  $^{99m}Tc$  sestamibi/ $^{99m}Tc$  pertechnetate scintigraphy and intraoperative IGP. SC was considered positive when images showed persistent sestamibi-avid foci or discordance; IGP was considered positive when *ex vivo* DPG counts measured  $>20\%$  *in vivo* counts. Glands were considered diseased based on one or more of the following: intraoperative gross findings, intraoperative parathormone (PTH) drop  $>50\%$  from baseline and into normal range after excision, pathology (weight, histopathology). Based on correct identification and lateralization of DPG removed at surgery, diagnostic performances of SC and IGP were classified as follows: successful (SCF), partially successful (PSCF), or unsuccessful (USCF).

## RESULTS

A total of 28 DPG weighing 89-6225 mg were removed. 12 (67%) patients had a single DPG and 6 (33%) had 2 (n=2) or 3 (n=4) DPG (MGD). In the single DPG group (10 with thyroid disease, 2 with recurrent PHPT), SC was SCF in 10 and USCF in 2, while IGP was SCF in 11 and USCF in 1. In the MGD group (2 with goiter, 1 with recurrent PHPT), SC was SCF in 2, PSCF in 2, and USCF in 2, while IGP was

SCF in 5 and USCF in 1. At follow-up, 17/18 patients were cured; 1 patient with MGD remained hypercalcemic.

#### CONCLUSION

In these complicated patients with PHPT, SC was successful in identifying and lateralizing single DPGs in virgin necks with/without concomitant thyroid disease. SC performed less well in MGD and recurrent PHPT; IGP was an essential surgical tool in these subgroups.

#### CLINICAL RELEVANCE/APPLICATION

Intraoperative gamma probe appears to outperform preoperative scintigraphy in localizing culprit parathyroid glands in multiglandular disease and/or recurrent primary hyperparathyroidism.

### CL-NMS-TU5A • [Cu-62]-ATSM PET-CT Study as Hypoxic Imaging in Patients with Gliomas: Comparison with Multitracer Approach Using [F-18]-FDG and [C-11]-Methionine

**Ukihide Tateishi MD, PhD (Presenter) ; Kensuke Tateishi ; Ayako Shishikura ; Tomohiro Yoneyama ; Ikuo Torii ; Tomio Inoue MD, PhD ; Nobutaka Kawahara**

#### PURPOSE

The purpose of study was to investigate multitracer approach by [Cu-62]-diacetyl-bis (N4-methylthiosemicarbazone) ([Cu-62]-ATSM) PET-CT as hypoxic imaging comparing with [F-18]-FDG PET-CT and [C-11]-Methionine PET-CT for differentiation of tumor grade in patients with glioma.

#### METHOD AND MATERIALS

Multitracer PET-CT studies using [Cu-62]-ATSM, [F-18]-FDG and [C-11]-Methionine were performed in 32 patients with glioma prior to surgery. The maximum standardized uptake value (SUV max), tumor/ background ratio (TBR), and volumetric analysis were quantitatively assessed. Distribution of trace uptake was qualitatively evaluated in comparison with MR images. To confirm tissue hypoxia, the transcription factor hypoxia inducible factor-1alpha (HIF-1alpha) utilized as a hypoxic marker was also assessed.

#### RESULTS

There were 17 glioblastoma multiformes (GBM) and 15 grade II or grade III gliomas. Of these, 19 (59.4%) patients were newly diagnosed. The SUVmax and TBR of [Cu-62]-ATSM were significantly higher in GBM than in non-GBM gliomas (p = 0.003 and 0.0001, respectively); however, there were no significant differences when assessed by [F-18]-FDG and [C-11]-Methionine. At a TBR cutoff threshold of 1.9, [Cu-62]-ATSM was the most predictive of GBM, with 94.1% sensitivity and 80.0% specificity. The mean TBR was significantly higher in HIF-1alpha positive tumors than those with HIF-1? negative tumors (p

#### CONCLUSION

Our results demonstrated that [Cu-62]-ATSM PET-CT provides the valuable information to discriminate GBM. [Cu-62]-ATSM appears to be a suitable tracer establishing attractive therapeutic strategies for hypoxic imaging in GBM.

#### CLINICAL RELEVANCE/APPLICATION

[Cu-62]-ATSM is a suitable biomarker establishing attractive therapeutic strategies for hypoxic imaging in GBM.

### CL-NME-TU6A • Alpha Therapy of Prostate Cancer Bone Metastases with Radium-223 Chloride

**Hossein Jadvar MD, PhD (Presenter) ; David I Quinn MD, PhD**

#### PURPOSE/AIM

To review the biological basis, clinical studies, and operational procedure for targeted alpha particle radionuclide therapy of prostate cancer bone metastases with Radium-223 chloride.

#### CONTENT ORGANIZATION

1. Alpha particle physics in comparison to beta particles 2. Pathophysiology of bone metastases in advanced prostate cancer 3. Mechanism of action with Radium-223 chloride therapy of bone metastases 4. Review of pre-clinical and clinical evidence for use of Radium-223 chloride therapy 5. Treatment indications, contraindications, operational and follow-up procedures

#### SUMMARY

This educational exhibit will present information about the alpha radiopharmaceutical, Radium-223 chloride (a natural calcium mimetic), for targeted treatment of bone metastases in men with castrate-resistant prostate cancer. It will review the evidence that demonstrated survival benefit in these patients and summarizes the issues related to mechanism of action, therapy administration, and radiation protection.

### CL-NME3054-TUA • Is Imaging the Extremities with PEM Feasible? A Novel Application for a High Resolution Positron Emission Scanner

**Sania Rahim MD, MPH (Presenter) ; Eric M Rohren MD, PhD \* ; Richelle Millican ; Shree Taylor ; Nancy M Swanston RT \* ; J. Elliott Brown MD**

#### PURPOSE/AIM

To demonstrate the novel use of Positron Emission Mammography, or PEM, to image lesions in the extremities. To describe the appearance of normal bone on PEM, a use that has not been yet reported in the literature. We also hope to explain how the superior spatial resolution of PEM, as compared to PET/CT, may be beneficial in the work-up of several disease processes.

#### CONTENT ORGANIZATION

The images of 21 patients who underwent sequential PET/CT and PEM imaging of lesions in their extremities were reviewed and their findings were used to support the assertions of this work. A) Similarities and differences of PET/CT and PEM physics B) Positioning and image acquisition C) Appearance of normal structures on PEM D) Imaging of lesions on PET/CT and PEM: how improved spatial resolution adds diagnostic information, e.g:

1. Activity seen in an adjacent bone that was not visualized on PET/CT or MRI
2. Localization of activity to the joint space rather than bone

E) Potential uses for PEM as a high resolution positron imaging device for the extremities include imaging of peripheral melanoma, rheumatoid arthritis and osteomyelitis

#### SUMMARY

1) Mechanics and utility of PEM as a high resolution imaging device for the extremities 2) Appearance of normal tissue versus pathologic lesions on PEM as compared to PET/CT

## Nuclear Medicine - Tuesday Posters and Exhibits (12:45pm - 1:15pm)

Tuesday, 12:45 PM - 01:15 PM • S503AB



CL-NMS-TUB • AMA PRA Category 1 Credit™:0.5

CL-NME-TU6B • Alpha Particles 2013: Current Perspectives on Alpha Particle Mediated Therapies

[Back to Top](#)

#### PURPOSE/AIM

Main aims of this presentation are to review the physical/chemical properties of alpha particles, to discuss alpha particle emitters used in clinical practice and to provide an overview of newer treatment agents currently being developed. Radiation safety concerns regarding the use and disposal of alpha emitter radiopharmaceuticals will also be reviewed.

#### CONTENT ORGANIZATION

1. Introduction and overview of alpha decay and properties of alpha emitters.
2. Historical perspective of alpha particle mediated therapies.
3. Review of currently used alpha particle emitters, including clinical indications and their role in oncologic management. Specifically, this presentation will discuss clinical applications of Astatine 211, Bismuth 212, Actinium 225, Radium 223 and Lead 212.
4. Overview of future alpha particle emitter radiopharmaceuticals currently under development.
5. Discussion of radiation safety considerations pertinent to alpha particle mediated therapies.

#### SUMMARY

This presentation will provide a better understanding of the growing role of alpha emitters, particularly in the treatment of cancer, and radiation safety considerations pertinent to this therapies.

### **CL-NMS-TU1B • FDG Uptake Heterogeneity Evaluated by Fractal Analysis Improves the Differential Diagnosis of Pulmonary Nodules**

**Kenta Miwa** RT (Presenter) ; **Masayuki Inubushi** ; **Kei Wagatsuma** ; **Tokuo Umeda** PhD ; **Akiko Okawa** MD, RN ; **Takuro Umeda** ; **Mitsuru Koizumi** ; **Masayuki Sasaki**

#### PURPOSE

The present study aimed to determine whether fractal analysis of morphological complexity and intratumoral heterogeneity of FDG uptake can help to differentiate malignant from benign pulmonary nodules.

#### METHOD AND MATERIALS

We retrospectively analyzed data from 54 patients with suspected non-small cell lung cancer (NSCLC) who were examined by contrast-enhanced chest CT and FDG PET/CT within the same week. Pathological assessments of biopsy specimens confirmed 35 and 19 nodules as NSCLC and inflammatory lesions, respectively. The morphological fractal dimension (m-FD), maximum standardized uptake value (SUVmax) and density fractal dimension (d-FD) of target nodules were calculated from CT and PET images. Fractal dimension (FD) is a quantitative index of morphological complexity and tracer uptake heterogeneity; higher values indicate increased complexity and heterogeneity.

#### RESULTS

The m-FD, SUVmax and d-FD significantly differed between malignant and benign pulmonary nodules ( $p < 0.05$ ). Although the diagnostic ability was better for d-FD than m-FD and SUVmax, the difference did not reach statistical significance. Tumor size correlated significantly with SUVmax ( $r = 0.51$ ,  $p < 0.05$ ), but not with either m-FD or d-FD. Furthermore, m-FD combined with either SUVmax or d-FD improved diagnostic accuracy to 92.6% and 94.4%, respectively.

#### CONCLUSION

The d-FD of intratumoral heterogeneity of FDG uptake can help to differentially diagnose malignant and benign pulmonary nodules. The SUVmax and d-FD obtained from FDG-PET images provide different types of information that are equally useful for differential diagnoses. Furthermore, the morphological complexity determined by CT combined with heterogeneous FDG uptake determined by PET improved diagnostic accuracy.

#### CLINICAL RELEVANCE/APPLICATION

Combining the morphological complexity of tumors on CT images with the heterogeneity of FDG uptake on PET images can help to differentially diagnose malignant and benign pulmonary nodules.

### **CL-NMS-TU3B • 4'-[methyl-11C]thiothymidine (4DST) PET for Proliferation Imaging in Head and Neck Cancer: Comparison with 18F-FLT PET**

**Yuka Yamamoto** MD, PhD (Presenter) ; **Yukito Maeda** ; **Yoshihiro Nishiyama** MD

#### PURPOSE

Although 3'-deoxy-3'-<sup>18</sup>F-fluorothymidine (FLT) has been used for imaging cell proliferation with PET, it is not incorporated into DNA. A new tracer, 4'-[methyl-<sup>11</sup>C]-thiothymidine (4DST), has been developed as an in vivo cell proliferation marker based on the DNA incorporation method. The purpose of this study was to investigate the feasibility of 4DST PET, compared with FLT PET, for the detection of head and neck cancer.

#### METHOD AND MATERIALS

Five patients with head and neck squamous cell carcinoma were examined with both 4DST PET and FLT PET. Tumor lesions were identified as areas of focally increased uptake, exceeding that of the surrounding normal tissue. PET results were evaluated by visual and semi-quantitative analyses. For semi-quantitative analysis, the maximal standardized uptake value (SUV) was determined by region-of-interest analysis.

#### RESULTS

4DST uptake in tumors peaked before 3 minutes and reached a constant level at approximately 10 minutes after injection. Physiological uptake in salivary glands of 4DST was stronger than that of FLT. Both 4DST PET and FLT PET detected all head and neck tumors. There was no significant difference between the mean ( $\pm$ SD) value of SUV in the tumor using 4DST PET ( $8.00 \pm 5.03$ ) and FLT PET ( $10.63 \pm 10.29$ ). A significant correlation was observed between SUV in the tumor on 4DST PET and FLT PET ( $r=0.959$ ,  $P$

#### CONCLUSION

These preliminary results indicate that 4DST PET is a potentially useful tracer for proliferation imaging in head and neck cancer.

#### CLINICAL RELEVANCE/APPLICATION

4DST PET may be a potentially useful tracer for proliferation imaging in head and neck cancer.

### **CL-NMS-TU4B • RAIU Underestimation due to off Axis Thyroid Positioning**

**Sean Reynolds** MD (Presenter) ; **James B Allison** MD ; **Marleen Moore** MS ; **Christin E Young** ; **Janusz K Kikut** MD

#### PURPOSE/AIM

The effect on radioiodine uptake (RAIU) related to displacement of the thyroid off the thyroid probe axis will be demonstrated.

#### CONTENT ORGANIZATION

Advances in ultrasound and thyroid assays led to decline in utilization of scintigraphy. RAIU is still used to calculate I131 therapeutic dose for the hyperthyroid. A thyroid probe with NaI crystal and flat field collimator is commonly used. It produces flat isoresponse lines over a narrow angle. Without imaging, gland alignment within the field may be offset by several centimeters. Resulting artificially low RAIU leads to excess I131 treatment dosage and patient absorbed dose. A Picker thyroid phantom was filled with dissolved 3.87 MBq I123.

Decrease in counts with incremental offsets of the phantom from the physical axis of the probe will be presented for 20, 27, 34, 41 cm distances from the crystal. Counts were sampled twice for 1 minute, averaged and decay corrected. For example, displacing the phantom from 1 to 4 cm offset from the physical axis resulted in count loss; 23% at 20 cm, 8% at 27 cm, 4% at 34 cm, 3% at 41 cm.

#### SUMMARY

When performing RAIU without thyroid scan inferred gland size or location, a larger distance (30-40 cm) from the crystal should be utilized to prevent underestimation of RAIU which may cause I-131 overtreatment with unnecessary absorbed dose to the patient.

### CL-NMS-TU5B • Value of 11C-choline PET/CT for Lymph-node Staging in Patients with High and Intermediate Risk Primary Prostate Cancer or Biochemical Relapse: A Retrospective Analysis with Histopathological Correlation

**Christina Pfannenber** MD ; **Michael Brosi** ; **Sergios Gatidis** MD (Presenter) ; **Cornelia Brendle** MD ; **Bernhard Klumpp** MD ; **Nina Schwenzer** MD ; **Claus D Claussen** MD ; **Daniel Zips** ; **Arndt-Christian Muller** ; **Matthias Reimold** MD

#### PURPOSE

To evaluate the accuracy of 11C-Choline PET/CT for preoperative lymph-node (LN) staging in patients (pts) with prostate cancer (PCA) or PSA relapse and to compare it with histological results after extended lymph-node dissection (eLND).

#### METHOD AND MATERIALS

Retrospective analysis of 22 pts (mean 64y, range 51-75y) with histologically proven primary PCA (n=16, 13 high risk, 2 intermediate risk, 1 low risk) and 29% risk of nodal involvement (Roach formula) or biochemical relapse (n=6). All pts underwent preoperative 11C-Choline PET/CT with a standard protocol (600 Mbq, uptake time 5 min, 3min/bed, contrast-enhanced CT) and a short term eLND or selective LND (mean interval 36d, range 7-90d). PET/CT images were analyzed blindly regarding surgical results in consensus (nuclear physician and radiologist) for localization, size and 11C-Choline uptake (visually and SUVmax) of suspected lesions. The reference standard was given by histopathology of removed LN and further follow-up.

#### RESULTS

A total of 490 LN♦s were removed and evaluated histologically, per-patient 19 (median, range 4-64). 64 LN♦s in 10 pts (5 primary PCA, 5 relapse) were histologically positive. 12 pts had no LN metastases. 11C-Choline PET/CT was true-positive in 8 pts (39 LN♦s), false-negative in 2 pts (25 LN♦s), true-negative in 9 pts and false-positive in 3 pts (7 LN♦s). For primary PCA the calculated values for sensitivity, specificity, PPV, NPV and accuracy were 60%/73%/50%/80% and 69% in the per-patient and 63%/96%/59%/98% and 94% in the per-node analysis. The respective numbers for the recurrent PCA were 100%/100%/100%/100% and 100% in the per-patient and 60%/100%/100%/27% and 65% in the per-node analysis. The mean diameter of true-positive LN♦s was 14.7 (range 5-25mm) and in the same range as false-positive LN♦s (mean 14.9, range 6-20 mm). The mean SUVmax of LN metastases was 3,4 (range 1,8-5,7).

#### CONCLUSION

11C-Choline PET/CT shows a high PPV and high specificity in LN staging of pts with biochemical relapse of PCA providing a basis for further therapy decisions. However sensitivity and NPV of the method are limited, especially in the case of small volume disease.

#### CLINICAL RELEVANCE/APPLICATION

Choline PET/CT has a higher accuracy than CT and MRI for LN staging in PCA, but the value of this method is still under debate because of divergent results and often lack of histological verification.

### Case-based Review of Nuclear Medicine: PET/CT Workshop-Lymphoma/Melanoma/Sarcoma (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, 01:30 PM - 03:00 PM • S406A

OI  NM  CT

[Back to Top](#)

**MSCC33** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

#### Director

**John A Parker**, MD, PhD  
**Heather Jacene**, MD

#### LEARNING OBJECTIVES

1) To understand the role of PET/CT in the management of patients with lymphoma, melanoma and sarcoma.

### Nuclear Medicine (GI, GU and Endocrine)

Tuesday, 03:00 PM - 04:00 PM • S505AB

NM

[Back to Top](#)

**SSJ21** • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:0.5

#### Moderator

**M. Elizabeth Oates**, MD  
**William G Spies**, MD

### SSJ21-01 • Efficacy of a One-week Stringent Low Iodine Diet for Decreasing Urinary Iodine Concentration and Enhancing I-131 Uptake in rhTSH-aided Radioiodine Ablation for Papillary Thyroid Cancer

**Kunihiro Nakada** (Presenter) ; **Mika Tamura** BS ; **Yasushi Satoh** BS ; **Ysushi Furuta** MD, PhD ; **Hiroki Sugie** MD ; **Masayuki Sakurai**

#### PURPOSE

Low iodine diet (LID) is an important preparation for radioiodine I-131 therapy for differentiated thyroid cancer. However, practice of LID for longer period is not easy for residents in iodine sufficient district. The aim of the study was to determine efficacy of a one-week LID program on total body iodine and radioiodine uptake in the remnant tissue after total thyroidectomy.

#### METHOD AND MATERIALS

#### RESULTS

#### CONCLUSION

A one-week LID successfully decreased total body iodine in patients with post surgical thyroid cancer without causing any significant side-effects. Moreover, low UIE enhanced I-131 uptake in the remnant tissue. A one-week LID may be simple and valuable in rhTSH-aided ablation for thyroid cancer.

#### CLINICAL RELEVANCE/APPLICATION

In patients undergoing rhTSH-aided ablation without stopping I-T4 replacement, low iodine diet for just 1 week may be as efficient as that for 2 to 3 weeks in enhancing I-131 uptake.

## **SSJ21-02 • Does the Finding of Two Foci of Tc-99m Sestamibi Retention on Parathyroid Scintigraphy Necessarily Indicate Double Parathyroid Adenoma?**

**Charles M Intenzo MD (Presenter) ; John Kairys MD ; Edmund Pribitkin MD ; Arnold Baskies MD ; Stacey Milan MD ; Sung M Kim MD ; David Capuzzi MD**

### **PURPOSE**

Tc-99m sestamibi (MIBI) scintigraphy is commonly utilized for the preoperative location of parathyroid adenomas. A focal area of tracer retention that persists on delayed images is fairly specific for a parathyroid adenoma. Occasionally, there are 2 foci of MIBI retention on delayed imaging, which theoretically suggests a double parathyroid adenoma. Our aim was to determine just how often this finding was shown to represent a double adenoma.

### **METHOD AND MATERIALS**

Over a 4-year interval, all parathyroid scans with the finding of 2 areas of MIBI concentration in initial images of the neck, that retained the tracer on 3-hour delayed images were collected and corresponding histopathological results were reviewed.

### **RESULTS**

A total of 16 patients demonstrated the above finding. Of these, 14 underwent neck exploration; 12 were diagnosed as having asymmetric parathyroid gland hyperplasia, while only 2 were diagnosed with double parathyroid adenoma.

### **CONCLUSION**

Of the group of 14 patients whose parathyroid scintigraphy showed 2 areas of MIBI retention on 3-hour delayed images of neck, 12 (85.7%) had asymmetric parathyroid hyperplasia, whereas only 2 patients with this finding had true double adenoma..

### **CLINICAL RELEVANCE/APPLICATION**

In parathyroid scintigraphy, 2 foci of tracer retention more than likely indicate parathyroid gland hyperplasia, as opposed to double parathyroid adenoma.

## **SSJ21-03 • Bleeding Focus on Tc 99m Red Blood Cell (RBC) Scintigraphy in Acute Lower Gastrointestinal Bleeding (LGIB): Relationship between Intensity of Bleeding Focus and Positive Rate of Subsequent Conventional Angiography**

**Timothy L Haaga MD (Presenter) ; Sun Ho Ahn MD ; Gregory J Dubel MD ; Don C Yoo MD ; Richard B Noto MD \***

### **PURPOSE**

Tc99m-labelled red blood cell (Tc99m RBC) scans detect bleeding at a rate of roughly 0.1 mL/h, approximately ten times slower than that detectable with conventional angiography. The primary purpose of this study is to evaluate how the intensity of a bleeding focus on Tc99m RBC scanning relates to the likelihood of positive findings on conventional angiography.

### **METHOD AND MATERIALS**

A retrospective review was conducted on PACS of all Tc99m RBC scans performed from 2003 through July 2011, and all visceral angiograms performed following Tc99m RBC scans during the same time period. Tc99m RBC scans initially interpreted as positive were reviewed independently by two board-certified, nuclear medicine (NM) fellowship-trained radiologists who were blinded to the initial interpretation. An RBC scan was considered 'intensely positive' by NM readers if intensity of the bleeding focus exceeded that of aortic blood pool and liver. Two board-certified, fellowship-trained interventional radiologists (IR), blinded to any interpretation of the Tc99m RBC scans, independently reviewed visceral angiograms. An angiogram was considered positive if it demonstrated extravasation or an etiology for bleeding.

### **RESULTS**

174 Tc99m RBC scans and 112 visceral angiograms were reviewed. Of the 112 patients who proceeded to angiogram following RBC scan, 60 and 47 RBC scans were read as intensely positive by NM readers A and B, respectively. 21/112 angiograms were read as positive by one or both IR readers. Of 21 patients with positive angiograms, the preceding RBC scans were read as intensely positive in 19/21 cases for reader A and 15/21 cases for reader B. Sensitivity, specificity, PPV and NPV of an intensely positive RBC scan for a positive angiogram were thus 91%,55%, 32% and 91%, respectively, for reader A and 71%, 65%, 32% and 96%, respectively, for reader B.

### **CONCLUSION**

Intensity of a bleeding focus on Tc99m RBC scan greater than that of aorta and liver has a high negative predictive value for a positive angiogram. If a bleeding focus demonstrates equal or lesser activity than that of liver or aorta on Tc99m RBC scan there is thus a high likelihood of a negative subsequent conventional angiogram.

### **CLINICAL RELEVANCE/APPLICATION**

By clarifying patients' pre-test probability of positive angiography, grading of bleeding intensity on RBC scan has the potential to lessen the number of unnecessary visceral angiograms performed.

## **SSJ21-04 • 18F-FDG PET/CT Imaging has High Sensitivity in Detecting Clinically Active IgG4-related Disease**

**Leslie K Lee MD (Presenter) ; Arezou Khosroshahi MD ; Emine Atac ; Mollie Carruthers MD ; John Stone MD, MPH ; Dushyant V Sahani MD**

### **PURPOSE**

IgG4-related disease (IgG4-RD) is an inflammatory disorder with varied manifestations that depend on the extent of organ involvement. Active disease may be clinically quiescent while rendering organ damage; serum markers can be insensitive in diagnosis and monitoring of the disease. In this retrospective series of 25 patients with biopsy-proven IgG4-RD, the sensitivity of serum IgG4 levels was compared to that of 18F-FDG PET/CT imaging.

### **METHOD AND MATERIALS**

In this IRB-approved study, patients with biopsy-proven IgG4-RD who had undergone 18F-FDG PET/CT of the chest, abdomen, and pelvis were identified. IgG4-RD history, symptoms, serum IgG4 levels, and PET/CT findings were recorded. The sensitivities of 18F-FDG PET imaging, and that of abnormal serum IgG4 levels, were compared with Fisher's exact test.

### **RESULTS**

From 2006 to 2012, a total of 25 patients with biopsy-proven IgG4-RD had undergone 18F-FDG PET/CT imaging. 18 patients were male (72%). Median age was 61 years (range, 27 to 81). All patients (100%) were deemed clinically to have at least one active IgG4-RD organ. Serum IgG4 levels were not available in 2 patients; levels were abnormally elevated in 10 of 23 patients (43%). PET imaging was abnormal in 24 of 25 patients (96%); PET/CT was abnormal in 25 of 25 patients (100%). Correlation of PET findings to biopsy sites was possible in 24 patients; abnormal 18F-FDG uptake was observed in 23 patients (96%). At the organ level, abnormal 18F-FDG uptake was observed at 26 of 29 sites (90%) from which biopsy had shown features of IgG4-RD. In 8 patients (32%), PET demonstrated an uptake abnormality at a site distinct from or more extensive than that suspected by the clinical presentation. Among the 23 patients for whom serum IgG4 levels were available, PET imaging was significantly more sensitive: PET was abnormal in 22 patients (96%), while serum IgG4 was abnormally elevated in 10 patients (43%, p

### **CONCLUSION**

18F-FDG PET/CT is significantly more sensitive than serum IgG4 levels in identifying patients with active IgG4-RD, and can demonstrate additional sites of disease not obvious by clinical presentation or laboratory markers.

### **CLINICAL RELEVANCE/APPLICATION**

18F-FDG PET/CT has high sensitivity in detecting clinically active IgG4-RD, a disorder in which clinical and laboratory evaluation may

underestimate disease status.

## SSJ21-05 • Can We Ignore Spleen Lesions that Are Not Metabolically Active?

**Manish Dhyani** MBBS (Presenter) ; **Michael S Gee** MD, PhD ; **Anuradha S Shenoy-Bhangle** MD ; **Peter F Hahn** MD, PhD \*

### PURPOSE

We undertook this study to determine the negative predictive value of PET for splenic lesions.

Although PET has been used extensively for evaluation of space-occupying lesions in other organs, the current medical literature is contradictory on the current role of 18F-FDG-PET for characterization of splenic masses. Some studies have demonstrated high accuracy with good sensitivity and specificity when clinical data was used as the gold standard while others have demonstrated poor accuracy when histopathology was used as a gold standard.

### METHOD AND MATERIALS

In this IRB approved single center retrospective study we searched an institutional database and reviewed imaging of all patients with a focal splenic lesion >6mm who had undergone an FDG-PET/CT scan with or without IV contrast. Splenic lesions with at least one-year follow-up and had metabolic activity less than or similar to the remainder of the spleen were identified. Lesions that exhibited >30% increase on the follow-up study were categorized as aggressive and included in the study.

### RESULTS

Twenty-four subjects (M:F = 15:9) with a mean age of 55 years (mean = 21-80 years) with one or more PET-negative splenic lesions were identified to have aggressive splenic lesions on subsequent studies. 22 of 24 had a primary extra-splenic or systemic malignancy. The most common primary malignancy in this cohort of patients was lymphoma (n=6, 25%) followed by lung cancer (n=5, 21%) and melanoma (n=3, 12.5%). Two of the lesions were primary splenic tumors (follicular dendritic cell tumor, littoral cell angioma); the other 8 arose in patients with extra-splenic malignancy and were clinically considered metastases.

### CONCLUSION

Aggressive PET-negative lesions can arise in the spleen.

### CLINICAL RELEVANCE/APPLICATION

Low metabolic activity as determined by FDG-PET cannot be used alone to exclude aggressive behavior of a splenic lesion.

## SSJ21-06 • Imaging Cold Activated Brown Adipose Tissue Using Functional MRI and 18F-FDG PET CT

**Bart Van Rooijen** (Presenter) ; **Anouk A Van Der Lans** ; **Boudewijn Brans** ; **Joachim E Wildberger** MD, PhD ; **Patrick Schrauwen** ; **Wouter Van Marken Lichtenbelt** ; **Walter H Backes** PhD

### PURPOSE

Brown adipose tissue (BAT) is involved in non-shivering thermogenesis (NST). Novel non-invasive imaging methods are required to monitor the pharmaceutical targeting of BAT as a potential treatment of obesity. FDG-PET combined with CT is so far the only non-invasive method to detect active BAT. The aim of this work was to investigate the use of MRI to determine the presence of active BAT.

### METHOD AND MATERIALS

Eleven healthy young adults were included. The subjects underwent MRI and FDG-PET/CT imaging of the supra-clavicular/cervical fat depots containing BAT. Cooling was performed by wrapping the subjects in a water-perfused suit connected to temperature controlled water baths. Prior to the PET/CT, subjects were exposed to mild cold conditions during which maximum NST occurs. Subjects were injected with 74 MBq FDG as a tracer of metabolic activity. BAT activity was quantified by auto-contouring BAT with a set threshold. In the MRI water-fat (Dixon) imaging was performed under normal ambient conditions followed by dynamic T2\* weighted imaging during which subjects were exposed to a repeated boxcar cooling paradigm to activate the BAT.

### RESULTS

Water-fat MRI showed that supra-clavicular/cervical fat depots had an average fat content of  $65.2 \pm 7.0$  %. For the regions identified as active BAT on PET/CT, the fat content was  $66.0 \pm 9.3$  %. The volume fraction of activated voxels in the depots as measured by fMRI correlated with the activity concentration of FDG uptake on the PET/CT ( $R=0.63$ ,  $P$

### CONCLUSION

Our results suggest (active) BAT cannot be identified based on the fat fraction of the supra-clavicular/cervical depots. The use of fMRI to measure the presence of active BAT is promising as the fraction of activating voxels correlated with FDG uptake on PET/CT.

### CLINICAL RELEVANCE/APPLICATION

Pharmaceutical targeting of BAT may be a potential strategy in the treatment of obesity and imaging methods are needed to monitor its response.

## Case-based Review of Nuclear Medicine: PET/CT Workshop-Cancers of the Thorax (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, 03:30 PM - 05:00 PM • S406A

[OI](#) [NM](#) [CT](#) [CH](#)

[Back to Top](#)

**MSCC34** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### Director

**John A Parker**, MD, PhD

**Terence Z Wong**, MD, PhD \*

### LEARNING OBJECTIVES

1) Understand the role that PET/CT can play in managing thoracic malignancies. 2) Describe the major pitfalls in interpreting thoracic PET/CT. 3) Discuss strategies for maximizing diagnostic accuracy in evaluating thoracic malignancy.

### ABSTRACT

FDG-PET/CT has proven diagnostic value for evaluating primary malignancy and metastatic disease within the thorax, and can have a significant impact on patient management. Malignancies that are frequently evaluated in the thorax include primary lung cancer, esophageal cancer, lymphoma, and pleural disease. Interpretation of thoracic FDG-PET/CT scans may be complicated by the presence of benign conditions that can have high metabolic activity simulating malignancy; examples include "brown fat", sarcoidosis, granulomatous disease, post-therapeutic changes, infection, and reactive inflammation. On the other hand, some malignant disease may exhibit only modest FDG accumulation; factors include tumor histology, partial volume averaging effects, and respiratory motion. Hence, factors other than intensity of FDG uptake are often essential to distinguish benign from malignant disease. Patient history and details of prior therapy are important. Additional helpful information includes patient history, lesion distribution and symmetry, and CT imaging characteristics of the lesions. Using a case-based approach, examples of FDG-PET/CT imaging will be presented for evaluating a variety of thoracic malignancies. The approach to interpretation and strategies for distinguishing malignant from benign processes will be highlighted.

## Cardiac PET/CT and PET/MR

Tuesday, 04:30 PM - 06:00 PM • N228

[Back to Top](#)





**RC403** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### **RC403A • Clinical Indications, Methods and Interpretation of Cardiac Magnetic Resonance Imaging**

**Gilbert Raff MD** (Presenter) \*

#### LEARNING OBJECTIVES

1) To learn appropriate indications for the use of cardiac magnetic resonance imaging. 2) To appreciate the strengths and weaknesses of cardiac MRI in relation to other cardiovascular imaging modalities. 3) To define the relative and absolute contraindications in selecting patients for cardiac MRI. 4) To know the spectrum of clinical information available from cardiac MRI. 5) To learn the basic pulse sequences and MRI protocols most commonly used in cardiac MRI.

#### ABSTRACT

Cardiac magnetic resonance imaging (CMR) is a noninvasive imaging modality most commonly available in tertiary referral centers. In general, it is a secondary, rather than primary test. However, in many appropriately referred patients, echocardiography, computed tomography, nuclear scintigraphy and/or invasive angiography are insufficient for definitive diagnosis. Additionally, in certain clinical situations primary referral for CMR is preferable due to unique capabilities or institutional preferences and/or expertise. The evaluation of cardiomyopathies is a frequent use of CMR; in particular to differentiate ischemic, infiltrative, restrictive, inflammatory, hypertrophic and idiopathic myopathies. This is due to its unique capacity for tissue characterization using first pass and delayed contrast enhancement and T1 and T2 sensitive pulse sequences. Another use is in pre- and post-operative evaluation of congenital heart disease, in which the ability to provide anatomic, functional and vascular information from the entire thorax is unique, and particularly advantageous in young, radiation sensitive patients. Another frequent indication is analysis of suspected intracardiac or pericardial masses, which also benefits from the anatomic flexibility and tissue characterization capabilities of this modality.

### **RC403B • Cardiac PET/MRI: Clinical Applications**

**Pamela K Woodard MD** (Presenter) \*

#### LEARNING OBJECTIVES

1) Participants in this course will learn clinical applications of cardiac PET/MRI. 2) Participants in this course will learn potential workflows for the performance of a cardiac PET/MRI myocardial perfusion examination.

### **RC403C • Cardiac PET Imaging: Perfusion and Viability**

**Fabio Esteves MD** (Presenter)

#### LEARNING OBJECTIVES

1) Identify the current clinical applications of cardiac PET. 2) Compare advantages and disadvantages of myocardial perfusion PET versus SPECT. 3) Recognize image artifacts associated with cardiac PET/CT. 4) Demonstrate understanding of myocardial viability interpretation and its use in clinical practice.

#### ABSTRACT

### **RC403D • The Promise of a Combined MRI/PET Scanner**

**Bruce E Hammer PhD** (Presenter)

#### LEARNING OBJECTIVES

Basic concepts behind acquiring a MRI and a PET image will be reviewed. Inherent resolution capabilities of MRI and PET imaging modalities as stand-alone scanners will be compared to that of combined MRI/PET scanners. The effect of MRI hardware on PET image quality and that of PET hardware on MRI image fidelity will also be explored.

## **Improving PET Interpretation: Present Updates in GI and GYN Cancers with Case Examples (An Interactive Session)**

**Tuesday, 04:30 PM - 06:00 PM • S505AB**



**RC411** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### **RC411A • Updates in PET Imaging of GYN Malignancies**

**Drew A Torigian MD, MA** (Presenter)

#### LEARNING OBJECTIVES

1) To learn about the diagnostic performance of PET/CT for evaluation of various gynecologic malignancies. 2) To better understand the practical utility of PET/CT for evaluation of gynecologic malignancies through case example. 3) To learn about new horizons in PET for evaluation of gynecologic malignancies.

#### ABSTRACT

### **RC411B • Updates in PET Imaging of Colorectal Malignancies**

**Harry Agress MD** (Presenter)

#### LEARNING OBJECTIVES

1) Understand the increasingly important role of PET/CT imaging in the evaluation of staging and restaging of colorectal cancer with the use of case studies and literature review. 2) Demonstrate how PET/CT helps guide surgical, endoscopic and CT-guided approaches for evaluating the presence of colonic malignancy in such cases as unexpected pre-clinical colonic lesions and metastatic disease. 3) Learn how to deal with subtle findings and understand the important correlation of the PET and CT components of the examination to optimize interpretation.

#### ABSTRACT

URL's

[www.hrgimaging.com](http://www.hrgimaging.com) Go to [For Physicians](#) ? [Download](#) ? RSNA 2010

### **RC411C • Updates in PET Imaging of Other GI Malignancies**

**Paul D Shreve MD** (Presenter)

#### LEARNING OBJECTIVES

1) List the gastrointestinal malignancies that tend not to be FDG avid. 2) Describe the role of FDG PET-CT in initial staging of pancreatic cancer. 3) Compare the GIST tumor response criteria of FDG PET vs CT. 4) Compare FDG PET-CT with MRI in evaluation of primary hepatic and biliary tract malignancies.

## Minicourse: Current Topics in Medical Physics-Nuclear Cardiac Imaging for Physicists

Tuesday, 04:30 PM - 06:00 PM • S403B

[Back to Top](#)



RC423 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**Moderator**

**G. Donald Frey**, PhD

LEARNING OBJECTIVES

1) The participant will understand the role of nuclear cardiology in the diagnosis of cardiac disease. 2) The participant will understand the role of the medical physicist in PET imaging of the heart. 3) The participant will understand the role of SPECT imaging of the heart.

### RC423A • Introduction

**G. Donald Frey** PhD (Presenter)

LEARNING OBJECTIVES

1) The participant will have an overall orientation to the role of medical physics in nuclear cardiology.

ABSTRACT

This section of the course will provide an overall introduction

### RC423B • SPECT Imaging of the Heart

**Mark T Madsen** PhD (Presenter)

LEARNING OBJECTIVES

1) Understand how cardiac SPECT studies are acquired. 2) Understand how cardiac SPECT studies are reconstructed and what corrections are required. 3) Understand how cardiac SPECT studies are analyzed. 4) Become familiar with cardiac SPECT instrumentation.

ABSTRACT

Cardiac SPECT is the most common nuclear medicine procedure and it contributes nearly 85% of the radiation dose associated with nuclear medicine imaging. In this presentation, the instrumentation and algorithms associated with cardiac SPECT will be reviewed. We begin with conventional general purpose SPECT systems that rely on parallel collimation along with the associated special purpose cardiac SPECT systems that are based on the conventional approach. Recent advances in SPECT instrumentation have made available cardiac systems that rely on novel collimation and detector systems and these will also be reviewed. SPECT reconstruction approaches will be discussed including methods for motion, scatter and attenuation correction. Commercially available resolution recovery software for improving image quality and potentially reducing patient dose will round out the presentation..

### RC423C • PET Imaging of the Heart

**Sameer Tipnis** PhD (Presenter)

LEARNING OBJECTIVES

1) To understand the basic physics of cardiac PET imaging and the differences with cardiac SPECT. 2) To learn the proper way of acquiring data, including ECG gating, choice of bins, list mode data acquisition. 3) To understand the factors that affect image quality. 4) To learn tips for acquiring good clinical images. 5) To understand the role of dynamic PET imaging for determination of coronary flow reserve (CFR).

ABSTRACT

## High-Resolution Radionuclide Breast Imaging (An Interactive Session)

Wednesday, 08:30 AM - 10:00 AM • S505AB

[Back to Top](#)



RC511 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### RC511A • Breast-specific Gamma Imaging: A Novel Approach to Breast Cancer Diagnosis

**Rachel F Brem** MD (Presenter) \*

LEARNING OBJECTIVES

1) To understand the principles of Breast Specific Gamma Imaging. 2) To understand the literature supporting the use of BSGI. 3) Understand the clinical uses of BSGI. 4) Understand how to integrate BSGI into a clinical breast imaging practice. 5) Understand how to biopsy lesions visualized with BSGI. 6) To review some of the ongoing developments in BSGI.

### RC511B • Positron Emission Mammography and Molecular Breast Imaging

**Wendie A Berg** MD, PhD (Presenter) \*

LEARNING OBJECTIVES

1) Understand currently approved uses of dedicated positron emission tomographic breast imaging ('positron emission mammography (PEM)'), including local staging, response to primary chemotherapy, and evaluation of possible recurrence. 2) Discuss areas for future research in high-resolution radionuclide breast imaging.

### RC511C • Algorithms in Breast Imaging

**Amy L Connors** MD (Presenter)

LEARNING OBJECTIVES

1) Identify strengths and weaknesses of breast MR, breast specific gamma imaging (BSGI)/molecular breast imaging (MBI) and positron emission mammography (PEM) in common diagnostic and screening settings. 2) Apply knowledge of MR and nuclear breast imaging techniques to determine appropriate use for specific indications including staging of known breast cancer, neoadjuvant chemotherapy response, evaluation of possible recurrence post-breast conservation therapy, and screening of patients at increased risk of breast cancer.

ABSTRACT

## Quantitative Imaging: Quantitative Imaging in FDG-PET

Wednesday, 08:30 AM - 10:00 AM • S102AB

[Back to Top](#)

PH NM BQ

**RC525** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**Director**

**Michael F McNitt-Gray**, PhD \*

### RC525A • Lessons Learned from Drug Development Trials Using Molecular Imaging

**Jeffrey L Evelhoch** PhD (Presenter) \*

#### LEARNING OBJECTIVES

1) Understand how pharma uses the information provided by FDG-PET. 2) Become familiar with site qualification and quality control methods used in clinical trial of an investigational therapeutic agent. 3) Understand why specific clinical trial imaging protocols may differ from clinical practice and importance of adhering to the clinical trial imaging protocol. 4) Realize which issues confound attempts to achieve more quantitative FDG-PET in the context of a clinical trial of an investigational therapeutic agent.

### RC525B • Examples of Multi-Center Molecular Imaging Trials: Trial Design and Quantitative Approaches

**David A Mankoff** MD, PhD (Presenter)

#### LEARNING OBJECTIVES

1) Describe applications of molecular imaging as a biomarker for cancer drug therapy. 2) Discuss elements of clinical study design for molecular imaging. 3) Contrast molecular imaging versus conventional imaging and therapy trials.

### RC525C • Understanding and Controlling Sources of Variability in Multi-Center PET Imaging

**Paul E Kinahan** PhD (Presenter) \*

#### LEARNING OBJECTIVES

1) Identify the importance of quantitative imaging principles in the setting of clinical trials. 2) Identify the role of standards, including DICOM and others, in the successful application of quantitative imaging principles. 3) Analyze quantitative imaging techniques and apply this knowledge to protocol development in the setting of clinical trials.

## Genitourinary (Functional and Anatomic Imaging in Staging and Follow-up of Gynecologic Cancers)

Wednesday, 10:30 AM - 12:00 PM • N228

[Back to Top](#)

OI NM MR GU

**SSK09** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**Moderator**

**Andrea G Rockall**, MRCP, FRCR \*

**Moderator**

**Elizabeth A Sadowski**, MD

### SSK09-01 • Anatomical and Functional Volume Concordance between FDG-PET, T2 and Diffusion Weighted MRI for Cervical Cancer: A Hybrid PET/MRI Study

**Hongzan Sun** (Presenter) ; **Jun Xin** MD ; **Shaomin Zhang** ; **Qiyong Guo** MD

#### PURPOSE

To evaluate the concordance of imaging by [18F] fluorodeoxyglucose (FDG) - positron emission tomography (PET), T2 weighted imaging (T2WI) and apparent diffusion coefficient (ADC) maps with diffusion-weighted imaging (DWI) in cervical cancer using hybrid whole-body PET/MRI.

#### METHOD AND MATERIALS

Cervical cancer patients (N=35) were prospectively recruited to undergo pretreatment 18FDG-PET/MRI. 18FDG-PET and MRI images were fused using standard software. The percent of the maximum standardized uptake value (SUVmax) was used to contour tumors on PET images and volumes were auto calculated. Tumor volumes measured by T2WI and DWI were calculated with standard techniques of tumor area multiplying slice profile. Data analysis used parametric statistics.

#### RESULTS

#### CONCLUSION

Hybrid PET/MRI showed strong concordance between FDG-PET, T2WI and DWI in cervical cancer. Cutoff at 35% or 40% of SUVmax is recommended during 18FDG PET-MRI SUV-based tumor volume estimation. Tumor subvolumes with increased metabolic activity on FDG-PET also have greater cell density by DWI.

#### CLINICAL RELEVANCE/APPLICATION

Hybrid PET/MRI was demonstrated a reliable method in cervical cancer imaging, and will benefit its clinical decision making by combining accordant anatomical and functional information together.

### SSK09-02 • Radiologists' Adherence to the 2010 Society of Radiologists in Ultrasound Guidelines for the Management of Incidental Adnexal Cysts Imaged at Ultrasound: Frequency and Associated Factors

**Andrea S Kierans** MD (Presenter) ; **Andrew B Rosenkrantz** MD

#### PURPOSE

To evaluate adherence to the 2010 Society of Radiologists in Ultrasound (SRU) guidelines for management of incidental adnexal cysts imaged at ultrasound.

#### METHOD AND MATERIALS

398 adnexal cysts initially detected at ultrasound were included; all studies had been performed after publication of the SRU guidelines and guideline review at departmental conferences. The ultrasound reports were retrospectively reviewed to determine whether the management recommendations were adherent to the guidelines. Non-adherent cases were categorized as over-management, under-management, or as incomplete in their recommendation. Impact of categories determining appropriate recommendation (menopausal status, cyst size, and other cyst imaging features) was assessed via the chi-square test, and the primary cause for non-adherence (over- vs. under-management) in each sub-category was identified.

## RESULTS

Among all 398 adnexal cysts, the frequency of adherence was 55%, over-management was 27%, under-management was 12%, and incomplete recommendation was 6%. Menopausal status, cyst size, and other cyst imaging features all significantly impacted adherence rate (all  $p < 0.05$ , adherence was 24% (under-management in 42%). Lesions adherent in most instances were simple cysts (55%), para-ovarian cysts (71%), corpus luteums (88%), and cysts suggestive of, but not classic for, a hemorrhagic cyst, endometrioma, or dermoid (57%). Lesions with under-management in most instances were cysts with multiple thin septations (83%), thick irregular septations (33%), or an avascular nodule (67%), and dermoids (78%). Lesion with over-management in most instances was cyst with one thin septation (64%).

## CONCLUSION

Radiologists at our institution adhered to the SRU guidelines for incidental adnexal cysts at ultrasound in 55% of cases. Non-adherence was greater in post-menopausal patients, larger cysts, and cysts with greater complexity.

## CLINICAL RELEVANCE/APPLICATION

Our findings will be used to direct future efforts to improve adherence to the SRU guidelines, which in turn will improve patient care. Causes of both under- and over-management will be addressed.

## SSK09-03 • Early Response Assessment to Concurrent Chemoradiotherapy in Cervical Cancer: Value of Diffusion-weighted and Dynamic Contrast-enhanced MR Imaging

**Sohee Song** (Presenter) ; **Chan Kyo Kim** MD, PhD ; **Jung Jae Park** MD ; **Sung Yoon Park** ; **Byung Kwan Park** MD ; **Seung Jae Huh** PhD

## PURPOSE

To prospectively investigate the value of diffusion-weighted (DWI) and dynamic contrast-enhanced MR imaging (DCEI) as early and reproducible response predictors in cervical cancer patients who received concurrent chemoradiotherapy (CCRT).

## METHOD AND MATERIALS

Sixteen consecutive patients with biopsy-proven cervical cancer who treated with CCRT were evaluated with MR imaging at 3T, including DWI and DCEI. Four serial MR examinations were performed before CCRT (preTx), after 1 week of therapy (postTx1), after 4 weeks after therapy (postTx2), and after 1 month after the end of therapy (postTx3). At each time point, apparent diffusion coefficient (ADC) and DCEI parameters were calculated in the tumor, gluteus muscle and normal uterus and the results were compared. Tumor response at postTx2 or postTx3, as determined by changes in tumor size or volume using MRI was correlated with tumor ADC or DCEI parameters at preTx and postTx1, or correlated with changes in tumor ADC and DCEI parameters between preTx and postTx1. For reproducibility of ADC and DCEI parameters measurement, 10 patients had two separate pretreatment DWI and DCEI at an interval of  $< 2$  weeks.

## RESULTS

At each time point, ADC and DCEI parameters (i.e.,  $k^{trans}$  and  $V_e$ ) in the tumors showed consecutive increase (all  $P < 0.05$ ), while those of gluteus muscle and normal uterus did not reveal a significant difference (all  $P > 0.05$ ). At postTx1 tumor ADCs showed a significant correlation with tumor size response at postTx2 ( $P = 0.003$ ). Changes in tumor ADCs between preTx and postTx1 had a significant correlation with tumor size ( $P = 0.001$ ) and volume response ( $P = 0.021$ ) at postTx2. At preTx, tumor  $k^{trans}$  showed a significant correlation with tumor volume response at postTx3 ( $P = 0.033$ ); tumor  $K_{ep}$  and  $V_e$  had a significant correlation with tumor size response at postTx2 ( $P = 0.043$  and  $P = 0.019$ , respectively). Reproducibility of ADC versus DCEI parameters measurements in the tumor, gluteus muscle and normal uterus was confirmed with a mean difference of 0.3% versus 0.6%  $\diamond$  16.6%, 1.7% versus 0.5%  $\diamond$  12.3%, and 2.2% versus 0.9%  $\diamond$  17.8% in sequence, respectively.

## CONCLUSION

DWI and DCEI, as early and reproducible biomarkers, have the potential to evaluate therapeutic response to CCRT in patients with cervical cancer.

## CLINICAL RELEVANCE/APPLICATION

As imaging biomarkers, ADC and DCEI parameters may aid in the development of more individualized, effective therapy regimens for the patient group.

## SSK09-04 • Clinical Application of Diffusion-weighted MR Imaging in Uterine Cervical Cancer

**Ying Liu** (Presenter) ; **Zhao Xiang Ye**

## PURPOSE

To investigate the application value of apparent diffusion coefficient (ADC) values in evaluating the histological type as well as pathologic grade of uterine cervical cancer; and to investigate whether ADC values could reflect tumor cellularity density.

## METHOD AND MATERIALS

Ninety-eight patients with histopathologically proven uterine cervical cancer were included in this prospective study. All of them received conventional MRI and DWI examinations before surgery or concurrent chemoradiation. Mean ADC value and minimum ADC value of the tumor were measured. Tumor cellularity density was counted using CMIAS (colored multifunction imaging analyzing system).

## RESULTS

Both mean ADC value and minimum ADC value of squamous cell carcinoma were significantly lower than that of adenocarcinoma ( $P = 0.001$ ;  $P = 0.000$ ). Using mean ADC criteria ( $= 0.965 \times 10^{-3} \text{mm}^2/\text{s}$ ) and minimum ADC criteria ( $= 0.844 \times 10^{-3} \text{mm}^2/\text{s}$ ), the sensitivity and specificity for differentiating squamous cell carcinoma from adenocarcinoma were 83.5% and 76.9%, 77.6% and 92.3%, respectively. The Az of mean ADC was not statistically greater than minimum ADC ( $P = 0.990$ ). Tumor cellularity density, mean ADC value and minimum ADC value of different pathological grade varied significantly ( $P = 0.000$ ,  $P = 0.000$ ,  $P = 0.000$ ). There was a significant positive linear correlation between tumor cellularity density and the pathological grade of tumor ( $P = 0.000$ ). Both mean ADC value and minimum ADC value correlated negatively with cellularity density ( $P = 0.000$ ,  $P = 0.000$ ) and the pathological grade of tumor ( $P = 0.000$ ,  $P = 0.000$ ). Comparisons of correlation coefficients showed no significant differences ( $P = 0.656$ ,  $P = 0.631$ ).

## CONCLUSION

DWI has a potential ability to indicate the histologic type of uterine cervical cancer. ADC measurements of uterine cervical cancer can represent tumor cellularity density, thus providing a new method for evaluating the pathological grade of tumor. Mean ADC value instead of minimum ADC value was recommended to fully reflect the whole tumor.

## CLINICAL RELEVANCE/APPLICATION

DWI with ADC measurement may be helpful for the noninvasive and preoperative prediction of the histologic type and degree of differentiation of uterine cervical cancer.

## SSK09-05 • Tumor ADC Value Is Associated with Depth of Myometrial Invasion and Is Negatively Correlated to Tumor Volume in Endometrial Carcinomas

**Jenny A Husby** MD (Presenter) ; **Inger J Magnussen** ; **Jone Trovik** MD ; **Oyvind Salvesen** ; **Line Bjorge** ; **Helga Salvesen** MD, PhD ; **Ingrid S Haldorsen** MD

## PURPOSE

Explore possible correlations between tumor apparent diffusion coefficient (ADC) values, morphological imaging findings and clinical and histological patient and tumor characteristics in endometrial carcinomas. To investigate interobserver agreement between readers on preoperative staging by MRI, including diffusion weighted imaging (DWI).

## METHOD AND MATERIALS

## RESULTS

## CONCLUSION

Low tumor ADC value is associated with presence of deep myometrial invasion and the ADC value is negatively correlated to tumor volume in endometrial carcinomas. Preoperative staging by MRI with DWI is prone to considerable interobserver variability. Calculation of tumor ADC values may aid in the prediction of deep myometrial invasion in endometrial carcinomas.

## CLINICAL RELEVANCE/APPLICATION

Low tumor ADC value is associated with presence of deep myometrial invasion, and DWI may aid in the prediction of deep myometrial invasion in endometrial carcinomas.

### SSK09-06 • Temporal Changes of Imaging Parameters of MRI and FDG-PET/CT during Treatment in Cervix Cancer

**Saba N Elias** MSc (Presenter) ; **Guang Jia** PhD ; **Nina A Mayr** MD ; **William T Yuh** MD ; **Jun Zhang** PhD ; **Michael V Knopp** MD, PhD ; **Nathan C Hall** MD, PhD \*

## PURPOSE

To prospectively assess the temporal changes of multi-imaging parameters from MRI and PET/CT, including ADC, tumor size, and standardized uptake value (SUV) for early therapy monitoring in cervix cancer patients.

## METHOD AND MATERIALS

Ten cervical cancer patients with stage IB2-IVA underwent: 4 multi-parametric 1.5 T MRI (pre-, early-, mid-and post-therapy) and 3 PET/CT using 18F-fluorodeoxyglucose (FDG), (pre-, early-, and mid-therapy). A total dose of 4500 cGy was given with external beam radiation therapy, as well as concurrent weekly chemotherapy with Cisplatin (25-40 mg/m<sup>2</sup>). 3-dimensional tumor region of interest were identified using MIM software. ADC map values and T2W based tumor size were calculated using MIPAV software for the four sequential MRIs. Max SUV body weight (bw) was calculated using MIM software for the 3 sequential PET/CT scans.

## RESULTS

Multi-parametric MRI showed gradual reduction in tumor size and an increase in the ADC values while PET/CT SUV decreased from pre-therapy to mid-therapy; the mean values of these parameters are : pre-therapy ADC 0.0010 ± 0.0002 mm<sup>2</sup>/s, tumor size 47.8±34.6 cm<sup>3</sup> and max SUVbw 15.8±5.4, early-therapy ADC 0.0011±0.0002 mm<sup>2</sup>/s, tumor size 34.4±24.3 cm<sup>3</sup> and max SUVbw 11±5.1, mid-therapy ADC 0.0012 ±0.0002 mm<sup>2</sup>/s, tumor size 15.4± 15.5 cm<sup>3</sup> and max SUVbw 7±2.3, and post-therapy ADC 0.0012±0.0002 mm<sup>2</sup>/s and tumor size 6.9±3.8 cm<sup>3</sup>. A negative correlation between pre-therapy ADC and max SUV was found (r =-0.56). A tumor size reduction rate from pre-therapy to post-therapy is negatively correlated to ADC increase rate (r =-0.73).

## CONCLUSION

Imaging parameters from the MR and PET/CT, standard modality for the assessment of treatment response in cervical cancer, correlate significantly and our limited data suggest both modalities are efficacious during early treatment. Our research establishes an opportunity to further investigate the comparative effectiveness of each parameter at different treatment time points and further augment the potentials of these parameters for the early responsiveness assessment and long-term outcome prediction.

## CLINICAL RELEVANCE/APPLICATION

Current research paves the foundation for cost-effective analysis of the presumed expensive MR and PET/CT and potential augmentation efficacy from the combined-modality approach.

### SSK09-07 • Blood Oxygenation Level-Dependent MR Imaging: Early Changes to Concurrent Chemoradiotherapy in Cervical Cancer

**Jungmin Bae** (Presenter) ; **Chan Kyo Kim** MD, PhD ; **Seung Hee Choi** ; **Sung Yoon Park** ; **Byung Kwan Park** MD

## PURPOSE

To investigate the feasibility of blood oxygenation level-dependent (BOLD) MR imaging (MRI) in assessing early changes to concurrent chemoradiotherapy (CCRT) in patients with cervical cancer.

## METHOD AND MATERIALS

This prospective study was approved by our institutional review board. 15 consecutive patients with biopsy-proven cervical cancer who treated with CCRT were evaluated with MRI at 3T, including BOLD MRI. Three serial MR examinations were performed before CCRT (preTx); after 1 week of therapy (postT1); and after 4 weeks after therapy (postT2). BOLD MRI was performed using a multiple fast field echo (mFFE) sequence with 8, 12, 16 and 20 gradient echoes. At each time, the rate of spin dephasing (R2\*) values at 4 different gradient echoes were measured in the tumor and normal uterus using manufacturer-supplied software (PRIDE Relaxation Maps Tool, version 2.1.1, Philips Healthcare), and the results were compared. For reproducibility of R2\* measurements, 8 patients had two separate pretreatment MRI at an interval of < 1 week. Repeated measures analysis of variance with a Bonferroni correction and Altman-Bland test were used for statistical analyses.

## RESULTS

The mean R2\* values of the tumors from preTx to postT2 tended to have consecutive increase at 8 echoes (20.7, 22.4 and 34.1), 12 echoes (20.9, 22.7 and 32.1), 16 echoes (21.3, 22.5 and 34.1) and 20 echoes (20.9, 22.8 and 33.3); however, compared with preTx, postT2 showed a significant increase in R2\* values (P < 0.001), while postT1 had no significant difference (P > 0.05). At each time, the mean R2\* values of the normal uterus were not significantly different at 4 different gradient echoes (P > 0.05). At 4 different gradient echoes, the reproducibility of R2\* measurements in the tumor and normal uterus was confirmed with a mean difference of 0.1%±2.8% and 0.2%±7.6%, respectively.

## CONCLUSION

BOLD MRI is a feasible, reproducible technique and may demonstrate early physiologic changes to CCRT in patients with cervical cancer.

## CLINICAL RELEVANCE/APPLICATION

As a noninvasive, reproducible biomarker, BOLD MRI can be used to evaluate early therapeutic response to CCRT in patients with cervical cancer.

### SSK09-08 • Diagnostic Accuracy of PET/MRI in Gynaecological Malignancies: Initial Results

**Patrick Veit-Haibach** MD (Presenter) \* ; **Nik Hauser** MD ; **Bianca Chilla** MD ; **Gustav K Von Schulthess** MD, PhD \* ; **Rahel A Kubik-Huch** MD

## PURPOSE

To assess and to compare the diagnostic accuracy of PET/CT and PET/MRI in primary and metastatic gynaecological malignancies.

## METHOD AND MATERIALS

13 patients (13 female, mean age: 64, range 55-76years) with different primary and recurrent gynaecological diseases underwent a contrast-enhanced tri-modality PET/CT-MRI examination (PET/CT D 690 and 3T MRI 750W, GE Healthcare). Patients were first injected with an average of 320 MBq F18-FDG and then rested for 30 minutes. Then, a full diagnostic, contrast-enhanced MRI of the abdomen and pelvis, based on the current guidelines, was acquired with the following sequences: coronal T2 SSFSE pelvis, axial T2 SSFSE liver, axial T1 LaveFlex whole abdomen, axial diffusion pelvis, sagittal/axial T2 propeller pelvis, sag/axial T1 LavaFlex post contrast whole abdomen. After the MRI, patients were transferred on a dedicated shuttle to the PET/CT. Here, a standard PET/CT with /without intravenous contrast media was acquired (FOV mid-thigh to the vertex of the skull. CT: 50-79 mAs/slice, automated dose modulation 120 kVp, 3.75

mm slice thickness. PET: 3D mode, 2 minutes/bed, iterative reconstruction with 3 iterations, 18 subsets). All data were evaluated on a commercially available workstation and can be displayed as PET, CT, PET/CT and PET/MRI. PET/MRI and PET/CT were evaluated concerning detection and conspicuity of the primary tumor, lymph node metastases and distant metastases. Readers also evaluated if the PET/MRI revealed relevant additional information compared to PET/CT.

#### RESULTS

Acquisition of PET/CT-MRI and PET/CT vs. PET/MRI evaluation was feasible in all patients. Concerning the primary tumour, the PET/CT was superior in 2 cases, PET/MRI in 5 cases, concerning lymph nodes PET/CT was superior in 2 cases, PET/MRI in 2 cases, in abdominal metastases PET/CT was superior in 2 cases, PET/MRI in none. PET/CT overall showed additional relevant additional information in 9 cases mainly concerning distant metastases, while PET/MRI showed relevant additional information in 3 cases concerning the primary tumour.

#### CONCLUSION

PET/MRI is well feasible within a tri-modality PET/CT-MRI system. The PET/MRI shows mainly advantages concerning the evaluation of the primary tumor/local pelvic situation while the PET/CT has advantages concerning distant metastases.

#### CLINICAL RELEVANCE/APPLICATION

PET/MRI might be eligible to replace PET/CT in the work-up of OB-Gyn cancers.

### SSK09-09 • 18F-FDG PET/MRI versus MRI Alone for Whole Body Staging of Patients with Recurrent Malignancies of the Female Pelvis

**Karsten J Beiderwellen MD (Presenter) ; Johannes Grueneisen ; Verena Hartung ; Philipp Heusch MD ; Rainer Kimmig ; Thomas C Lauenstein MD ; Lale Umutlu MD \***

#### PURPOSE

To evaluate the diagnostic benefit of integrated 18F-FDG PET/MRI for whole-body staging of female patients with recurrent pelvic malignancies compared to MRI alone.

#### METHOD AND MATERIALS

#### RESULTS

In 10 of 13 patients malignant lesions were present. A total of 41 lesions, comprising 29 malignant and 12 benign lesions were detected. PET/MRI offered correct and respectively superior identification of all 10 patients with cancer lesions, compared to MRI (without DWI, 6/10; including DWI 8/10). Additionally, 18F-FDG PET/MRI exhibited higher conspicuity (PET/MRI: median: 4, range: 3-4; MRI: median: 4, range 1-4; MRI + DWI: median: 4, range 2-4) and diagnostic confidence (PET/MRI: median: 3, range 2-3; MRI: median: 2, range 1-3, MRI +DWI: median: 3, range 1-3) in the detection of malignant lesions (p

#### CONCLUSION

Our results demonstrate the superiority of 18F-FDG PET/MRI in detecting malignant lesions compared to MRI alone. Thus, whole body PET/MRI may be utilized as a stand-alone imaging technique for staging of patients with suspected pelvic malignancies, allowing for significant time reduction due to omission of T2w and DWI MRI.

#### CLINICAL RELEVANCE/APPLICATION

Whole-body 18F-FDG PET/MRI may be applied as a stand-alone staging technique for patients with suspected pelvic malignancies.

### Nuclear Medicine (PET/MRI for Oncology)

Wednesday, 10:30 AM - 12:00 PM • S505AB

[RO](#) [OI](#) [NM](#) [MR](#)

[Back to Top](#)

SSK17 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

#### Moderator

**Terence Z Wong**, MD, PhD \*

#### Moderator

**Farrokh Dehdashti**, MD \*

### SSK17-01 • Effects of Ferumoxytol on Quantitative Accuracy of PET in Simultaneous PET/MR Imaging - A Validation Study

**Ronald J Borra MD, PhD (Presenter) ; Ulrike I Attenberger MD \* ; Spencer L Bowen PhD ; Ciprian Catana MD, PhD ; Grae E Arabasz ARRT ; Bruce R Rosen MD, PhD \* ; Jacob M Hooker PhD ; Alexander R Guimaraes MD, PhD \***

#### PURPOSE

Simultaneous PET/MR imaging depends on MR-derived attenuation maps (mu-maps) for accurate attenuation correction (AC) of the PET data. MRI Contrast agents (MRCA) have the potential to affect obtained mu-maps and in turn reduce the quantitative accuracy of the PET measurements. Currently, the effects of i.v. administered ferumoxytol, which is FDA approved for iron replacement and is a MRCA belonging to the class of ultrasmall superparamagnetic iron oxides (USPIO), are unknown. The purpose of this study is to study the possible effects of ferumoxytol on simultaneously obtained PET/MR data.

#### METHOD AND MATERIALS

An agarose phantom was constructed with homogeneous concentrations of ferumoxytol (Feraheme, AMAG Pharmaceuticals, Inc.) ranging from 0-20 mg/kg. The phantom was scanned on a Siemens Biograph mMR PET/MR scanner, using a 2-point DIXON 3-D (VIBE) sequence. The default algorithm for reconstruction of the mu-map was used, including selection of the lung compartment option. In addition, repeated in-vivo PET/MR 18F-FDG studies were performed in a 13.2 kg male baboon, in an animal committee approved protocol, at four different time points: baseline (before and after injection of 10mg/kg ferumoxytol i.v.), 1, 3 and 5 weeks after the baseline scan. All studies were performed using a body Matrix coil and the built-in spine coil as the receiving coil elements.

#### RESULTS

*Phantom experiment:* Misclassification was observed in the mu-maps of the phantom regions with ferumoxytol concentrations of 10 mg/kg and higher. *Baboon imaging:* In data obtained later than 5 minutes after the i.v. ferumoxytol injection, significant signal loss was observed in the mu-maps, particularly in the liver, resulting in liver tissue being misclassified as lung. This translated in a decrease of observed standard uptake value (SUV) of liver tissue from 1.23 to 0.54 (-57%) within the first 57 minutes. This change persisted over the next 5 weeks (SUV 0.48, -61% compared to baseline).

#### CONCLUSION

Our data suggests that ferumoxytol, when used as an MRCA (at FDA approved clinical doses (e.g. 10 mg/kg Fe)) in simultaneous PET/MR imaging, has the potential to cause misclassification of tissues on AC maps resulting in >50% changes in observed SUV.

#### CLINICAL RELEVANCE/APPLICATION

Ferumoxytol has good vascular, lymph node and macrophage activity, however, our data suggests that PET/MR AC algorithms and dose response need improvement prior to its utilization for cancer staging.

### SSK17-02 • Performance of Whole-body Integrated 18F-FDG PET/MR for Evaluation of Malignant Bone Lesions in Comparison to PET/CT

**Matthias J Eiber MD (Presenter) \* ; Marius E Mayerhoefer MD, PhD ; Michael Souvatzoglou ; Markus Schwaiger MD \* ; Ernst**



#### PURPOSE

Whole-body PET/MR offers potential advantages compared to PET/CT for evaluation of bone lesions due to a higher soft tissue contrast. Opposed to PET/CT, in PET/MR the contribution of cortical bone in the attenuation map is ignored. The aims of this study were to evaluate the diagnostic performance of <sup>18</sup>F-FDG PET/MR for bone lesions and to analyze differences in SUV-quantification compared to PET/CT.

#### METHOD AND MATERIALS

119 patients with FDG-avid malignancies underwent a single-injection/dual-imaging protocol on a PET/CT-scanner and a subsequent PET/MR-scan (Biograph mMR) with a T1w VIBE Dixon for attenuation correction (AC) and coronal T1w TSE sequence. Three sets of images (CT with PET [from PET/CT; set A], T1w VIBE Dixon with PET [set B] and T1w TSE with PET [both from PET/MR; set C]) were analyzed. Every lesion was rated using a 4-point-scale for conspicuity of PET, a 4-point-scale for anatomical allocation of PET positive lesions and a 5-point-scale for the nature dignity. For all lesions and regions of normal bone SUV-analysis was performed in PET/MR and PET/CT.

#### RESULTS

98 bone lesions were identified in 33 pts. 630 regions of normal bone were analyzed. Visual lesion conspicuity in PET was comparable (PET/CT: mean rating  $2.82 \pm 0.45$ ; PET/MR:  $2.75 \pm 0.51$ ;  $p=0.3095$ ). Anatomical delineation and allocation of suspicious lesions was significantly superior in T1w TSE (mean rating  $2.84 \pm 0.42$ ) compared to CT ( $2.57 \pm 0.54$ ,  $p=0.0001$ ) and T1w VIBE Dixon ( $2.57 \pm 0.54$ ,  $p=0.0002$ ). No significant difference could be found for correctly classifying all malignant bone lesions for set A (85/90), set B (84/90) and set C (86/90), respectively. For bone lesions and regions of normal bone a highly significant correlation could be found between the SUVs ( $R=0.950$ ,  $R=0.917$ , respectively,  $p$

#### CONCLUSION

Fully integrated whole-body <sup>18</sup>F-FDG PET/MR is technically robust for evaluation of bone lesions despite differences in AC compared to PET/CT. PET/MR including diagnostic T1w sequences was superior compared to PET/CT for anatomical delineation/allocation of bone lesions, which might be of clinical relevance in selected cases.

#### CLINICAL RELEVANCE/APPLICATION

Neglecting bone in AC for PET/MR is clinical not relevant for bone lesions. A higher rate of concordant findings between T1w and PET in PET/MR could improve diagnostic certainty.

### **SSK17-03 • FDG PET/MR for the Assessment of Lymph Node Involvement in Lymphoma: Preliminary Results and Role of Diffusion Weighted MR**

**Ivan Platzeck MD (Presenter) ; Bettina Beuthien-Baumann MD ; Jens Langner PhD ; Michael Laniado MD ; Jorg Van Den Hoff PhD**

#### PURPOSE

The purpose of this study was to evaluate the sensitivity and specificity of PET/MR (positron emission tomography/magnetic resonance imaging) with FDG (<sup>18</sup>F-fluorodeoxyglucose) for nodal involvement in malignant lymphoma and to assess the additional value of DWIBS (diffusion weighted MR imaging with background suppression) as a part of the PET/MR examination.

#### METHOD AND MATERIALS

Eighteen patients with malignant lymphoma (10 m, 8 f, mean age 44 y) were included in this retrospective study (Hodgkin's disease:  $n=10$ ; non-Hodgkin lymphoma:  $n=8$ ). The patients underwent FDG PET/MR on a whole-body hybrid system after intravenous injection of FDG (176 - 357 MBq FDG, 276 MBq on average). The PET/MR examination included DWIBS images of the neck, thorax, abdomen and pelvis. Ten patients underwent FDG PET/MR for initial staging, while 8 patients had PET/MR for assessment of therapy response. Lymph node involvement was documented according to the scheme introduced by the German Hodgkin Study Group. Follow-up imaging and histology served as the standard of reference. The sensitivity and specificity of FDG PET/MR and DWIBS were calculated and compared using the McNemar test. In patients referred for initial staging, disease stage according to the Ann Arbor classification was determined with FDG PET/MR and DWIBS.

#### RESULTS

Ninety out of 468 lymph node stations were rated as having lymphoma involvement based on the standard of reference. No evidence for organ involvement was found. Eighty-four lymph node stations were rated as positive by PET/MR and 78 by DWIBS. The sensitivity and specificity of FDG PET/MR for nodal involvement was 93.3% and 99.5%, while DWIBS had a sensitivity of 89.6 % and a specificity of 97.4%. Both the sensitivity ( $p=0.03$ ) and specificity ( $p=0.008$ ) of FDG PET/MR were significantly better in comparison to DWIBS. In patients referred for initial staging, Ann Arbor stage determined by PET/MR and DWIBS was identical in nine cases and differed in one case ( $p=0.81$ ).

#### CONCLUSION

FDG PET/MR allows for lymphoma staging with high sensitivity and specificity for nodal involvement. The use of DWIBS is not recommended as a part of FDG PET/MR examinations in lymphoma, because it does not provide relevant additional information.

#### CLINICAL RELEVANCE/APPLICATION

FDG PET/MR is a promising method for lymphoma staging which allows for metabolism evaluation in analogy to PET/CT, while ionising radiation associated with CT is eliminated.

### **SSK17-04 • PET/MRI in the Detection and Characterization of Pulmonary Lesions: Technical and Diagnostic Evaluation in Comparison to PET/CT**

**Isabel Rauscher (Presenter) ; Matthias J Eiber MD \* ; Sibylle Ziegler \* ; Ernst J Rummeny MD ; Markus Schwaiger MD \* ; Ambros J Beer MD \***

#### PURPOSE

PET/MRI differs substantially from PET/CT concerning PET-detector technology and attenuation correction, which might be of special relevance in the lung. We thus compared PET/MRI and PET/CT for evaluation of pulmonary lesions.

#### METHOD AND MATERIALS

Forty patients (23 men, 17 women; mean age 53.2 years) underwent a single injection dual imaging protocol with [<sup>18</sup>F]FDG PET/CT (Siemens Biograph 64) and PET/MRI (Siemens Biograph mMR). Pulse sequences for the lung included T1-weighted VIBE Dixon for attenuation correction and contrast-enhanced VIBE pulse sequences. All patients had a diagnostic CT of the chest in deep inspiration. Two blinded readers assessed in consensus all images randomly concerning quality, detection, standardized uptake value (SUV) and size of pulmonary nodules. Correlations were performed using linear correlation.

#### RESULTS

All scans together revealed 47 pulmonary lesions (mean size  $10.0 \pm 11.4$  mm; range 2-60 mm) in 25/40 patients. The PET datasets of PET/MRI and PET/CT revealed both 22/47 pulmonary lesions with focal [<sup>18</sup>F]FDG uptake. SUV-values of lung lesions in PET/MRI and PET/CT correlated significantly ( $r=0.9$ ;  $p=0.0001$ ) with a tendency for higher SUVs in PET/MRI. There was a significantly lower image quality comparing Dixon and VIBE sequence with CT whereas PET from PET/CT and PET from PET/MRI showed similar results. Dixon images detected 15/47 lung lesions while VIBE images detected 32/47 lesions, respectively. The detection rates for small lung lesions < 1 cm diameter ( $n=33$ ) of CT and MR imaging was significantly lower with a detection rate of 9/33 for Dixon sequence and 15/33 for VIBE sequence. There was a high correlation of pulmonary lesion size of CT versus VIBE ( $r=0.97$ ;  $p$

#### CONCLUSION

PET image quality and detection rate of [<sup>18</sup>F]FDG positive lung lesions in PET/MRI is equivalent to PET/CT despite differences in attenuation correction techniques. Additionally, a high linear correlation coefficient in the SUV mean for the PET images from PET/CT and

PET/MR was found. The detection rate of lung lesions can be significantly improved by adding a diagnostic contrast-enhanced VIBE sequence to the PET/MRI protocol. However, the detection rate of small lung lesions is still inferior compared to PET/CT with diagnostic CT of the chest.

#### CLINICAL RELEVANCE/APPLICATION

Also for lung evaluation the PET part of PET/MRI is equivalent to PET/CT.

### SSK17-05 • Whole-body PET/MRI: The Effect of Ignoring Bone during MR-based Attenuation Correction in Oncology Imaging

**Thomas Beyer** PhD (Presenter) \* ; **Rachida Sersar** ; **Julie Sabyee** ; **Johan Lofgren** ; **Claes Ladefoged** ; **Flemming L Andersen** MSc, PhD ; **Rasmus Larsen** ; **Marianne C Aznar** MS

#### PURPOSE

Standard PET attenuation correction (AC) in integrated PET/MRI is based on tissue segmentation following in-/opposed phase MR imaging (ACin\_op) and does not account for bone tissue. We evaluate PET quantification in whole-body (WB)-PET/MRI following MR-AC without and with accounting for bone tissue using separate CT.

#### METHOD AND MATERIALS

20 oncology patients referred for a PET/CT were injected with [18F]-FDG or [18F]-NaF and scanned on PET/CT (mCT, Siemens) followed by a PET/MR scan (mMR, Siemens) following clinical WB-protocols. PET(/MR) images were reconstructed using standard MR-AC and four modified attenuation maps. These were created by co-registering (b-spline) the CT images to (ACin\_op) and adding CT bone mask values representing cortical bone: 1200HU (ACcortCT), spongiosa bone: 350HU (ACspongCT), average CT value (ACmeanCT) and original CT values (ACorgCT). PET images were reconstructed after MR-AC using AW-OSEM (3iterations, 21subsets, 4mm Gaussian) on 344-matrices. Relative difference images of PET following modified MR-AC and MR-AC using ACin\_op were compared. Mean/max standardized uptake values (SUVbw) were calculated in anatomical reference regions and PET-positive lesions.

#### RESULTS

Visual assessment of the AC-PET and relative difference images indicated most prominent changes over standard MR-AC (ACin\_op) limited to the skeletal system. The average relative difference of PET following MR-ACorgCT was 14% across reference regions in healthy bone structures and slightly less (12%) in PET-positive bone lesions. Mean SUV in soft tissue lesions in the neck following MR-ACorgCT was 10% higher than MR-ACin\_op.

#### CONCLUSION

Ignoring bone tissue during MR-AC causes an average underestimation of (10-14)% in reference tissues, bone and soft tissue lesions, which is visually insignificant but considerable during follow-up.

#### CLINICAL RELEVANCE/APPLICATION

Standard MR-AC appears acceptable in clinical routine for now but mandates improvements in accuracy and reliability for quantitative follow-up examinations.

### SSK17-06 • 18-FDG PET/MRI Compared with 18-FDG PET/CT and Whole Body MRI for Lesion Detection, Confidence and Radiation Dose in the Evaluation of Metastatic Breast Cancer

**Amy N Melsaether** MD ; **Akshat C Pujara** MD (Presenter) ; **Rajan Rakheja** ; **Mohammed B Shaikh** MD ; **Eric Sigmund** PhD ; **Suncheon Kim** ; **Christian Geppert** \* ; **Linda Moy** MD

#### PURPOSE

PET/CT is often used to evaluate for systemic breast cancer (BC), but provides low contrast at a relatively high radiation dose. Whole body (WB) MRI is also being investigated in this role. Simultaneous PET/MRI scanners are recently available. We therefore evaluated PET/MRI performance for lesion detection, reader confidence and radiation dose as compared with PET/CT and contrast enhanced WB MRI.

#### METHOD AND MATERIALS

For this HIPAA compliant, IRB approved prospective study, 26 women (age 37-76 mean 56) with n=1 newly diagnosed T2 BC or n=25 history of metastatic disease underwent WB simultaneous 18-FDG PET/MRI on an integrated 3T PET/MR scanner (Siemens Biograph mMR), after PET/CT,

#### RESULTS

Compared with PET/CT, PET/MRI detected treatment changing brain and bone metastases and a primary endometrial cancer in one patient each. PET/MRI also detected breast cancers in two patients which were not seen on PET/CT. WB MRI detected the brain metastases and endometrial cancer, but did not see the treatment changing bone metastasis. In addition, PET/MRI detected liver, bone, lung, pleural and nodal metastases in 2, 7, 1, 1 and 6 patients with high confidence. PET/CT saw the same lesions with lower overall confidence. WB MRI saw bone metastases in only 6 of these patients and detected the same liver, lung, pleural, nodal and brain metastases with lower confidence. WB MRI detected additional low confidence nodal and liver lesions in 9 and 2 patients. Mean PET/MRI radiation dose was 50% less than PET/CT (10.4 mSv vs 20.7 mSv).

#### CONCLUSION

18-FDG PET/MRI may outperform PET/CT and WB MRI at half the radiation dose of PET/CT. Further investigation is warranted.

#### CLINICAL RELEVANCE/APPLICATION

18-FDG PET/MRI may provide greater lesion detection and confidence at half the radiation dose as compared with PET/CT and greater specificity and confidence as compared with WB MRI in BC patients.

### SSK17-07 • PET/MRI as an Alternative Reduced Radiation Staging Algorithm in Patients with Lymphoma

**Alexander R Guimaraes** MD, PhD (Presenter) \* ; **Onofrio A Catalano** MD ; **Wendy Atkinson** MS ; **Michael A Blake** MBBCh \* ; **Ciprian Catana** MD, PhD ; **Bruce R Rosen** MD, PhD \*

#### PURPOSE

In patients with lymphoma, FDG PET-CT is critical in the initial staging with early interim PET CT being a strong independent predictor of progression free survival. Diffusion weighted MRI is also a biomarker of malignancy with an uncertain role in lymphoma. The goal of this work was to evaluate the diagnostic performance of simultaneous PET/MR compared to PET/CT in patients with lymphoma.

#### METHOD AND MATERIALS

15 subjects with lymphoma underwent an IRB approved, single-injection/dual-imaging protocol, consisting of a PET/CT and subsequent PET/MR scan. PET-images of both modalities were reconstructed iteratively. Attenuation, decay and scatter correction and regional allocation was performed using low dose CT data for PET/CT and Dixon-MR sequences for PET/MR. Whole body DWI was performed using a respiratory gated SSEPI (TI/TE/TR 220/68/7800ms) with 3 b- values (0,50,800). ADC was calculated using a mono-exponential fit. SUVmax for FDG-avid lesions were measured and compared using ROI analysis by a single radiologist and Osirix (Osirix ♦, Lausanne, Switzerland) for each imaging modality. ROI analysis was performed as well comparing ADC fused to FDG-PET/MR SUVmax. Strength of correlation between variables was measured using the Spearman rank correlation coefficient (rs).

#### RESULTS

Of the 15 subjects, 4 had Hodgkin's and 11 had non-Hodgkin's (NHL) lymphoma. The mean age was 53 +/- 16 years. Thirty-seven FDG-avid lesions were identified. The mean difference in time between PET/CT and PET/MR acquisitions was (209.9 +/- 43.9 min). SUVmax from FDG-PET/MR (mean 8.5 +/- 4.6) versus FDG-PET/CT (mean 4.6 +/- 2.7) was on average higher and demonstrated a strongly positive correlation (rs=0.84 (0.71, 0.92); p

#### CONCLUSION

FDG-PET/MR offers an equivalent whole body staging examination as compared with PET/CT with an improved radiation safety profile (by negating the CT component) in lymphoma patients. Correlation of ADC to SUVmax was weak understating the potential importance of both biomarkers in this disease process.

#### CLINICAL RELEVANCE/APPLICATION

The equivalence of PET/MRI both qualitatively and quantitatively offer a provocative, future clinical staging and surveillance option in patients with lymphoma with dramatic savings in radiation dose.

### SSK17-08 • Utility of a Dedicated [18F]-FDG-PET/MRI Protocol for Thoracic Staging in Lung Cancer: Comparison to [18F]-FDG-PET/CT

**Philipp Heusch MD (Presenter) ; Jens Kohler ; Christian Buchbender ; Felix Nensa MD ; Verena Hartung ; Till A Heusner MD**

#### PURPOSE

Therapeutic decisions in non-small cell lung cancer (NSCLC) patients depend on the tumor stage. Positron emission tomography/computed tomography (PET/CT) with [18F]-FDG is widely accepted as the diagnostic standard of care. The feasibility of pulmonary tumor staging with simultaneous [18F]-FDG-PET/MRI has recently been proven, but no state-of-the-art lung MRI protocol was used in this early study. The purpose of this study was to compare a dedicated pulmonary [18F]-FDG-PET/MRI protocol to [18F]-FDG-PET/CT for thoracic staging in NSCLC patients.

#### METHOD AND MATERIALS

38 patients (23 male, 15 female, mean age 63.9±10.5 years) with histopathologically confirmed NSCLC underwent [18F]-FDG-PET/CT followed by a [18F]-FDG-PET/MRI (including a dedicated pulmonary MRI protocol). The TNM stage was determined in separate sessions for PET/CT and PET/MRI by two readers in consensus. The mean and maximum standardized uptake values (SUVmean; SUVmax) and the maximum diameter of the primary tumor were measured. TNM stages, SUVmean/max and tumor size obtained from PET/CT and PET/MRI were compared and Pearson correlation analysis and Bland-Altman plots were performed for quantitative parameters.

#### RESULTS

PET/MRI and PET/CT agreed on T-, N- and thoracic M-stages in 33/38 (87%), 32/38 (84%) and 35/38 (92%) of patients. Compared to PET/CT, T-stages, N-stages and thoracic M-stages were staged down by PET/MRI in 3 (8%), 3 (8%) and 3 (8%) and were staged up in 2 (5%), 3 (8%) and 0 (0%) patients, respectively. Pearson correlation coefficients for the primary tumors SUVmean, SUVmax and maximum diameter in PET/CT and PET/MRI were 0.89, 0.90 and 0.98, respectively. Using Bland-Altman analysis, the lower and upper limits of agreement between PET/CT and PET/MRI were -3.45 to 3.15 for SUVmean, -7.43 to 6.55 for SUVmax and -0.86 to 0.96 for the tumor size, respectively.

#### CONCLUSION

PET/MRI using a dedicated pulmonary MRI protocol and PET/CT generally show a good agreement on thoracic TNM- stages in NSCLC patients. Comparability of primary tumor sizes measured in PET/CT and PET/MRI is substantial and is very well for quantitative measures of [18F]-FDG uptake.

#### CLINICAL RELEVANCE/APPLICATION

In NSCLC the choice of therapeutic options is based on the individual tumor stage. Hence, comparability of thoracic TNM- stages and primary tumor sizes assessed by PET/CT and PET/MRI is essential.

### SSK17-09 • PET/MRI Attenuation Correction: Differences in Correlation Based on Bone Density

**Shaunagh McDermott FFRCSI ; Michael A Blake MBBCh \* ; Ciprian Catana MD, PhD ; Dushyant V Sahani MD ; Bruce R Rosen MD, PhD \* ; Alexander R Guimaraes MD, PhD (Presenter) \***

#### PURPOSE

PET/MRI attenuation correction (AC) is derived from tissue classifications based on DIXON in and out of phase images, which ignore bone density. The aim of this study was to evaluate whether there were regional differences in correlation between PET/CT and PET/MRI SUVmax within the same subject.

#### METHOD AND MATERIALS

#### RESULTS

#### CONCLUSION

Although there is a very high overall correlation between maximum SUVs of suspicious lesions on PET/MR and PET/CT, the location of the lesion does have an effect with combined soft tissue and bone attenuation (abdomen and pelvis) lowering the correlation as compared to air and soft tissue (chest). The low correlation in neck lesions warrants further study, but may be related to lack of coil overlap in this region with only a subset of patients having head/neck coils for the examination.

#### CLINICAL RELEVANCE/APPLICATION

PET/MRI is a unique tool for oncologic staging. The data presented here elucidates a possible limitation in the attenuation correction that might have impact on SUV and therefore patient management.

## Nuclear Medicine - Wednesday Posters and Exhibits (12:15pm - 12:45pm)

### Wednesday, 12:15 PM - 12:45 PM • S503AB

NM

[Back to Top](#)

**CL-NMS-WEA • AMA PRA Category 1 Credit™:0.5**

**Host**  
**Akash Sharma, MD**

**CL-NMS-WE1A • Fixed Volume ROI for Semiquantification of Striatal Dopamine Transporter Specific Uptake in the SPECT/CT System**

**Chia-Yang Lin MD (Presenter) ; Yu-Wen Chen MD ; Yu-Ling Hsu ; Hsiu-Lan Chu ; Kuei-Lan Chang ; Yang-Pei Chang**

#### PURPOSE

Semiquantitative analysis of striatal dopamine transporter (DAT) specific uptake is a more subjective way than visual interpretation of DAT images. Due to CT-based data can improve attenuation correction accuracy for SPECT applications as well as delineate ROI. The aim of this study was to evaluate the decreased degree of the striatum by semiquantitative method.

#### METHOD AND MATERIALS

Fifteen patients with Parkinson's disease and four healthy volunteers served as control were enrolled in this study. Parkinson's disease was diagnosed according to generally accepted criteria. All the enrolled subjects were injected with 30mCi 99mTc-TRODAT-1 and brain SPECT studies were commenced 3 hours later. With dual-head camera equipped with LEHR collimators, data were acquired. Images were reconstructed using the iterative method and CT-based attenuation correction. Fixed regions of interest were marked for the caudate nucleus and putamen of each hemisphere, on composite images of the 16 slices (40.3mm) containing the basal ganglia activity. The putamen, and caudate uptake ratios (ratioPO and ratioCO) were estimated as mean counts of the putamen, and caudate ROIs divided by

means of the occipital cortices (OC), that is, (putamen)/OC, and ratioCO: (caudate)/OC, respectively. We even half divided the caudate nucleus and putamen into two groups as the upper and lower groups. The lower putamen, caudate uptake ratios (ratioPO1, and ratioCO1) and the upper putamen, caudate uptake ratios (ratioPO2, and ratioCO2) were estimated. We define the uptake ratio in right brain (RratioPO, RratioCO, RratioPO1, RratioCO1, RratioPO2, and RratioCO2) and vice versa in left brain.

#### RESULTS

As compared to healthy subjects, the uptake ratio in the Parkinson's disease showed marked decreased radioactivity in some areas, especially in the lower putamen. With t test, we got significant p value (p0.05) in this study.

#### CONCLUSION

The study demonstrate that the lower putamen may be the early target in Parkinson's disease, whereas those to the caudate nucleus are relatively spared.

#### CLINICAL RELEVANCE/APPLICATION

Under the SPECT/CT system with the reconstructed images by CT attenuation correction, the 'fixed volume ROI' over the basal ganglion can serve as a semiquantitative method in clinical practice.

### **CL-NMS-WE2A • The Clinical Impact of DaTscan Imaging in the Management of Clinically Uncertain Parkinson's Disease in a Secondary Hospital Setting**

**Thomas J Gordon** BSc (Presenter) ; **Vineet Prakash** MBBCh ; **Renukha Govinda-Rajoo** MBBCh ; **Ranbir Sandhu** MBBS, MRCS ; **Joann Simpson** ; **Jan Coebergh** MD ; **Susanna Davidson** MBBCh, FRCR

#### PURPOSE

DaTscan imaging has an established diagnostic role in neurology for differentiating parkinsonian syndromes from other aetiologies. This imaging is now being used in secondary referral centres. DaTscans are relatively expensive. We evaluate its clinical impact in patients management for this secondary care setting.

#### METHOD AND MATERIALS

- Retrospective standards audit
- 1 year 2011-12, with 6 month clinical follow-up.
- Mean age of patients: 77 years old
- 20 patients were selected at random out of all patients who had a DAT scan over 12 months
- Overall positive imaging findings were recorded with final clinical disease diagnosis
- Image findings were correlated with any change in the management focusing on stopping or starting medication, triggering of supplementary investigations

#### RESULTS

Overall Findings:

- ◆ The DAT scan was positive for Parkinson's disease in 65%.
- ◆ When positive, the DAT scan led to a change in management in 55%

This change involved:

Starting treatment in 35%

Change in dose or medication regimen in 20% ◆ The DAT scan was negative for Parkinson's disease in 35%.

- ◆ 30% of patients were on pre-existing treatment for Parkinson's disease prior to the DAT scan.

#### CONCLUSION

For the investigation of clinically uncertain Parkinson's disease in a secondary hospital setting, preliminary results reveal DaTscans were positive in 65% of patients and in these patients led to a change of management in 55% of subjects. 30% of patients were on pre-existing treatment for Parkinson's disease prior to the DAT scan. Further data will be presented at the meeting summing this preliminary finding.

#### CLINICAL RELEVANCE/APPLICATION

DaTscan imaging is a useful investigation in the tertiary care management of a challenging neurological condition. It may also be of clinical utility in the secondary care domain.

### **CL-NMS-WE3A • Assessment of Myocardial Damage and Prediction of Future Cardiac Function in Patients with Acute Myocardial Infarction Using Sestamibi Early Washout Imaging**

**Ryo Tanaka** (Presenter) ; **Tokuo Kasai** ; **Tomoharu Nakamura** ; **Keiko Yamamoto**

#### PURPOSE

The aim of this study is to elucidate the usefulness of early phase of washout rate of MIBI in predicting future cardiac functional recovery.

#### METHOD AND MATERIALS

Forty-two AMI patients were hospitalized within 24 hours of the onset and underwent successful PCI then enrolled in this study. MIBI SPECT was obtained in sub-acute phase and repeated 6 months later. Images were acquired at five minutes (0h), one hour (1h), and six hours (6h) after MIBI injection. Washout rate was calculated as washout index (WI) between 0h and 1h, 1h and 6h, respectively. ECG gated acquisition was performed at 1h and 6 months later (6M). The relationships between washout rate of MIBI and various parameters, such as perfusion defect, peak CPK, BNP, and LVEF were investigated.

#### RESULTS

There were 18 patients whose WI showed 0 from 0h to 1h (group A) and 24 patients whose WI was accelerated (group B) (0 vs.  $13.7 \pm 3.1$ , p No differences were found in the number of perfusion defect segments (NPDS) on SPECT among 0h, 1h and 6M in group A. On the other hand, significant differences were found between 0h and 1h, 1h and 6M, in group B ( $3.8 \pm 3.0$  vs.  $5.0 \pm 3.1$ , p Group B demonstrated much higher peak CPK value than that in group A ( $4074 \pm 1627$  IU/l vs.  $1457 \pm 976$  IU/l, p LVEF improved from  $55.7 \pm 12.1\%$  to  $63.2 \pm 8.8\%$  over six months in group A. On the other hand, no improvement was found in group B (from  $46.7 \pm 11.6\%$  to  $49.5 \pm 11.6\%$ ).

#### CONCLUSION

It is suggested that in patients with AMI, early myocardial washout rate derived from MIBI SPECT associates with severity of myocardial damage and predicts poorer cardiac functional recovery.

#### CLINICAL RELEVANCE/APPLICATION

This parameter is useful in predicting future cardiac functional recovery.

### **CL-NMS-WE4A • Leveraging the Complimentary Power of Retrospectively Co-registered and Fused Multimodality PET-CT and Multiparametric MRI in Oncologic Imaging**

**Shanker Raja** MD (Presenter) ; **Bandar R Alfheed** MD ; **Abdullah Aldosary** MD ; **K. M. Das** MD ; **Mazharuddin Anasari** MD ; **Serguei Roumiantsev** MD

#### PURPOSE/AIM

Concurrent multimodality imaging such as PET-CT/PET-MR is increasingly utilized in oncologic imaging. We present a unique series that demonstrate the power of co-registration and fusion of PET and MRI. The portfolio provides the broad clinical indications wherein PET and MR have complimentary roles. The use of fusion images in accurate localization of PET lesions as well as the complimentary strengths of the 2 modalities in characterizing indeterminate lesions; improvements in specificity, accuracy and changes in patient management will be presented.

#### CONTENT ORGANIZATION

Review of PET-CT studies from Aug 2012 to present, revealed 24 pts. wherein co-registration and review of fused PET and MRI led to significant changes in the interpretation of preregistered PET-CT or MRI and/or changed clinical management. In 16/24 pts (66%) indeterminate/suspicious lesions on MRI, were clarified as definitely +ve/-ve for viable tumor by PET, while MR improved the localization of PET abnormalities in 6/24 (25%). MR improved the specificity of PET in 5/24 (21%). In 2 pts. the false negative reports on PET were amended to true positive. Lastly, in 6 (25%) and 5 (20%) pts. additional lesions were detected on PET or MR respectively.

#### SUMMARY

Coregistration of PET and MRI significantly improves diagnostic accuracy, localization, and change in clinical management.

### **CL-NMS-WE5A • Simultaneous Segmentation from Hybrid MRI-PET and PET-CT Images Using Fuzzy Connectedness Image Co-segmentation**

**Ziyue Xu** PhD (Presenter) ; **Ulas Bagci** PhD, MSc ; **Jayaram K Udupa** PhD ; **Daniel J Mollura** MD

#### PURPOSE

To develop a simultaneous segmentation method that automatically delineates regions of abnormal uptake activities and corresponding anatomical structures from the state-of-the-art hybrid imaging technology, i.e. MRI-PET and PET-CT scans, for precise quantitative analysis.

#### METHOD AND MATERIALS

With IRB approval, a retrospective study was performed on nine MRI-PET and nine PET-CT images. Each patient's scan was positive for at least one mass lesion in the neck, thorax, abdomen, or pelvis. Lesions were linked to Von Hippel-Lindau disease, pheochromocytoma, or hereditary leiomyomatosis and renal cell cancer, as previously identified (but not circumscribed) by a radiologist. We first identified uptake regions of interest by computing 40% of the SUVmax value from the PET images. After labeling candidate object seeds, we then conducted a 3-D co-segmentation algorithm based on the fuzzy connectedness image segmentation framework. We utilized the information from both anatomical and functional imaging modalities with novel affinity functions.

#### RESULTS

Manual delineations from two expert observers on MRI-PET and PET-CT images were used as reference for evaluation. The segmentation performance was evaluated using two conventional segmentation metrics, the Dice Similarity Coefficient (DSC) and Hausdorff Distance (HD). The results of our proposed co-segmentation algorithm are shown qualitatively in Fig. 1.1 and 1.2, and quantitatively in Fig. 1.3 and Fig. 1.4. As illustrated, the achieved mean DSC is around 85% and mean HD around 5mm. It is worth noting that the statistics of the proposed method is better than the inter-observer agreement. To the best of our knowledge, the proposed algorithm is comparable to the state-of-the-art method based on Markov random walk that we presented previously, but much faster (in the order of four times). Our results also revealed that the proposed method is able to delineate lesions from both MRI-PET and PET-CT images.

#### CONCLUSION

A co-segmentation framework that makes use of both anatomical and functional images was proposed in a 3-D image domain, with the flexibility to segment various lesions with different visibility conditions.

#### CLINICAL RELEVANCE/APPLICATION

Accurately assessing radiotracer uptake from PET image and extracting corresponding anatomical tissue boundaries simultaneously from MRI or CT images is an important application in computational radio

### **CL-NME-WE6A • FDG PET/MRI: Workflow Solutions for Oncologic Staging**

**Alexander R Guimaraes** MD, PhD (Presenter) \* ; **Michael A Blake** MBBCh \* ; **Onofrio A Catalano** MD ; **Dushyant V Sahani** MD ; **Bruce R Rosen** MD, PhD \* ; **Ciprian Catana** MD, PhD

#### PURPOSE/AIM

PET/MRI is a cutting edge imaging modality that combines simultaneous acquisition of PET with MRI. In patients with pelvic (e.g. rectal, and cervical cancer), whole body (e.g. lymphoma), breast, and thoracic (e.g. pleural) malignancies, PET/MRI provides high spatial resolution and soft tissue contrast required for T staging, fused with whole body FDG PET for N (nodal) and M (metastatic) staging. This education exhibit will demonstrate the decision algorithms and protocol design considerations needed for a complete FDG PET/MRI in order to properly stage these malignancies in imaging times less than one hour, thereby producing a potentially time-saving and cost-saving alternative.

#### CONTENT ORGANIZATION

We discuss the unique attributes of protocol development in order to maximize the benefits of PET/MR for complete staging of patients with whole body, thoracic, breast, and pelvic malignancies. We will demonstrate the ability of combined PET/MR to stage accurately the primary malignancy, in addition to liver and in bone marrow. We will illustrate these in example case studies.

#### SUMMARY

Combined PET/MR offers a single modality, low radiation, well-tolerated solution to staging patients with various malignancies because of its higher sensitivity and specificity over existing imaging modalities.

## **Nuclear Medicine - Wednesday Posters and Exhibits (12:45pm - 1:15pm)**

**Wednesday, 12:45 PM - 01:15 PM • S503AB**



[Back to Top](#)

**CL-NMS-WEB • AMA PRA Category 1 Credit™:0.5**

### **CL-NME-WE6B • Imaging Form and Function in Osseous Malignancies: Scintigraphic and MR-based Approaches to Bone Metastases and Multiple Myeloma**

**Benjamin E Northrup** MD (Presenter) ; **James D Barnwell** MD ; **Sebastian R McWilliams** MBBCh ; **Daniel E Wessell** MD, PhD \* ; **Jonathan E McConathy** MD, PhD \* ; **Kathryn J Fowler** MD \*

#### PURPOSE/AIM

1. Review the pathophysiology of diffusion restriction and FDG uptake in osseous metastases.
2. Illustrate the appearance of multiple myeloma (MM), lymphoma, and bone metastases on MRI/DWI, FDG-PET/CT, fluoride-PET/CT, FDG-PET/MR, and MDP bone scintigraphy.
3. Describe the correlation between the different modalities and their use as noninvasive biomarkers for monitoring treatment response.
4. Discuss the emerging role of PET/MR.

#### CONTENT ORGANIZATION

1. Explain the importance of imaging biomarkers for monitoring treatment response and the potential role of functional and metabolic

markers of disease status. 2) Review via case examples the appearance of MM and metastatic osseous lesions on DWI, MDP scintigraphy, FDG-PET, and fluoride-PET: -Progressive and post-treatment lesions -Osteoblastic vs. osteolytic lesions -Pitfalls of flare phenomenon 3. Discuss the possible role of PET/MR in evaluating bone lesions: -MR-based PET attenuation correction in cortical bone -Description of protocols

#### SUMMARY

The appearance of MM and skeletal metastases on DWI is complex with variable ADC values depending on the stage of treatment. It is essential to understand the interplay between ADC values, MDP scintigraphy, fluoride-PET, and FDG-PET uptake in monitoring osseous lesions with the emergence of PET/MR as a new hybrid imaging modality.

### **CL-NMS-WE1B • Evaluation of Functional Improvements of the Patients with Severe Brain Injury in the Chronic Stage Using FDG-PET-Relation between Brain FDG Uptake and Discontinuation of Antiepileptics**

**Yoshio Uchino** MD, PhD (Presenter)

#### PURPOSE

Many patients with severe brain injury in the chronic stage (SBIC) have epilepsy, so most of them need to continue antiepileptics (AEDs). However, AEDs have the influence on cognitive function. We studied the changes of the brain FDG uptake and functional improvement of the patients, before and after withdrawal of AEDs.

#### METHOD AND MATERIALS

Forty-two patients were included in this study, ranging from 19 to 70 ( $40 \pm 14$ , mean  $\pm$  SD). Time from head injury to the first PET was  $3.2 \pm 2.7$  years. The interval between 1st and 2nd scan was  $24 \pm 7$  months. We tried withdrawal from AEDs in all patients. The cases were divided into two groups based on whether or not AEDs were successfully withdrawn. One was 27 cases who needed to continue AEDs (continued-AEDs group), and the other was 15 cases with successful withdrawal of AEDs (discontinued-AEDs group). Each average SUV of bilateral thalamus (Th) and whole brain (WB) were obtained from each scan. Functional Improvement of the patients was defined as the increase of more than five points in the CHIBA score.

#### RESULTS

In the continued group, the SUVs of bilateral Th and WB have not changed between two scans, and three patients out of 27 (11%) have improved function. In the discontinued group, SUVs have significantly increased (right Th  $p=0.001$ , left Th  $p=0.002$ , and WB  $p=0.001$ ).

#### CONCLUSION

Brain FDG uptake was increased after withdrawal of antiepileptic drugs in patients with SBIC. In patients with functional improvement, thalamic FDG uptake also increased. Thalamus is the key structure for the functional improvement.

#### CLINICAL RELEVANCE/APPLICATION

Discontinuation of antiepileptics help to improve the patient's brain FDG uptake. Functional improvements can be expected in patients with preserved thalamic function.

### **CL-NMS-WE2B • Clinical Relevance of 30-Minute Retention Value in Diagnosing Rapid Gastric Emptying by 4-Hour Scintigraphy Test**

**Jesus R Diaz** MD (Presenter) ; **Arya Bagherpour** DO ; **Joshua Reber** ; **Soyoung Lee** MS, MSc ; **Irene Sarosiek** MD ; **Richard W McCallum** MD ; **Alok K Dwivedi** PhD ; **Chad Cooper** MD

#### PURPOSE

Currently, a 60-min measurement of a standardized gastric emptying scintigraphy (GES) is used for diagnosis of rapid gastric emptying, and shorter intervals such as the 30-min retention value have not been widely utilized. The purpose of our study is to determine the potential diagnostic power of the percent retention of the study meal at the 30-min interval.

#### METHOD AND MATERIALS

We retrospectively reviewed 450 results of 4-h GES test. Among these reports, 71% ( $n=320$ ) were non-delayed, of which 38% ( $n=122$ ) had both a 30- and 60-min retention values recorded. Rapid emptying was defined as

#### RESULTS

Of the 122 non-delayed GES reports with both 30- and 60-min retention values, 34% ( $n=42$ ) were classified as normal at both time points, and 38% ( $n=46$ ) met criteria as rapid at both intervals. Combined, the overall concordance was determined to be 72%. Additionally, 27% ( $n=33$ ) were classified as rapid at 30 min, but normal at 60 min, and one showed normal value at 30 min and rapid at 60 min. Among all GES reports, the 30-min retention value classified 65% of results as rapid whereas only 38% of this group were classified as rapid at 60 min. Using McNemar's test, the proportion of discordant pairs was found to be significantly different between two times ( $p < 0.001$ ).

#### CONCLUSION

Our analysis of GES reports with both 30- and 60-min retention value demonstrated that: 1) 30-min interval data, diagnosed an additional 27% of patients with rapid emptying as compared to the 60-min value alone; 2) The addition of the 30-min retention data significantly increases the diagnostic power of GES to identify rapid gastric emptying.

#### CLINICAL RELEVANCE/APPLICATION

Addition of a 30-min retention value to GES increases the detection of rapid gastric emptying.

### **CL-NMS-WE3B • Increased FDG Uptake in the Right Ventricle Indicates a Poor Prognosis in Patients with CTEPH: A Comparative Study between Hemodynamic Parameters and FDG PET/CT**

**Salih Ozguven** (Presenter) ; **Fuat Dede** ; **Bedrettin Yildizeli** ; **Serpil Tas** ; **Mehmet Yanartas** ; **Serkan Gungor** ; **Mustafa Aras** ; **Tunc Ones** ; **Sabahat Inanir** ; **Tanju Y Erdil** ; **Halil T Turoglu**

#### PURPOSE

Chronic thromboembolic pulmonary hypertension (CTEPH), is a rare disease that occurs after acute pulmonary embolism and causes significant morbidity and mortality. Hemodynamical parameters plays a great role in the assessment of prognosis and severity of the disease. Right ventricular overload is an expected finding. In this study we investigated the relationship between right ventricular FDG uptake and the measured hemodynamical parameters.

#### METHOD AND MATERIALS

We performed FDG PET/CT before endarterectomy operation in order to distinguish thrombus / endovascular malignancy (angiosarcoma, etc.) which is seen as filling defects in main pulmonary artery and its branches. In FDG PET/CT study we measured the SUVmaximum (SUVmax) values of right (RV) and left ventricles (LV) and detected the RV-SUVmax and RV/LV SUVmax ratio. After this we compared the RV-SUVmax and RV/LV SUVmax ratio with the systolic (SPAP) and mean (MPAP) pulmonary artery pressures and pulmonary vascular resistance (PVR) values which are measured by echocardiography and/or right heart catheterization.

#### RESULTS

20 patients (11 women, 9 men) with a mean age of  $52.2 \pm 12.1$  years were included in this study. We found statistically significant positive relationship between the mean ( $\pm$  standard deviation) values of RV-SUVmax and SPAP (Spearman  $r = 0.48$ ,  $P = 0.037$ ), and between PVR and RV / LV ratio (Spearman  $r = 0.50$ ,  $P = 0.024$ ). There was no significant correlation found between other parameters.

#### CONCLUSION

Hemodynamic measurements are important objective parameters in determining the severity and prognosis in patients with CTEPH. Increase in these values indicates poor prognosis. On the other hand, in those patients who had RV hypertrophy and decreased systolic function due to pulmonary hypertension, can be detected by routine echocardiography, right heart catheterization and CT-pulmonary angiography in the evaluation stage. In the literature, only few studies reported the relationship between the level of the



RV FDG uptake in FDG PET/CT and the severity of pulmonary hypertension in pulmonary hypertensive patients.

#### CLINICAL RELEVANCE/APPLICATION

This study, we observed a positive correlation between the level of the right ventricular FDG uptake, PVR and SPAP in patients with CTEPH. Also increased RV-FDG uptake was shown to be a poor prognosis

### CL-NMS-WE4B • Evaluation of Quantitative Accuracy in CZT-based Pre-clinical SPECT for Different Isotopes

**Su-Jin Park** (Presenter) ; **A Ram Yu** ; **Hee-Joung Kim** PhD

#### PURPOSE

In vivo pre-clinical SPECT is a valuable imaging tool for functional small animal imaging, but several physical factors such as scatter radiation limit the quantitative accuracy in conventional scintillation crystal-based SPECT. Semiconductor detectors such as CZT may overcome the deficiencies through superior energy resolution. To our knowledge, the quantitative analysis in CZT-based pre-clinical SPECT has not been investigated rigorously. The aim of this work is to assess the quantitative accuracy of CZT-based pre-clinical SPECT for four different isotopes:  $^{125}\text{I}$ ,  $^{201}\text{Tl}$ ,  $^{99\text{m}}\text{Tc}$ , and  $^{111}\text{In}$

#### METHOD AND MATERIALS

The quantitative accuracy of the CZT-based Triumph X-SPECT (Gamma-Medica Ideas, Northridge, CA, USA) was compared with those of the conventional SPECT using GATE simulation. The quantitative errors due to the scatter effects were evaluated with the four different isotopes, and energy windows of 5, 10, and 20 %.

#### RESULTS

The CZT-based pre-clinical SPECT had overall higher quantitative accuracy than that of the conventional SPECT. Using the conventional SPECT with the energy window of 10 % as an example, the scatter effects degraded quantitative accuracy were by up to 33.74 %, 11.52 %, 5.10 %, and 1.73 % for  $^{125}\text{I}$ ,  $^{201}\text{Tl}$ ,  $^{99\text{m}}\text{Tc}$ , and  $^{111}\text{In}$ , respectively. However, using the CZT-based pre-clinical SPECT, the degradations were by up to 15.20 %, 5.45 %, 2.40 %, and 1.41 % for  $^{125}\text{I}$ ,  $^{201}\text{Tl}$ ,  $^{99\text{m}}\text{Tc}$ , and  $^{111}\text{In}$ , respectively. In addition, as the energy window was increased, the quantitative errors increased for both SPECT systems. Moreover, in CZT-based pre-clinical SPECT, the errors significantly increased when the energy window varies from the 5% to 10%.

#### CONCLUSION

The quantitative accuracy of CZT-based pre-clinical SPECT was evaluated for the different isotopes by the comparison of those of the conventional SPECT. Our results demonstrated that the CZT-based pre-clinical SPECT had overall lower quantitative errors due to the minimal scatter. Furthermore, we are planning to investigate the optimal energy window for each isotope in order to take the advantage of the high quantitative accuracy in CZT-based preclinical SPECT.

#### CLINICAL RELEVANCE/APPLICATION

Our results offer insights into the potential of CZT-based SPECT quantitative imaging in clinics, and may provide clinicians with useful reference information for the task-based quantitative study.

### CL-NMS-WE5B • Effect of Errors in MR-based Attenuation Maps of the Pelvis on PET Reconstructions in Simultaneous PET-MRI

**David Lalush** (Presenter) ; **Meher Juttukonda** \* ; **Hongyu An** DSc

#### PURPOSE

MR-based attenuation maps of the pelvis do not completely account for bone and introduce errors into PET reconstructions. This study examines the effects of erroneous bone attenuation factors on PET reconstructions in a realistic simulation model.

#### METHOD AND MATERIALS

Simulations used the realistic body anatomy of the XCAT digital phantom. The phantom was generated with both simulated PET uptake and realistic attenuation factors. Two activity distributions were simulated: a uniform-uptake distribution and a lesion-centric distribution including four high-uptake spherical lesions placed at different locations around the pelvis. PET lines of response were simulated for the Siemens Biograph mMR geometry, and attenuation effects of the true attenuation map (including bone) were applied to the set of oblique sinogram data. A series of erroneous attenuation maps for reconstruction were then applied to "correct" the sinogram data. Erroneous maps included one where bone was given water-equivalent attenuation, and a series of others where a fraction (25%, 50%, and 75%) of bone voxels were correctly assigned bone attenuation. Reconstructions of the erroneously-corrected data were produced using Fourier rebinning followed by OSEM reconstruction. Reconstructions were compared to those using the true attenuation map by computing percentage errors in each voxel.

#### RESULTS

Error maps show that quantitative errors in the erroneously-mapped PET reconstructions are nonuniformly distributed and are most severe in the immediate vicinity of calcified bone, where they are as high as 40-50% relative to the reconstructions from the correct maps. Lesion quantitation was also shown to vary with location and ranged from 10-12% in some superior and inferior locations less impacted by the pelvic bone to 30-50% in locations in the planes of thickest calcified bone.

#### CONCLUSION

Reconstructions of PET data in the pelvic region from MR-based attenuation maps that do not fully account for bone will likely result in underestimation of PET uptake as compared to those from CT-based attenuation maps. Errors range from 10 - 50% and are location- and patient-dependent, further complicating the comparison of PET-MR acquisitions with those from PET-CT.

#### CLINICAL RELEVANCE/APPLICATION

Simultaneous PET-MRI is being considered in potential clinical applications, but the comparison with standard-of-care PET-CT will be impacted by errors due to bone attenuation.

## Nuclear Medicine (Comparative Technologies and Modalities)

Wednesday, 03:00 PM - 04:00 PM • S505AB

**NM** **MR** **CT**

[Back to Top](#)

**SSM17** • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1

**Moderator**

**Richard K. J. Brown**, MD \*

**Moderator**

**Farrokh Dehdashti**, MD \*

### SSM17-01 • Comparison of F18-FDG PET-CT vs. 3T Diffusion Weighted (DWIBS) Whole-body Magnetic Resonance Imaging in Colon Cancer Staging

**Ettore Squillaci** MD (Presenter) ; **Guglielmo Manenti** MD ; **Francesca Bolacchi** ; **Marco Nezzo** MD ; **Orazio Schillaci** MD ; **Giovanni Simonetti** MD

#### PURPOSE

To assess the accuracy of 3T whole-body MRI (WB-MRI) in comparison with whole-body [ $^{18}\text{F}$ ]-2-Fluoro-2-deoxy-D-glucose (FDG) PET/CT for staging newly diagnosed colon cancer.

#### METHOD AND MATERIALS

40 consecutive patients with previously diagnosed colon cancer underwent 3T WB-MRI (Philips Achieva, Best, The Netherlands) and Whole-Body [18F]-2-Fluoro-2-deoxy-D-glucose (FDG) PET/CT (GE Discovery ST 64) for staging of lymph node (N) and distant metastases (M) after resection of the primary tumor. WB-MRI was performed with multi-stacks approach, in the coronal plane using morphological (T1W, T2W-STIR), Diffusion-Weighted Imaging With Background Suppression (DWIBS) and contrast-enhanced T1w 3D sequences. Evaluation was done according to the American Joint Committee on Cancer Staging classification. MR images were evaluated by two radiologists while the PET/CT images by one radiologist and one nuclear physician. Histology and a mean clinical-radiological follow-up of 6-9 months served as the standards of reference.

#### RESULTS

The mean follow-up time was 22 months. Regional lymph node involvement was correctly determined in 30/40 cases as N-positive for WB-MRI (75%, p

#### CONCLUSION

WB-MRI is a fast and feasible method for staging colon cancer patients but up-to-date does not reach the accuracy of 18F-FDG-PET/CT.

#### CLINICAL RELEVANCE/APPLICATION

The present study demonstrated expected advantages of PET/CT over WB-MRI in staging colon cancer patients.

### **SSM17-02 • Comparison of Diffusion Weighted MR Imaging with 18-FDG PET-CT for Lymph Node Assessment in Known Cases of Malignancy**

**Salil Bhargava** DMRD (Presenter) ; **Chalapathi R M. V.** MD ; **Pupshpalatha Sudhakar** MD

#### PURPOSE

To perform a node-by-node correlation of the maximum standard uptake value ( $SUV_{max}$ ) and the minimal apparent diffusion coefficient ( $ADC_{min\ abs}$ ) for each lymph node that shows radiotracer uptake on 18-FDG PET-CT. Develop a visual grading of diffusion restriction and assess its correlation with radiotracer uptake. Calculate the sensitivity and specificity of diffusion weighted imaging (DWI) for the assessment of lymph nodes while using 18-FDG PET-CT as the gold standard.

#### METHOD AND MATERIALS

The study included 40 patients with histologically confirmed diagnosis of malignancy who were found to have significant lymph node involvement on 18-FDG PET-CT examination. These patients were subsequently imaged on a 1.5 T MR scanner using a Torso-PA coil where DWI was performed using b values of 0, 100 and 1000 without respiratory gating. Blinded reading of the PET-CT and DW images was performed and  $SUV_{max}$ ,  $ADC_{min\ abs}$  and visual grade of diffusion restriction were recorded for each lymph node. Pearson's correlation was performed over the entire data set and after segregating it into various subgroups.

#### RESULTS

Evaluation of 241 lymph nodes revealed a statistically significant inverse correlation ( $r=-0.190$ , p  $_{min\ abs}$  and  $SUV_{max}$ ). The mean values of  $ADC_{min\ abs}$  for PET-CT negative and PET-CT positive lymph nodes were  $1.197 \pm 0.392 \times 10^{-3} \text{mm}^2/\text{s}$  and  $0.907 \pm 0.356 \times 10^{-3} \text{mm}^2/\text{s}$  with their difference being statistically significant (p

#### CONCLUSION

Increasing visual grade of lymph nodes on DWI consistently correlates with increase in radiotracer (18-FDG) uptake and low ADC values. DWI has a sensitivity and specificity of 89.9 and 90.3% when compared to PET-CT. However, it is inaccurate in the evaluation of mediastinal lymph nodes suggesting the need for respiratory gating.

#### CLINICAL RELEVANCE/APPLICATION

DWI is a cheaper, radiation free imaging alternative that allows for qualitative and quantitative evaluation of lymph nodes, with findings closely paralleling those of 18-FDG PET-CT.

### **SSM17-03 • Misregistration of Intra-abdominal and Intrapelvic Organs: Comparison between PET-CT and PET-MR**

**Pinakpani Roy** MD (Presenter) ; **Joseph K Lee** MD ; **Arif Sheikh** MD ; **Meagan Shepherd** ; **Stacy Hengsterman** ; **Yueh Z Lee** MD, PhD \* ; **Weili Lin** PhD

#### PURPOSE

To quantify and compare organ misregistration between PET-CT data and PET-MR data obtained on a hybrid whole body PET-MR system.

#### METHOD AND MATERIALS

Biograph mMR consists of a 3.0T whole-body magnet with body coils optimized for minimal 511-keV photo attenuation. The PET detectors are made of lutetium oxyorthosilicate crystals in combination with MR-compatible avalanche photodiodes.

PET-CT data were acquired using a Siemens Biograph mCT system. Approximately 1 hour after 18-FDG injection, the CT data was acquired, followed sequentially by PET acquisition. IRB approval and informed consent were obtained.

After fasting for at least 4 hours, 9 normal PET-MR volunteers (5 men and 4 women, age range 26-50 years, BMI range 20-30) were imaged approximately 1 hour after 18-FDG injection. Breath-hold T2 HASTE, T2 STIR and T1 VIBE sequences were obtained simultaneously or sequentially (following PET acquisition). 10 clinical PET-CT studies performed during the same time frame were chosen, with the patients' BMI range matching those of the PET-MR volunteers. Registration of MR-PET data in selected organs (liver, spleen, kidneys, colon, small bowel, bladder, uterus) was compared to that of PET-CT data with respect to organ type, MR sequence and mode of acquisition. Statistical analysis was performed using student T-test and Analysis of Variance (ANOVA).

#### RESULTS

With respect to misregistration, there was no significant difference between simultaneously obtained PET-MR data (mean 0.50 cm) and PET-CT (0.48 cm), but sequential acquired data (1.25 cm) showed significantly higher misregistration than PET-CT data (p=0.03). With respect to sequences, mean misregistration with T1 VIBE (mean 1.24 cm) was significantly (p=0.03) higher than with PET-CT (0.48 cm). Although mean misregistration with T2 STIR (0.27 cm) was lower than PET-CT and misregistration with breath hold T2 HASTE (0.82 cm) was higher than PET-CT, the results were not statistically significant.

#### CONCLUSION

Comparing BMI matched subjects, sequentially obtained PET-MR data has significantly higher misregistration than PET-CT data. Simultaneously obtained PET-MR data is non-inferior to PET-CT in that regard. Misregistration with T1 VIBE is significantly higher than with PET-CT.

#### CLINICAL RELEVANCE/APPLICATION

Simultaneously acquired PET-MR using T2 STIR sequence is comparable to PET-CT in terms of misregistration, which has diagnostic implications.

### **SSM17-04 • Preliminary Investigation of Composite Biomarkers in Simultaneous PET/MR: Relationship between SUV and ADC in Oncology Patients**

**Rajan Rakheja** ; **Hersh Chandarana** MD \* ; **Linda Demello** ; **Kimberly Jackson** ; **Christopher Glielmi** PhD \* ; **Kent P Friedman** MD (Presenter)

#### PURPOSE

To assess the correlation between SUV and ADC of neoplastic lesions using a simultaneous PET/MR and to investigate the value of a composite biomarker,  $SUV_{max}/ADC_{min}$ .

#### METHOD AND MATERIALS

Twenty-four patients with known primary malignancies underwent FDG-PET/CT followed by PET/MR (Biograph mMR). Diffusion weighted imaging was acquired using a single shot spin echo EPI sequence with b-values of 0, 350 and 750 s/mm<sup>2</sup>. ROIs were manually drawn on PET/MR along the contours of neoplastic lesions larger than 1cm. SUVmax, SUVmean, ADCmin and ADCmean were recorded for each FDG-avid tumor with a maximum of 3 lesions per patient. Relationships between SUVmax and ADCmin, SUVmean and ADCmean, and SUVmax/liver mean versus ADCmin were assessed using Pearson's correlation coefficient. A sub-analysis of patients with progressive disease (PD) and partial treatment response (PR) by RECIST 1.1 was performed using a ratio of SUVmax/ADCmin for the most metabolically active lesion.

#### RESULTS

#### CONCLUSION

Simultaneous PET/MR is a promising technology for detection of neoplastic disease. There is an inverse correlation between SUVmax and ADCmin and between SUVmax/liver ratio and ADCmin. Given that the correlation between both biomarkers is relatively weak, the authors hypothesize that SUV and ADC values may offer complimentary information to aid in determination of prognosis and treatment response. Preliminary results suggest that SUVmax/ADCmin may increase more rapidly than SUVmax in progressive disease, thus warranting further study of this ratio as a composite biomarker.

#### CLINICAL RELEVANCE/APPLICATION

There is a need to develop better imaging biomarkers for assessment of treatment response; our study investigates SUVmax/ADCmin measured by PET/MR as marker of cancer therapy response.

### **SSM17-05 • The Correlation between SUVmax of 18F-FDG PET/CT and Apparent Diffusion Coefficients (ADC) in Pancreas Cancer and Biliary Cancer?**

**Shigeki Nagamachi** MD, PhD (Presenter) ; **Ryuichi Nishii** MD, PhD ; **Youichi Mizutani** ; **Shogo Kiyohara** ; **Eiji Furukoji** MD, PhD ; **Tatefumi Sakae** MD ; **Shozo Tamura** MD, PhD ; **Hideyuki Wakamatsu** MD ; **Seigo Fujita** MD ; **Shigemi Futami** ; **Keiichi Kawai**

#### PURPOSE

Apparent diffusion coefficient (ADC) is a quantitative parameter providing information regarding tumor cellularity. Several studies demonstrated that ADC and SUVmax of FDG-PET had negative correlations in various cancers. The aim of this study was to investigate and to compare the correlations between ADC and SUV in pancreatic cancer or biliary cancer.

#### METHOD AND MATERIALS

This study included 110 patients with pathologically proven pancreatic cancer and 65 patients with pathologically proven biliary cancer. The SUVmax was automatically obtained by setting 3D ROI over the abnormal FDG uptake in the cancer lesion to cover the entire tumor volume. Obtained indices were obtained in both early (1hr) and delayed (2hr) images (SUVmax early and SUV delayed). ADC maps were made from 1.5T-MR image on workstation. A circular ROI which was minimally smaller than the actual solid portion of pancreatic lesion and biliary lesion were carefully placed on the b-1,000 DWI and copied to the ADC map. Both minimal ADC (ADC min) and mean ADC (ADC mean) were measured. Pearson correlation coefficients were calculated to assess the relationship between ADC and SUVmax in pancreas cancer and biliary cancer respectively.

#### RESULTS

In pancreas cancer, both ADC mean and ADC min was negatively correlated with SUVmax of early image ( $r = -0.350$  and  $r = -0.346$ ) and of delayed image ( $r = -0.329$  and  $r = -0.334$ ). In biliary cancer, both ADC mean and ADC min also negatively correlated with SUVmax of early image ( $r = -0.602$  and  $r = -0.414$ ) and of delayed image ( $r = -0.599$  and  $r = -0.381$ ).

#### CONCLUSION

The present study demonstrated negative correlations between ADC and SUVmax in both pancreas cancer and biliary cancer. However, the correlation coefficients of biliary cancer were higher than those in pancreatic cancer. The correlation between cell density and glucose metabolism seems to be different considerably according to disease respectively.

#### CLINICAL RELEVANCE/APPLICATION

Because it is difficult to estimate SUVmax from a value of the ADC in pancreas tumor, both indices had better be evaluated together for understanding biological characteristics.

### **SSM17-06 • Growth and Utilization Trends in Outpatient PET by Place-of-Service and Specialty**

**David C Levin** MD (Presenter) \* ; **Vijay M Rao** MD ; **Laurence Parker** PhD ; **Charles M Intenzo** MD ; **Andrea J Frangos** MPH

#### PURPOSE

PET is the most rapidly growing segment of nuclear medicine. Our purpose was to study recent PET growth trends in private offices and hospitals, also to determine who owned the PET facilities in offices and who interpreted the PET scans in hospitals.

#### METHOD AND MATERIALS

The nationwide Medicare Physician/Supplier Procedure Summary Master Files for 2001-2011 were studied. All CPT codes for PET were selected and procedure volumes were determined for each year. Medicare location codes identified the settings where the scans were performed, and specialty codes identified the specialties of the facility owners (in offices) and interpreting physicians (in hospitals). Ownership in offices was established by tabulating global and technical component claims, while interpreting physician specialty in hospitals was determined by tabulating global and professional component claims.

#### RESULTS

In offices, Medicare PET volume grew from 31,422 in 2001 to 342,397 in 2011. In 2011, radiologists owned the office unit in 141,289 (41.3 % share). Independent diagnostic testing facilities (IDTFs) had the next largest ownership share, 19.2%. IDTFs are listed as a specialty by Medicare, although the actual specialty of the physician provider cannot be determined. Cardiologists had a 13.4% share, and all other internal medicine specialties as a group had an 18.8 % share. In hospitals, PET volume grew from 65,099 in 2001 to 340,870 in 2011. 95.6% of volume in the latter year was in outpatients. In 2011 in hospitals, radiologists interpreted 325,664 (95.5% share), while cardiologists interpreted 10,178 (3.0% share). Examination of the growth curves showed that in hospitals, PET volume underwent continued rapid growth during the entire period. Private office PET volume grew even more rapidly from 2002 to 2008, but then slowed from 2008-2011.

#### CONCLUSION

Outpatient PET is evenly split between private offices and hospitals. Rapid growth occurred from 2001-2011 in both locations, but the trend line began to flatten in offices in more recent years. Radiologists strongly predominated in hospital-based PET (96% share) in 2011. In offices, they also had a strong role, with the largest plurality (41%) of any medical specialty.

#### CLINICAL RELEVANCE/APPLICATION

Not applicable

**Controversy Session: The Heart of the Matter: Nuclear Stress Test vs CTA for Low to Intermediate Risk Cardiac Patients with Chest Pain**

**Wednesday, 04:30 PM - 06:00 PM • S404CD**

[Back to Top](#)

SPSC45 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Suhny Abbara, MD \*  
Sharmila Dorbala, MBBS \*

LEARNING OBJECTIVES

1) To review the current literature on cardiac CT in the setting of chest pain with low to intermediate risk. 2) To review the current literature on radionuclide myocardial perfusion imaging in the setting of chest pain with low to intermediate risk. 3) To understand the strengths and weaknesses of radionuclide imaging and MDCT in this particular situation.

ABSTRACT

URL

<http://www.mgh-cardiovascimages.org/>

**Hot Topic Session: Multimodality Imaging with MR-PET**

Thursday, 07:15 AM - 08:15 AM • E350

[Back to Top](#)

SPSH50 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1

Moderator  
Kathryn J Fowler, MD \*

LEARNING OBJECTIVES

1) Understand challenges and potential solutions associated with PET/MR attenuation correction. 2) Become aware of advanced body applications for PET/MR. 3) Understand challenges of integrating PET/MR into clinical workflow.

**SPSH50A • Advanced PET/MR**

Ciprian Catana MD, PhD (Presenter)

LEARNING OBJECTIVES

View learning objectives under main course title.

**SPSH50B • Integration of PET/MR into Clinical Workflow**

Kathryn J Fowler MD (Presenter) \*

LEARNING OBJECTIVES

View learning objectives under main course title.

**SPSH50C • Challenges of Attenuation Correction**

Martin Judenhofer PhD (Presenter)

LEARNING OBJECTIVES

View learning objectives under main course title.

**Advances in Cardiac Nuclear Imaging: SPECT/CT and PET/CT**

Thursday, 08:30 AM - 10:00 AM • S505AB

[Back to Top](#)

RC611 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

LEARNING OBJECTIVES

1) Understand the technical advancements associated with new scintillation cameras and SPECT-CT and PET-CT cameras. 2) Appreciate the benefits of CT attenuation correction. 3) Appreciate the adjunctive benefits of anatomic definition provided with CT and physiologic/function information provided by SPECT and PET. 4) Improve interpretive skills related to SPECT and PET-CT.

ABSTRACT

Camera and software technology recently has rapidly advanced, providing improved SPECT image resolution and increased counting statistics. These advancements in turn have provided the possibility of reduced-time and reduced radiopharmaceutical dose image acquisitions. Moreover, increased flexibility in imaging protocols has been realized. Future development of these methods hold promise in increasing diagnostic accuracy and expanding diagnostic applications. The addition of CT to SPECT and PET has afforded the ability to perform attenuation correction, thereby minimizing attenuation artifacts and increasing diagnostic specificity. With CT acquisitions of sufficient resolution, complementary anatomic diagnostic information is provided. In addition, more precise anatomic localization of SPECT and PET abnormalities significantly increases clinical applicability.

**RC611A • Advances in Cardiac SPECT**

E. Gordon Depuey MD (Presenter) \*

LEARNING OBJECTIVES

1) Understand software methods to cope with lower SPECT counting statistics in order to reduce scan acquisition time and/or radiopharmaceutical injected activity and their clinical impact. 2) Understand instrumentation advances that allow new cameras to perform SPECT with markedly reduced acquisition times and/or less radiopharmaceutical activity and their clinical impact. 3) Implement protocols that facilitate patient-centered imaging and that reduce patient radiation exposure. 4) Recognize new software methods to select appropriate patients for cardiac resynchronization therapy (CRT).

ABSTRACT

A long-standing limitation of radionuclide myocardial perfusion SPECT is its relatively lengthy acquisition time, as compared to stress echocardiography and cardiac CT. New software methods and new innovative hardware, however, now allow for significantly shortened SPECT acquisition times without a decrease in image quality. Advancements include iterative reconstruction, resolution recovery, and noise reduction software, and focused collimation and solid state detectors incorporated into new camera designs. More recently the media, the public, and the medical community have drawn attention to patient radiation exposure associated with radiographic, nuclear medicine, and nuclear cardiology procedures and the potential associated patient risk. The radiology and nuclear imaging communities have responded rapidly and definitively by implementing a variety of guidelines to decrease patient radiation exposure and to avoid exposure in higher risk patient populations. The American society of Nuclear Cardiology has set a goal to decrease patient radiation exposure associated with myocardial perfusion SPECT to less than 9 mSv per entire study in 50% of patients by 2014, and the ACR Image Wisely Guidelines encourage reduced radiation doses. New software and hardware methods described in this

presentation will help us achieve this goal by providing the ability to maintain or improve SPECT image quality with the lower image counting statistics associated with significantly decreased injected radiopharmaceutical doses. There has been an intersocietal effort to promote patient-centered imaging with a focus on appropriateness guidelines, cost-containment, radiation dose reduction, and the selection of the most appropriate imaging test and protocol to suit particular patient needs. The technical advancements described above facilitate implementation of patient-centered imaging.

## RC611B • Advances in Cardiac PET

**Sharmila Dorbala** MBBS (Presenter) \*

### LEARNING OBJECTIVES

1) Review the advantages and disadvantages of myocardial perfusion PET compared to SPECT for evaluation of coronary artery disease. 2) Learn the added value of absolute quantitative parameters derived from PET for assessment of cardiovascular disease. 3) Update of current and future clinical applications of cardiac PET imaging in cardiovascular medicine.

ABSTRACT

## ISP: Nuclear Medicine (Neurologic Imaging)

Thursday, 10:30 AM - 12:00 PM • S505AB

NM NR

[Back to Top](#)

SSQ16 • AMA :1.5 • ARRT:1.5

**Moderator**

**Satoshi Minoshima**, MD, PhD \*

**Moderator**

**Alexander Drzezga**, MD \*

### SSQ16-01 • Nuclear Medicine Keynote Speaker: State-of-the-Art Molecular Neuroimaging

**Alexander Drzezga** MD (Presenter) \*

### SSQ16-03 • Does Computer Aided Diagnostic (CAD) Software Decrease Inter-reader Variability of Florbetapir PET Brain Scan Interpretation?

**Ameya Nayate** MD (Presenter) \* ; **Jacob G Dubroff** MD, PhD \* ; **James E Schmitt** MD, PhD ; **Rekha I Kishore** MD \* ; **Ilya M Nasrallah** MD, PhD ; **David A Mankoff** MD, PhD ; **Daniel Pryma** MD \*

#### PURPOSE

#### METHOD AND MATERIALS

29 patients enrolled in the Alzheimer's disease neuroimaging initiative (ADNI 2) were included. Readers classified each case using a binary system, positive or negative for significant beta amyloid deposition. Each case was interpreted twice by each reader, once qualitatively and once with the aid of SUVr measurements generated by Scenium software (Siemens Medical). Cases were randomly assigned to 4 reading sessions separated by a washout period and interpreted by 5 blinded, board certified and Florbetapir-interpretation trained readers. No case was repeated within an individual session. To quantify inter-rater agreement, a kappa coefficient was calculated for the raters with and without the use of Scenium.

#### RESULTS

When Florbetapir PET brain studies were read qualitatively, there was inter-reader disagreement in 8/29 cases. When the same Florbetapir PET studies were read with SUVr, there was inter-reader disagreement for only 1 case. The kappa coefficient for the studies read with SUVr (0.94) was statistically significantly higher compared to the qualitatively only read studies (0.71),  $p < 0.005$ .

#### CONCLUSION

The use of semi-quantitative indices (SUVr) to aid the interpretation of Florbetapir images improves inter-reader agreement. Further study is needed to confirm the impact on the accuracy of interpretation.

#### CLINICAL RELEVANCE/APPLICATION

Computer aided diagnostic software can decrease inter-reader variability of F-18 Florbetapir PET brain scan interpretation.

### SSQ16-04 • A Novel Metric of Volumetric Statistical Amyloid Burden by Comparison to a Database of Health Controls

**Jon W Piper** BEng (Presenter) \* ; **Aaron S Nelson** MD \* ; **Sara Pirozzi** BS \* ; **Zhilei Shen**

#### PURPOSE

Statistical parametric mapping allows voxelwise comparison between florbetapir PET brain images with reference to a database of cognitively normal subjects, after having registered each brain into a stereotactic brain atlas space. Here, we propose a metric, Volumetric Statistical Amyloid Burden (VSAB) computed as the volume of gray matter that exceeds a z-score threshold when compared to a database of young healthy controls.

#### METHOD AND MATERIALS

Consensus reads among three readers for 130 Florbetapir scans, as described in Fleisher et. al (2011), were classified as either amyloid+ or amyloid-. MIMneuro 5.6 was used without intervention to deformably register each scan to a common atlas space with reference to 3 florbetapir PET templates. Z-scores were computed for every voxel in each Florbetapir scan, as compared to 74 young healthy controls. A gray matter mask, defined as the VOI encompassing the high uptake voxels of an average of many amyloid+ patients and excluding the high uptake voxels of an average of many amyloid- patients, was used to only consider gray matter burden in computing the final VSAB metric. Z-score thresholds from 3 to 7 were considered for the computation of VSAB, defined as the percentage of voxels within the gray matter mask that exceeded the z-score threshold.

#### RESULTS

The Kappa statistics for agreement with consensus reads for VSAB computed with z-score thresholds 3, 4, 5, 6, and 7 were 0.90, 0.90, 0.92, 0.94, and 0.97, respectively. The VSAB used were 30.0%, 12.8%, 4.0%, 1.4%, and 0.7%, respectively.

#### CONCLUSION

Volumetric Statistical Amyloid Burden shows promise as an additional metric for distinguishing amyloid+ from amyloid-. Additionally, the agreement of this metric with visual assessment suggests that there may be value in computing voxel-level z-scores for amyloid images. Further work will investigate even more robust methods for gray matter mask definition and will compare VSAB with updated visual assessment methods.

#### CLINICAL RELEVANCE/APPLICATION

Incorporation of quantitative and statistical analysis of functional neuroimaging has been shown to increase the accuracy and confidence of visual interpretation of these studies.

### SSQ16-05 • High Resolution PET Scanner Optimized for Neurological Imaging

#### PURPOSE

Dementias and motion disorders such as Alzheimer's disease (AD) and Parkinson's disease (PD) present a huge societal and economic burden. Accurate, early diagnosis of these disorders using biomarkers is a research and clinical priority. Recent development of Positron Emission Tomography (PET) radiopharmaceuticals for evaluation of Alzheimer's disease, and other dementias such as F18-Florbetapir, F18-FDDNP, F18-Florbetaben, F18-Flutemetamol, and F18-AV-133, and others - position PET as a key diagnostic modality in evaluation of dementia and other brain disorders. Currently available PET scanning infrastructure relies on bulky Whole Body PET (WB PET) machines developed for oncology applications. While WB PET machines can acquire acceptable brain images, large-scale deployment of WB PET scanners to accommodate estimated volume of brain imaging procedures will be inefficient and costly. There is a clear need for a high-resolution, small-footprint, inexpensive PET scanner focusing on neurological applications.

#### METHOD AND MATERIALS

We constructed a dedicated brain PET scanner with a bore diameter of 25 cm and a 20 cm axial field of view. The intrinsic spatial resolution of the detector block is 1.9mm. The bore and the head-support system are constructed to ensure that the scanner gantry does not obstruct the patient's line of sight, which is important for claustrophobic patients and patients with neurological or psychiatric conditions, who may need to be in visual contact with the caregiver or healthcare staff at all times. The scanner performance was evaluated using various phantoms, including point sources, uniformity phantom, and Hoffman brain phantom.

#### RESULTS

The measurements demonstrated spatial resolution of 2-3mm across the field of view, energy resolution of less than 13% for all detector blocks, image uniformity of better than 15%. Quantitative accuracy is better than 10% after calculated attenuation correction as benchmarked against the whole-body PET scanner.

#### CONCLUSION

Novel dedicated brain PET imaging device provides an acceptable alternative to whole-body PET machines at reduced cost to the healthcare facility. The device does not obstruct patient line of sight and could, potentially, eliminate claustrophobia.

#### CLINICAL RELEVANCE/APPLICATION

New PET imaging device could be used for F18-FDG and F18-florbetapir imaging in evaluation of Alzheimer's disease, and clinical neuroscience research with novel CNS radiotracers.

### SSQ16-06 • Quantitative Analysis of FDG PET Hypometabolism in Pre-operative Identification of Seizure Foci Not Detected on Routine MR and Qualitative PET

Bhawana Rathore MD (Presenter) ; Vina Ravichandran BA ; Pearce Korb MD ; James R Galt PhD ; Robert E Gross ; David M Schuster MD ; Bruce J Barron MD \* ; Larry Olson ; Jonathon Nye PhD \* ; Hamilton E Reavey MD

#### PURPOSE

Approximately 30% of patients with epilepsy are refractory to medications and may require resective brain surgery. Identification of candidate regions of seizure onset is crucial to successfully guide resection or placement of surgically implanted electrodes for intracranial electroencephalography (iEEG). However many patients do not have visually identifiable lesions on brain MRI or PET making it a challenge for surgical planning. The primary aim of this proof of concept study is to determine if the most hypometabolic regions of the interictal brain PET using quantitative analysis software correlates with the seizure onset zone determined by subsequent iEEG.

#### METHOD AND MATERIALS

Eighteen interictal PET-CT scans of brain in patients who had also undergone iEEG were retrospectively reviewed. All patients originally had MR and qualitative PET interpreted as negative. The studies were then processed with quantitative analysis software (MimNeuro 5.6; Cleveland, Ohio) which compares PET images to a normal database. The 10 most hypometabolic foci were recorded on a scale of 1-10 with 1 being most hypometabolic. Foci which corresponded to white matter or cerebellum on co-registered CT were eliminated from analysis since these are rare locations for origin of seizures. Candidate foci based on rank order of hypometabolism were then compared to the actual location of the seizure onset zone as identified on iEEG.

#### RESULTS

Mean ( $\pm$ SD) age was 43.6 ( $\pm$ 11.7); range 24-60 years. Ten patients were male and 8 female. For all 18 patients the seizure onset zone from the iEEG correlated with one of the hypometabolic foci on the quantitative PET analysis. Mean ( $\pm$ SD) rank order of hypometabolism for the seizure onset zone was 1.7 ( $\pm$ 1.1); range 1-5. In 10 out of 18 patients (56%) the most hypometabolic focus correlated with the proven seizure onset zone on iEEG.

#### CONCLUSION

Quantitative analysis of PET hypometabolism may be useful in identifying candidate seizure onset zones and guiding placement of intracranial electroencephalography electrodes even in patients with negative MR and unrevealing qualitative PET. Further analyses with a larger sample size and co-registration of PET and MR is warranted to determine diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of PET hypometabolism may bring added value to pre-operative identification of seizure foci not detected on routine MR and qualitatively interpreted PET thereby improving outcomes.

### SSQ16-07 • PET/CT versus PET/MR for the Clinical Evaluation of Patients with Dementia: Comparison of Visual Interpretation by Two Experienced Readers

Kent P Friedman MD (Presenter) ; Rajan Rakheja ; Timothy M Shepherd MD, PhD ; Rachel Bartlett PhD ; Yu-Shin Ding PhD ; Fernando Boada

#### PURPOSE

Simultaneous PET/MR is a new technology that may be used in the evaluation of dementia patients. There are few data in the literature regarding quantitative differences between PET data obtained at PET/CT versus PET/MR and how this may impact image interpretation. This study compared the PET interpretation of PET/CT versus PET/MR by two independent experienced nuclear medicine physicians.

#### METHOD AND MATERIALS

Forty-five minutes following injection of 10 mCi of FDG, 19 patients with clinically-suspected dementia underwent a 15-minute clinical brain PET/CT. Simultaneous PET/MR scanning was subsequently performed (60 minute list-mode) at approximately 90 minutes post-injection. Two experienced nuclear medicine physicians blindly interpreted the PET portion of all PET/CT scans, attributing a specific diagnosis (normal, AD, FTD, LBD, other dementia, mixed phenotype or unspecified disease) and severity scale (mild, moderate or severe abnormality). The readers then blindly interpreted the PET data obtained from PET/MR. Concordance between PET/CT (reference standard) and PET/MR with respect to diagnosis and disease severity was assessed for each reader.

#### RESULTS

Reader A classified 12 PET/CT scans as AD, 5 as unspecified dementia, 1 as LBD and 1 as normal with a mean severity score of 2.0. Reader B classified 10 PET/CT scans as AD, 3 as unspecified, 1 as LBD and 5 as normal with mean severity score of 2.1. PET/MR interpretations with comparison to PET/CT yielded an 84% (16/19) intra-reader concordance of diagnosis, with 95% (18/19) of severity scores varying by one point or less. Reader B exhibited 84% intra-reader concordance of dementia pattern diagnosis, with 89% (17/19) of all scores varying by one point or less.

#### CONCLUSION

Our preliminary analysis in clinically-suspected dementia patients showed a relatively high concordance of intra-reader assignment of



diagnosis and severity of findings between PET/CT and PET/MR when evaluated by two blinded experienced nuclear medicine physicians. These results suggest PET/MR brain scans acquired on hybrid PET/MR are of diagnostic quality and interpretation results compare favourably to PET/CT.

#### CLINICAL RELEVANCE/APPLICATION

Prior to widespread implementation of PET/MR for dementia evaluation; PET results obtained by PET/MR need to be validated and compared to PET/CT.

### **SSQ16-08 • A Novel MR Atlas-based Method Outperforms the Silver-standard CT Segmentation-based Method in PET Attenuation Correction**

**Meher Juttukonda** (Presenter) \* ; **Yasheng Chen** PhD ; **Yueh Z Lee** MD, PhD \* ; **Felipe Espinoza** ; **Weili Lin** PhD ; **Dinggang Shen** PhD ; **David Lalush** ; **Hongyu An** DSc

#### PURPOSE

Since MR signal depends on proton (not electron) density and tissue relaxation, MR-based attenuation correction (AC) for MR/PET imaging is challenging. In this study, we have developed an atlas-based MR method for PET AC and have evaluated its accuracy using simulations.

#### METHOD AND MATERIALS

In a group of 10 patients with paired MR and CT images, 3 AC maps were generated for each patient. First, gold-standard maps (CTSC) were derived using bilinear scaling of their CT images. Second, nonlinear registration was performed to generate a T1w-MR and CT atlas. A hidden Markov random field method was then used in a leave-one-out scheme to derive a pseudo-CT (pCT) for each patient using the atlas and their MR image. These pCTs were then scaled to obtain MR-based AC maps (MRAC). Last, the original CTs were segmented into 3 classes (bone, air, soft tissue) and each class was assigned its attenuation value to yield a third AC map (CTSEG). The CTSEG method is considered the silver standard because it represents the best possible outcome of using an MR-segmentation-based AC method. Realistic, patient-specific PET simulations were then conducted to evaluate the performance of MRAC and CTSEG in the 10 patients for two cases: 1) normal brain and 2) brain with a focal lesion added. Attenuation was applied at the sinogram stage using the CTSC map and was corrected for using CTSEG and MRAC. The results were reconstructed and a percent-error analysis against the gold standard was performed.

#### RESULTS

The MRAC method resulted in a lower average whole-brain absolute percent-error (WBAE) across patients of 1.84% compared to the 4.57% achieved by the CTSEG method (p

#### CONCLUSION

We have developed a MR T1w-based AC method that outperforms the silver standard. In addition, the presence of a focal lesion does not affect the accuracy of the proposed method.

#### CLINICAL RELEVANCE/APPLICATION

An accurate MR-based AC method allows the MR/PET to become quantitatively reliable and opens the door for simultaneous quantitative-PET and MR applications.

### **SSQ16-09 • Serial Brain SPECT Imaging Using Neurogram Software to Monitor Treatment Response to Stem Cell Therapy in Patients with Cerebral Palsy**

**Parul Mohan** MBBS, MD (Presenter) ; **Geeta Shroff** MBBS, MD ; **Harsh Mahajan** MD, MBBS

#### PURPOSE

Hypoxic brain injury is one of the major causes of cerebral palsy. Stem cell therapy has shown promise in clinical trials and is sought by many parents of children with cerebral palsy (CP). Brain perfusion studies with single photon emission computed tomography (SPECT) have been applied in these patients and have been evaluated either by visual interpretation or using semiquantitative analysis. Several processing protocols for 3D voxel-by-voxel analysis of brain perfusion SPECT have been applied, mainly the three-dimensional stereotactic surface projection (3DSSP) and the statistical parametric mapping (SPM) and recently the NeuroGam software. Although many studies have been published dealing with brain perfusion abnormalities in various neurological disorders, there is negligible literature concerning the interval changes in perfusion in cortical functional areas, pre and post therapy. The present study was to evaluate the treatment response (improvement or deterioration) in perfusion of specific areas of the brain cortex using Tc-HMPAO brain SPECT.

#### METHOD AND MATERIALS

Sixty three patients (49 boys, 14 girls; age range 1 yr to 31 yr) with clinical manifestations of cerebral palsy underwent brain SPECT after intravenous injection of Tc-HMPAO.

#### RESULTS

The results were elaborated as mild improvement when 10%- 30% changes were noted, moderate improvement when 30%-60% changes were noted and significant improvement when 60%-90% changes were noted. Thirty six patients had a normal brain SPECT after treatment. Seventeen patients had minimal residual hypoperfusion after treatment. The rest showed significant improvement after treatment with mild to moderate hypoperfusion. None of the patient in the series showed deterioration or no improvement.

#### CONCLUSION

Brain SPECT is an extremely useful tool in monitoring the treatment response to stem cell therapy in patients of cerebral palsy. It showed changes at the molecular level, hence indicating improvement even before the clinical changes were manifested.

#### CLINICAL RELEVANCE/APPLICATION

Brain SPECT showed changes at the molecular level, hence indicating improvement even before these changes became clinically apparent.

## **Nuclear Medicine - Thursday Posters and Exhibits (12:15pm -12:45pm)**

**Thursday, 12:15 PM - 12:45 PM • S503AB**

NM

[Back to Top](#)

**CL-NMS-THA • AMA PRA Category 1 Credit™:0.5**

Host

**Akash Sharma**, MD

**CL-NMS-TH1A • 18F-FAMT PET/CT for Accurate Tumor Volume Prediction in Oral Squamous Cell Carcinoma: Correlation with Immunohistological Findings and Comparison with 18F-FDG**

**Mu Kim** (Presenter) ; **Tetsuya Higuchi** MD, PhD ; **Yukiko Arisaka** MD ; **Azusa Tokue** MD ; **Shigeyasu Sugawara** ; **Arifudin Achmad** MD ; **Yoshito Tsushima** MD ; **Satoshi Yokoo**

#### PURPOSE

L-3-[18F]-fluoro-?-methyl tyrosine (18F-FAMT) is an amino acid tracer for positron emission tomography/computed tomography (PET/CT) which evidenced additional usefulness to the 2-[fluorine-18]-fluoro-2-deoxy-D-glucose (18F-FDG) PET/CT for diagnosis of malignancies.

In this study, both modalities were tested for their accuracy in tumor volume prediction of oral squamous cell carcinoma using PET-VCAR software. Relationship between the radiotracers uptake, expression of cell proliferative marker and pathological prognostic marker were elucidated using immunohistochemical study.

#### METHOD AND MATERIALS

Fourteen OSCC patients were enrolled in PET/CT studies using 18F-FDG and 18F-FAMT before surgery. The functional tumor volumes (cm<sup>3</sup>) were calculated from volume of interest (VOI) generated by the PET-VCAR using the pre-determined cut-off values. Semi quantitative analyses were performed using a representative maximal standardized uptake value (SUVmax) of both radiotracers. Post-surgical pathological examination results were used as the reference to determine the final diagnoses and the actual tumor size. Immunohistochemical studies were performed to evaluate the clinicopathological variables.

#### RESULTS

18F-FAMT uptake correlates with tumor viability. Tumor volumes derived from 18F-FDG PET were significantly bigger than that derived from 18F-FAMT images, and the actual tumor size (P

#### CONCLUSION

Tumor volumes obtained from 18F-FAMT PET/CT uptakes correlates with cellular proliferative and prognostic markers in OSCC.

#### CLINICAL RELEVANCE/APPLICATION

18F-FAMT PET/CT for accurate tumor volume prediction in oral squamous cell carcinoma

### **CL-NMS-TH2A • Prognostic Utility of FDG PET Metabolic Tumor Volume in HPV Positive, Stage III and IV Oropharyngeal Squamous Cell Carcinoma**

**Krishna Alluri MD (Presenter) ; Abdel K Tahari MD, PhD ; Christine Chung MD ; Harry Quon MD ; Wayne Koch MD ; Richard L Wahl MD \* ; Rathan M Subramaniam MD, PhD \***

#### PURPOSE

To establish the prognostic utility of (18)F-fluorodeoxyglucose (FDG) positron emission tomography/ computed tomography (PET/CT) parameters SUVmax, SUVmean, SUVpeak, metabolic tumor volume (MTV) and total lesion glycolysis (TLG) in human papilloma virus (HPV) positive stage III and IV oropharyngeal squamous cell carcinoma (OPSCC).

#### METHOD AND MATERIALS

We included 70 patients who had a biopsy-proven, HPV positive (in situ hybridization), stage III and IV oropharyngeal SCC and had a baseline PET/CT examination at our institution in the study. Outcome endpoint was event free survival (EFS). An event can be either recurrence or death. Cox proportional hazards univariate and multivariate regression analyses were performed, creating two multivariate models. Imaging and clinical parameters were included in the models. Survival analysis was performed using Kaplan Meir survival curves.

#### RESULTS

In Cox regression proportional hazard univariate analysis, total MTV (MTV-T) (HR, 1.019; P = 0.008), primary tumor MTV (MTV-P) (HR, 1.021; P = 0.024), neck nodal MTV (MTV-N) (HR, 1.03; P = 0.006) and nodal TLG (TLG-N) (HR, 1.005; P = 0.006) showed a statistically significant association with EFS. There was no statistically significant association of EFS with SUVmax, SUVmean, SUVpeak and total TLG. In Cox regression proportional hazard multivariate analysis model I, total MTV remained an independent prognostic marker for EFS when adjusted for every other variable in the model and in model II, the primary tumor MTV remained an independent prognostic marker for EFS when adjusted for other variables, except for neck lymph node status and SUVpeak. The Kaplan Meir survival curves, using median cut point of 23.3ml for total MTV were not statistically different (log rank p = 0.86).

#### CONCLUSION

Total MTV and primary tumor MTV have superior prognostic utility in patients with HPV positive stage stage III and IV oropharyngeal squamous cell carcinoma than other FDG PET parameters.

#### CLINICAL RELEVANCE/APPLICATION

Identification of PET/CT related prognostic factors that predict long-term survival would enable the detection of patients who can undergo therapy de-intensification among HPV positive OPSCC patients.

### **CL-NMS-TH3A • 18F-FDG PET/CT for Detection and Localization of Residual or Recurrent Disease in Patients with Multiple Myeloma after Stem Cell Transplantation**

**Christoph Weber MD (Presenter) ; Christian R Habermann MD ; Susanne Klutmann ; Gerhard B Adam MD ; Thorsten Derlin**

#### PURPOSE

To determine the diagnostic performance of (18)F-fluorodeoxyglucose (FDG) positron emission tomography (PET)/CT for the detection and localization of residual or recurrent disease in patients with multiple myeloma (MM) after stem cell transplantation (SCT).

#### METHOD AND MATERIALS

A total of 197 whole-body (18)F-FDG PET/CT scans were performed in 99 patients with MM at different time points in the course of disease after autologous or allogeneic stem cell transplantation. Post-transplant PET/CT scans and clinical remission status as determined by the clinical gold standard (Uniform Response Criteria) were analysed and compared.

#### RESULTS

A total of 576 focal osseous and extramedullary lesions were detected in 79 scans. Additional diffuse bone marrow involvement was detected in 17 patients. (18)F-FDG PET/CT had a sensitivity of 54.6%, a specificity of 82.1%, a positive predictive value of 82.3%, a negative predictive value of 54.2% and an overall accuracy of 65.5%. The sensitivity of (18)F-FDG PET/CT was shown to depend on the disease category according to the Uniform Response Criteria for myeloma.

#### CONCLUSION

In patients with MM in the post-transplant setting, (18)F-FDG PET/CT may contribute to the detection and localization of disease, provide information about the extent of distinct myeloma manifestations and the total disease burden and add information about the metabolic activity of disease, but has substantially lower sensitivity for this purpose compared to the pretreatment setting.

#### CLINICAL RELEVANCE/APPLICATION

(18)F-FDG PET/CT allows a more comprehensive evaluation of persisting or recurrent myeloma, therefore it might be suitable as method of choice for an imaging based therapy monitoring after SCT.

### **CL-NMS-TH4A • Estimation of Pericardial Fat, Novel Cardiovascular Disease Risk Factor, with Low Dose CT (of PET/CT)**

**Shanker Raja MD (Presenter) ; K. M. Das MD**

#### PURPOSE

A strong association between pericardial fat (PAT) estimated by diagnostic CT (diagCT), and CAD, especially vulnerable plaques, has been documented. Recently PAT has been touted as an independent risk factor for CAD. However, significant variability in PAT estimates have been reported, including ethnicity, technical factors (CT acquisition parameters) etc. Currently low dose CT (lowCT) is routinely obtained as part of SPECT/PET-CT. We sought to explore the feasibility of estimating PAT on lowCT in comparison to PAT estimated on diagCT.

#### METHOD AND MATERIALS

A subset of 16 pts (male =11, female =5; mean age = 27 yrs (range=6-70)) referred to PET-CT, and with history of prior diag CT, were randomly selected for further analysis. All lowCT were acquired on GE STE 960 PET-CT scanner (General Electric, Waukesha, Milwaukee, USA). at 50-80 milliamp, based on vendor specifications. To estimate PAT, axial CT slices were post processed utilizing the volume

analysis toolbox on a AW-4 .6 GE workstation. To exclude extra-visceral thoracic fat, the heart and pericardium were manually contoured and extracted. The extracted datasets were thresholded semiautomatically (-190 to -30 Hounsfield units), to obtain the voxels containing PAT.

#### RESULTS

The PAT estimates were statistically analyzed using Excel and medical (statistical analysis suite). The mean and standard deviation for lowCT=36.47 +/- 26.6, while for diagCT =21.84 +/- 19.5ml. The correlation coefficient 'r' value was 0.9174, p-value =0.0005,95% CI for r = 0.7645 to 0.9726. While Bland Altman differences versus averages plots of PAT estimates of diagCT and lowCT, revealed good agreement between the techniques.

#### CONCLUSION

We have demonstrated the feasibility of estimating PAT on lowCT. To the best of our knowledge this is the first report of estimating PAT on lowCT. Our pilot study demonstrates a tight correlation between the two techniques, and Bland Altman analysis suggests PAT estimated via low dose CT may be clinically acceptable. However, significant differences observed in the estimated means and reasons for the wider standard deviation of PAT estimates by lowCT, needs further exploration.

#### CLINICAL RELEVANCE/APPLICATION

Recent trends in CT technology is leaning towards ever lower radiation exposures and lowCT, our small series has demonstrated that PAT can be estimated by lowCT.

### CL-NMS-TH5A • Myocardial Perfusion Positive Rates Based on Reader Specialty

**Aaron S McAllister** MD (Presenter) ; **Kenneth A Veselicky** DDS, MD

#### PURPOSE

The purpose of this study was to analyze the percentage of abnormal myocardial perfusion studies for each interpreting specialty to see if a measureable difference exists.

#### METHOD AND MATERIALS

Depending on the day of the week, myocardial perfusion SPECT/CT studies at a tertiary referral center were read by either cardiologists or radiologists. From 2008-2010, studies performed on Tuesday and Thursday were read by cardiologists, while the remaining days of the week were read by radiologists. All studies were otherwise similar. They were performed on patients from the same referral base by the same technologists on the same equipment at the same hospital with the same radioisotopes. This natural randomization was utilized in a retrospective review to determine whether a difference exists between the rate of abnormal myocardial perfusion scans read by cardiologists and radiologists.

The impression and reading physician were extracted from the imaging database for all 2744 myocardial perfusion studies performed between 2008 and 2010. Reviewers were blinded to the identity and specialty of the reading physician and assigned each impression to one of three categories, normal (no ischemia), abnormal (demonstrated ischemia), or indeterminate. Incomplete studies such as rest only studies were not included in the analysis. The proportion of abnormal, normal, and indeterminate scans was then tabulated based on interpreting specialty. Subsequent patient treatment was not included in this analysis.

#### RESULTS

A total of 981 studies were interpreted by cardiologists and 1735 were interpreted by radiologists. There were a total of 18 readers, including 2 cardiologists and 3 radiologists who each read more than 400 studies over this time period. Collectively radiologists interpreted 21% positive for ischemia, 78% normal, and 1% indeterminate. The cardiologists interpreted 34% positive for ischemia, 57% normal, and 9% indeterminate.

#### CONCLUSION

There is a significant difference between the rates of positive myocardial perfusion scans depending on the interpreting physician's specialty.

#### CLINICAL RELEVANCE/APPLICATION

This study raises concern for variability in the interpretation of myocardial perfusion scans based on the specialty of the interpreting physician.

### CL-NME-TH6A • Yttrium-90 Radioembolization Therapy: A Systematic Pictorial Review Using SPECT-CT Integrated with Angiographic Images

**Hamilton E Reavey** MD (Presenter) ; **Bhawana Rathore** MD ; **Valeria Moncayo** MD ; **Vina Ravichandran** BA ; **Hyun S Kim** MD ; **David M Schuster** MD

#### PURPOSE/AIM

The purpose of this study is to provide a pictorial review of Yttrium-90 therapy centered on correlative vascular anatomy as validated with SPECT-CT. We demonstrate examples of target and non-target embolization and correlate angiographic images to radiotracer distribution. We demonstrate the value that pre-therapy MAA SPECT-CT and post-therapy Bremsstrahlung SPECT-CT adds to the clinical management of these patients. We include examples of both target and non-target embolization including gastric, duodenal and mesenteric deposition of radionuclide. Our goal is to familiarize radiologists with expected and unexpected pre and post therapy findings and to provide them with the tools to more effectively interpret and perform these exams.

#### CONTENT ORGANIZATION

A. Anatomy: Liver anatomy and vascular anatomy B. Pathophysiology of Y-90 therapy C. Indications/contraindications for Y90 therapy D. Outcomes: MAA and Bremsstrahlung images from selected cases that demonstrate examples of both target and non-target embolization with review of corresponding angiographic images.

#### SUMMARY

After reviewing our exhibit, the reader should know hepatic anatomy and vascular supply including common variants, be familiar with indications for Y-90 therapy and understand the value of obtaining pre and post-therapy planning SPECT-CT to guide clinical management.

## Nuclear Medicine - Thursday Posters and Exhibits (12:45pm - 1:15pm)

Thursday, 12:45 PM - 01:15 PM • S503AB



[Back to Top](#)

CL-NMS-THB • AMA PRA Category 1 Credit™:0.5

### CL-NME-TH6B • SPECT/CT User's Guide for Imaging Complicated Musculoskeletal Infections

**Francisco J Lazaga** MD (Presenter) ; **Anshul Agarwal** MD, PhD ; **Aron J Gould-Simon** MD ; **Orhan K Oz** MD, PhD ; **William A Erdman** MD

#### PURPOSE/AIM

To describe a logical approach to selection of the most effective SPECT/CT imaging techniques and radiopharmaceuticals in complicated musculoskeletal infections.

To illustrate SPECT/CT findings and pitfalls in diagnosing musculoskeletal infections using radionuclides such as Tc-99m, In-111 and Ga-67. To correlate complementary imaging such as MRI and other associated clinical findings in such cases. Illustrate some advantages of SPECT/CT imaging over conventional imaging in musculoskeletal infection assessment and follow up.

#### CONTENT ORGANIZATION

Indications for different SPECT/CT techniques in musculoskeletal infections.

SPECT/CT imaging using Tc-99m labeled leukocytes.

SPECT/CT imaging using In-111 labeled leukocytes.

Dual Isotope SPECT/CT imaging using Tc-99m Sulfur Colloid and In-111 labeled leukocytes, simultaneously.

SPECT/CT imaging using Ga-67.

MRI and Clinical Correlation.

Advantages of SPECT/CT Imaging.

#### SUMMARY

Hybrid SPECT/CT imaging is an effective tool in the evaluation of complicated musculoskeletal infections. Depending on the clinical scenario, selection of the appropriate radioisotope and imaging techniques is often essential for correct diagnosis. We aim to provide a logical approach to the utilization of SPECT/CT imaging, which can be expected to improve the management of patients with complicated musculoskeletal infections.

### CL-NMS-TH1B • Association between Enhancement Patterns on Dynamic Contrast-enhanced CT/MRI and FDG PET-CT Findings in Primary Liver Tumors

**Mitsuaki Tatsumi MD, PhD (Presenter) ; Makoto Sakane MD ; Tonsok Kim MD ; Kayako Isohashi ; Noriyuki Tomiyama MD, PhD ; Jun Hatazawa MD, PhD ; Hiromitsu Onishi MD ; Masatoshi Hori MD ; Eku Shimosegawa**

#### PURPOSE

Primary liver tumors (PLTs) are often evaluated with FDG PET-CT after being detected on CT or MRI. Dynamic contrast-enhanced (DCE) CT/MRI provides information of tumor vascularity relative to surrounding liver tissue. The purpose of this study was to compare enhancement patterns (EPs) on DCE CT/MRI and PET-CT findings in PLTs, especially focusing on the hepatocellular carcinoma (HCC) and cholangiocarcinoma (CC).

#### METHOD AND MATERIALS

This retrospective study included 74 PLTs (one lesion per patient) evaluated with FDG PET-CT (28 HCCs, 40 CCs, and 6 others). DCE CT was performed separately from PET-CT in all pts with or w/o MRI (EOB DCE 54, SPIO non-dynamic 3, and no MRI 17). There were 4 major EPs observed on CT/MRI; type 1: arterial enhancement and washout (typical in hypervascular HCCs), 2: no arterial enhancement and mild washout (typical in hypovascular HCCs), 3: peripheral rim and gradual centripetal enhancement (typical in hypovascular CCs), and 4: other EPs. These EPs were compared to the positivity on PET and to SUVmax in PET-positive tumors, referring to the histological results.

#### RESULTS

CT/MRI exhibited type 1, 2, 3, and 4 EPs respectively in 22, 2, 45, and 5 of all 74 tumors. Only 6 (27%) of the 22 type 1 tumors showed positive PET findings (1 fresh HCC, 4 rec HCCs, and 1 rec CC). All but one (13/14) type 1 fresh HCCs were negative on PET. The 45 type 3 tumors comprised 37 CCs (2 rec), 7 HCCs (1 rec), and 1 FNH. Most (36: 80%) of them were positive on PET, including 31 CCs and 5 HCCs (both fresh). Additional 1 type 2 (HCC) and 2 type 4 (CC and lymphoma) tumors were positive on PET. Overall, 45 (61%) of 74 tumors exhibited positive PET findings (6/22, 1/2, 36/45, and 2/5 respectively in type 1, 2, 3, and 4). Mean SUVmax was 5.7+/-3.1 in type 1 and 7.7+/-4.7 in type 3 tumors. PET-positive HCCs (11/28: 39%) represented either type 3 EP or recurrence/large in type 1 EP, while CCs exhibited positive PET findings in most (33/40: 83%) of the cases without specific characteristics.

#### CONCLUSION

This study demonstrated that most hypervascular HCCs showed negative PET findings. CCs and HCCs with similar enhancement to CCs tended to show intense FDG uptake on PET. This information may help better understanding of the characteristics of HCCs and CCs.

#### CLINICAL RELEVANCE/APPLICATION

Hypervascular HCCs tended to represent negative findings on FDG PET-CT, while CCs and HCCs mimicking CC showed positive findings.

### CL-NMS-TH2B • 18FDG-PET to Assess Recurrence and Long Term Survival in Patients with Malignant Melanoma

**Thomas C Lauenstein MD (Presenter) ; Sandra Rosenbaum MD ; Joachim Klode ; Andreas Bockisch ; James Nagarajah**

#### PURPOSE

To assess the diagnostic and prognostic value of FDG-PET/CT in the follow-up of malignant melanoma in comparison to the serum protein S100B.

#### METHOD AND MATERIALS

Ninety patients with either low-risk or high-risk malignant melanoma were included in this study. The follow-up was pursuant with the guidelines of the German Dermatological Association. The diagnostic accuracy and diagnostic power were determined for FDG-PET/CT and for the serum protein S100B.

#### RESULTS

In 28 of the 90 patients PET/CT was positive in the follow up, 47 patients had an elevated Serum S100B level. Sensitivity, specificity, PPV and NPV of PET/CT were 77%, 93%, 86% and 89%. The corresponding values for the serum protein S100B were 65%, 54%, 43% and 74%, respectively.

PET/CT positive patients showed a significantly (p

#### CONCLUSION

The diagnostic accuracy and the prognostic power of FDG-PET/CT for the depiction of malignant melanoma and its recurrence is higher compared to the serum protein S100B.

#### CLINICAL RELEVANCE/APPLICATION

FDG-PET/CT is suitable to confirm or exclude recurrences and can be used to assess the prognosis in patients with malignant melanoma.

### CL-NMS-TH3B • Impact of Inter-reader Agreement, and Placement of Volume of Interest on Dual-Time Images at FDG PET/CT Liver SULmean

**Abdel K Tahari MD, PhD (Presenter) ; Alin Chirindel MD ; Vasavi Paidpally MD ; Rathan M Subramaniam MD, PhD \***

#### PURPOSE

To evaluate inter-reader agreement and how the site of the volume of interest (VOI) affect the agreement and variability of liver mean standardized uptake value normalized to lean body mass (SULmean) on dual-time FDG PET/CT scans

#### METHOD AND MATERIALS

Two PET/CT studies from each of 130 patients (83 males and 47 females) performed in two different dates and who had normal livers by structural imaging were included in the study. The mean length of time between the scans was 235 ± 192 days. The average uptake time was 65.7 ± 15.9 min for first set of studies and 65.5 ± 13.5 min for second set of studies. SULmean was measured with a 30-mm-diameter spherical VOI placed within the right lobe of the liver (above, below, and at the level of the main portal vein) by two readers independently. Studies within two standard deviations around the mean were retained (110 cases), excluding the outliers. Analysis of

variance, intraclass correlation coefficient (ICC) analysis, and Bland-Altman analysis were performed

#### RESULTS

The mean SULmean was between 1.52 and 1.55 in first set of studies and between 1.53 and 1.56 in second set of studies at the upper, portal, and lower levels of the right lobe of the liver. The ICC of the two readers varied between 0.968 and 0.977 in first images and between 0.983 and 0.986 in second images at each level. The ICC for first and second set of studies varied between 0.487 and 0.535 for reader 1 and between 0.472 and 0.545 for reader 2. There was significant but weak correlation for liver SULmean between first and second scans for each reader and level. Mean percentage bias was  $0.83 \pm 14.62\%$ ,  $2.21 \pm 15.46\%$ , and  $19.1 \pm 14.28\%$  between first and second scans for reader 1 at the upper, portal, and lower levels respectively, and  $2.08 \pm 14.77\%$ ,  $2.09 \pm 16.15\%$ , and  $2.42 \pm 14.75\%$  respectively for reader 2

#### CONCLUSION

Liver SULmean at FDG PET/CT has excellent inter-reader agreement, with similar values and variance whether measured at the upper, lower, or portal vein levels. However, there was weak intra class correlation between liver SULmean as measured between first and second set of studies for each reader and level. The standard deviation for percentage variation of liver SUL averaged 15.00 % between the two-time PET scans

#### CLINICAL RELEVANCE/APPLICATION

Comparison of SUL on followup PET/CT scan should allow for at least 30% normal variation

### CL-NMS-TH4B • 18F-FDG PET/MRI Fused Images: Potential Clinical Applications in Neurology

**Jose Leite MD, MSc (Presenter) ; Emerson L Gasparetto MD ; Carlos A Buchpiguel MD ; Romeu C Domingues MD ; Roberto C Domingues MD ; Tadeu T Kubo MSc ; Lea M Barbosa**

#### PURPOSE

The aim of this study is to illustrate potential clinical applications of brain PET/MRI fused images.

#### METHOD AND MATERIALS

#### RESULTS

#### CONCLUSION

1. The brain PET/MRI fused images can benefit patients with neurological diseases. 2. In neurodegenerative diseases, including parkinsonism, it seem to have a low correlation between metabolism changes on PET and structural changes on MRI. 3. PET/MRI fused images contributed to a more reliable focus diagnosis in epilepsy and can optimize functional capabilities of MRI for differentiating relapse from radionecrosis in brain tumors.

#### CLINICAL RELEVANCE/APPLICATION

Hybrid PET/MR imaging of the brain seems to be not only superior to each modality alone, but synergic.

### CL-NMS-TH5B • Impact of Routine Acquisition of Brain in Whole Body FDG PET-CT Study on Management in Patients with Extra-cranial Malignancies

**Rahul M Nikam MBBS, DMRD (Presenter) ; Abhijith M Singh MBBS ; Abhijit A Raut MD ; Sachin K Gawde MBBS ; Rahul B Gujrathi MD ; Atul Marwah MBBS, MD**

#### PURPOSE

To evaluate the significance of routine acquisition of brain in a whole-body Fluorine 18-Fluorodeoxyglucose (18F-FDG) Positron Emission Tomography/Computed Tomography (PET-CT) study and its impact on management in patients with extra-cranial malignancies.

#### METHOD AND MATERIALS

412 WB PET/CT scans were analyzed retrospectively, done between Jan 2012 to March 2013 in the Nuclear Medicine department of a tertiary care hospital. All these patients had undergone a dedicated brain PET - CT along with the routine whole body PET-CT as per the departmental protocol.

#### RESULTS

A total of 412 patients with extra-cranial malignancies were analyzed. Of these, 204 had presented for baseline evaluation, 86 were for interim treatment response, 63 were for end-treatment evaluation and 59 were for suspected recurrence and restaging. A total of 64 patients (15.5 %), were found to have brain metastases. Of these, 29 were for staging, 18 were for interim response, 11 were for end-treatment response and 6 were for suspected recurrence and restaging. Of the 64 patients a change in management resulted in 28 patients (6.8 %) amongst these 20 patients (4.9 %) had unsuspected brain metastases with no other distant metastatic disease.

#### CONCLUSION

Brain PET-CT was responsible for change in management in 6.8 % of patients and upstaging of disease in 4.9 % of patients. All these patients were clinically asymptomatic for brain metastases at the time of the study, and hence MR brain would not have been done. Thus routine acquisition of brain during WB PET/CT has the potential to provide beneficial information that may significantly alter treatment protocols while adding minimally to the overall radiation burden and operational costs.

#### CLINICAL RELEVANCE/APPLICATION

A dedicated brain study as part of routine WB PET-CT has the potential to provide beneficial information that may significantly alter treatment protocols while adding minimally to the radiation dose.

## Hot Topic Session: Amyloid Imaging

Thursday, 03:00 PM - 04:00 PM • S404AB

**NM** **MR** **NR**

[Back to Top](#)

**SPSH54 • AMA PRA Category 1 Credit**™:1 • ARRT Category A+ Credit:1

#### Moderator

**Kejal Kantarci**, MD, MS \*

#### Moderator

**Satoshi Minoshima**, MD, PhD \*

#### LEARNING OBJECTIVES

- 1) Describe the role of amyloid and FDG PET imaging for tracking the progression of Alzheimer's disease from preclinical stage to dementia.
- 2) Properly choose amyloid imaging, MRI and FDG PET for the differential diagnosis of dementia.
- 3) Learn the appropriate use criteria for amyloid PET.

### SPSH54A • Amyloid PET and FDG PET across the AD Spectrum: Redundant or Complementary?

**Alexander Drzezga MD (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### SPSH54B • Multimodality Imaging and the Role of Amyloid PET in Differential Diagnosis of Dementia

**Kejal Kantarci MD, MS (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### SPSH54C • Appropriate Use Criteria of Amyloid PET

**Satoshi Minoshima MD, PhD (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

#### ABSTRACT

This session will review the Appropriate Use Criteria for Amyloid PET Imaging published in 2013 by the Amyloid Imaging Task Force jointly supported by the Society of Nuclear Medicine and Molecular Imaging (SNMMI) and Alzheimer's Association (AA) and discuss various clinical scenarios in which amyloid PET imaging is appropriate and not appropriate in dementia workup.

URL

## Head and Neck Cancer PET Interpretation with Case Examples (An Interactive Session)

**Thursday, 04:30 PM - 06:00 PM • S505AB**

**NM CT NR HN**

[Back to Top](#)

**RC711 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

#### LEARNING OBJECTIVES

1) Recognize the strengths of FDG PET/CT and dedicated CT imaging in head and neck cancer. 2) Recognize the false positives and false negatives associated with FDG PET/CT and CT imaging. 3) Understand the importance of combining PET and dedicated CT imaging findings for a thorough interpretation.

#### ABSTRACT

Accurate staging and timely detection of recurrence are of prime importance for for improving outcome in head and neck cancer patients. FDG PET/CT imaging helps in staging and detecting persistent or recurrent disease, estimate its extent and monitor tumor response and occasionally detect synchronous second primary tumors. After radical surgery or radiation therapy for HNC, conventional imaging modalities can be highly inaccurate in differentiating tumor from non-neoplastic post-treatment changes as normal tissue planes are altered substantially. FDG-PET has higher sensitivity and specificity for detecting metastatic lesions in HNC than other conventional imaging modalities including CT. Although in some instances PET can be false negative without the existence of a morphologic imaging component. Combined PET/CT scanners overcome some of these limitations by fusing the morphologic data obtained by CT with the functional data of PET. In this session case examples will be presented to highlight the superior sensitivity and specificity of FDG PET/CT imaging. In addition, case examples of dedicated CT will be presented in those cases when FDG PET imaging can be misleading with false positive or negative results.

### RC711A • Correlative CT and PET Imaging: Superiority of CT

**Peter M Som MD (Presenter)**

#### LEARNING OBJECTIVES

1) The attendee will learn from case examples how the morphologic information of CT and MR imaging are a critical part of a of PET study. 2) The attendee will learn by case examples the imaging findings on CT and MR that should make one question the pathologic significance of PET avidity.

#### ABSTRACT

Although PET avidity can identify head and neck cancers that may be poorly seen on morphologic imaging, there are times when the PET findings may be misleading. These include PET avidity in non-cancerous lesions, apparant PET avidity related to artifact, and the absence of PET avidity due to limited biomass in necrotic lesions. Case examples will be presented to illustrate these pointns.

### RC711B • Correlative CT and PET Imaging: Superiority of PET

**Lale Kostakoglu MD,MPH (Presenter)**

#### LEARNING OBJECTIVES

1) Recognize the strengths of FDG PET/CT imaging over CT imaging in head and neck cancer. 2) Recognize the false positives and false negatives associated with FDG PET/CT imaging. 3) Understand the importance of combining PET and CT imaging findings for a thorough interpretation.

### RC711C • Correlative PET and MRI Imaging: Superiority of MRI

**John A Arrington MD (Presenter)**

#### LEARNING OBJECTIVES

1) Understand and recognize the advantages and strengths of MRI as well as the complementary roles of MRI, CT, and FDG PET/CT in the diagnosis and treatment of head and neck cancer. 2) Attendee will learn through case studies the areas of superiority of MRI as well as evaluating and correlating MRI examinations with false positive and false negative PET examinations.

#### ABSTRACT

MRI, CT, and FDG PET/CT have strengths and weaknesses in the detection and staging head and neck carcinoma. While PET/CT is highly sensitive in the detection of primary head and neck carcinoma and metastatic nodal disease, there are limitations including avidity in muscle activation and inflammatory lesions as well as the detection of perineural tumor spread and metastatic necrotic nodal disease. MRI case studies will be presented highlighting the areas of superiority of MRI over FDG PET/CT.

## Advances and Updates in SPECT/CT

**Friday, 08:30 AM - 10:00 AM • S504CD**

**NM CT**

[Back to Top](#)

**RC811 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**



## RC811A • SPECT/CT in Musculoskeletal Diseases

**Christopher J Palestro** MD (Presenter)

### LEARNING OBJECTIVES

1) Describe the role of SPECT/CT in the workup of patients with malignancy. 2) Describe the role of SPECT/CT in musculoskeletal infection. 3) Use SPECT/CT to improve the accuracy of radionuclide studies for diagnosing musculoskeletal diseases.

### ABSTRACT

## RC811B • SPECT/CT in Endocrine Disorders and Others

**Don C Yoo** MD (Presenter)

### LEARNING OBJECTIVES

1) Discuss the advantages of SPECT/CT for the evaluation of endocrine disorders. 2) Discuss the limitations of SPECT/CT for the evaluation of endocrine disorders. 3) Discuss the impact of SPECT/CT on management in patients with endocrine disorders.

## Minicourse: Recording and Reporting Radiation Dose: Nuclear Medicine

**Friday, 08:30 AM - 10:00 AM • S403B**

**QA PH NM**

[Back to Top](#)

**RC823 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

### Director

**J. Anthony Seibert**, PhD

## RC823A • Nuclear Medicine Dose Indices

**Wesley E Bolch** PhD (Presenter)

### LEARNING OBJECTIVES

1) Identify the more common radiopharmaceuticals used in functional imaging of normal and diseased tissues. 2) Demonstrate understanding of the parameters needed to estimate tissue dose during nuclear medicine imaging and therapy. 3) Identify fundamental data sources for organ and effective dose per unit administered activity. 4) Demonstrate understanding of the physiological and anatomic sources of individual variability in organ and effective dose per unit administered activity. 5) Identify key features of new generation anatomical models that can reduce dose uncertainties through improved matching of patient body morphometry.

### ABSTRACT

A main clinical application of nuclear medicine is that of functional imaging of normal and diseased tissue, and the localization of malignant tissue and its potential metastatic spread. In these applications, the amount of administered activity is such that the absorbed dose to both imaged and non-imaged tissues are typically very low and thus stochastic risks of cancer induction are greatly outweighed by the diagnostic benefit of the imaging procedure. Nevertheless, these tissues doses and their stochastic risks should be quantified for each patient, and placed in context of both their cumulative values received over multiple imaging sessions, and of doses and risks received by other diagnostic imaging procedures they may have (fluoroscopy and computed tomography, for example). The role of internal dosimetry in diagnostic nuclear medicine is thus to provide the basis for stochastic risk quantification. Once this risk is quantified, it may be used to optimize the amount of administered activity in order to maximize image quality while minimizing patient risk. This optimization process is of particular importance for pediatric patients owing to their enhanced organ radiosensitivities and years over which any stochastic effects may become manifest. This optimization should consider, as much as possible, patient age, gender, and body morphometry, and pharmacokinetics, along with all available image acquisition and processing techniques. Unlike other forms of diagnostic imaging, for which dose indices are readily measured, only the administered radioactivity is typically available for dose tracking. In this course, we will review data sources for organ and effective dose per unit administered activity for the more common molecular imaging radiopharmaceuticals. Particular attention will be given to sources of individual variability in both organ and effective dose attributed to both physiological and anatomical variations among patients. Advances in computat

## RC823B • Tracking Doses in the Pediatric Population

**Frederic H Fahey** DSc (Presenter)

### LEARNING OBJECTIVES

1) List three considerations in estimating the radiation dose from pediatric nuclear medicine. 2) Discuss three factors that affect the radiation dose from the CT component of hybrid imaging. 3) Describe three factors that can affect the appropriate choice of administered activity for a nuclear medicine study. 4) List 2 advances that may lead to further reduction in the administered activity in pediatric nuclear medicine.

## ISP: Nuclear Medicine (Cardiovascular Imaging)

**Friday, 10:30 AM - 12:00 PM • S505AB**

**NM CT VA**

[Back to Top](#)

**SST12 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

### Moderator

**Akash Sharma**, MD

### Moderator

**Pamela K Woodard**, MD \*

## SST12-01 • Nuclear Medicine Keynote Speaker: New Horizons in Cardiovascular Imaging with PET/MRI

**Pamela K Woodard** MD (Presenter) \*

## SST12-03 • FDG-PET/CT: Do Contrast Enhanced CT for Attenuation Correction and Ultra-HD-PET Influence the SUV-values in Large Vessel Walls?

**Ingo Janssen** (Presenter) ; **Inga Buchmann** ; **Florian M Vogt** MD

### PURPOSE

To optimize large-vessel-imaging in FDG-PET/CT we evaluated, if contrast enhanced CT (ceCT) for attenuation correction (AC) in FDG-PET-CT and ultraHD-(high-definition-PET+ time of flight) (uHD) compared with iterative reconstruction (IR) may lead to differences in large-vessel-SUV.

### METHOD AND MATERIALS

50 patients (pat), who underwent FDG-PET/CT in malignant-disease-staging, were included in this retrospective study. All pat were

large-vessel-vasculitis. 25 pat underwent FDG-PET-CT with ceCT for AC (group A; 100 ml Xenetix 300 i.v., delay 50 sec) and 25 pat FDG-PET-CT with non-contrast (nc) CT for AC (group B).  $242 \pm 15$  MBq FDG were applied i.v. PET-CT-scans with acquisition of uHD and IR data started  $82 \pm 19$  min p.i. (Biograph mCT, Siemens). SUVmax-values in identical localizations in the wall of ascending aorta, aortic arch and descending aorta were evaluated by VOI-analysis in all patients. Further a SUVmax/mediastinal-bloodpool (MB)-ratio and SUVmax/liver-bloodpool(LB)-ratio were calculated. MB was determined by drawing a VOI directly inside of the ascending aorta, LB by drawing a VOI in visually physiological liver-tissue. Mean SUVmax, mean MB-ratio and mean LB-ratio of both groups were compared in uHD and IR. Significance level was defined as  $p = 0.05$ .

#### RESULTS

Mean SUVmax-values in group A were significantly higher than in group B (uHD:  $p$

#### CONCLUSION

CeCT for AC in FDG-PET/CT shows significant higher SUVmax-values in aortic wall and uHD demonstrates significant higher aortic-wall to background-contrasts. These results may significant influence the interpretation of large-vessel-vasculitis imaging in FDG-PET/CT.

#### CLINICAL RELEVANCE/APPLICATION

Further studies have to be performed, to evaluate the influence of ceCT for AC and uHD-PET on vasculitis-imaging in FDG-PET/CT.

### SST12-04 • 11C-Choline PET/CT Evaluation of Atherosclerotic Disease

**Ann Packard MD (Presenter) ; Geoffrey B Johnson MD, PhD ; Christopher H Hunt MD ; Mark A Nathan MD ; Patrick J Peller MD \***

#### PURPOSE

Choline is known to be a prominent constituent of atherosclerotic plaque. This study measures the 11C-Choline accumulation in the abdominal aorta compared to vessel wall calcification and conventional risk factors of atherosclerotic disease.

#### METHOD AND MATERIALS

The 11C-choline PET/CT database was searched retrospectively from 1999-2012 for patients with data related to atherosclerotic risk factors, including medications, laboratory data, and medical history with an accrual target of 100 patients. PET/CT scans were evaluated blinded to clinical information by a Nuclear Medicine physician with 25 years of PET/CT experience, for radiotracer activity and calcium quantification. The aorta was analyzed from the renal arteries to the bifurcation. Max SUV was obtained from an ROI placed around the aorta on axial imaging at the level of peak activity. Max SUV ratios of aorta to blood pool were calculated. Clinical atherosclerotic risk factors were correlated to 11C-choline max SUV/BP ratio. Basic statistical analysis included Students-T test and ANOVA.

#### RESULTS

All 11C-Choline PET/CTs were performed for prostate cancer recurrence. Of a cohort of 900 11C-choline PET/CTs, 104 patients with adequate clinical data were targeted, and of these, 94 had complete imaging, and had a mean age of 69.6 (SD 8.33 yrs, range 45-86) at the time of scan; 50 had prior or active smoking history, 38 were on statin therapy for hyperlipidemia, and 14 had prior cardiovascular events including MI or stroke. Patients with a prior cardiovascular event had a higher max SUV ratio ( $2.99 \pm 0.599$ ,  $p$

#### CONCLUSION

Patients with prior cardiovascular events and those on statin therapy had higher choline uptake within the abdominal aorta. No relationship was found between choline and calcium, or a difference in calcium score between groups stratified for cardiovascular risks.

#### CLINICAL RELEVANCE/APPLICATION

11C-Choline PET/CT may be useful in evaluating and identifying active atherosclerotic vascular disease in patients receiving PET/CTs for other reasons.

### SST12-05 • Quantification of Myocardial Blood Flow and Coronary Flow Reserve with an Innovative Tc-99m Sestamibi Dynamic SPECT/CT Method: Validation with Coronary Angiography in a Pilot Study

**Chung-Chieh Huang (Presenter) ; Fu-Chung Chen ; Po-Nien Hou ; Guang-Uei Hung ; Ran Klein \* ; Robert Dekemp PhD \* ; Wan-Chen Chen ; Bailing Hsu**

#### PURPOSE

Myocardial blood flow (MBF)/coronary flow reserve (CFR) quantification with positron emission tomography has demonstrated the incremental value in diagnosis and risk stratification of coronary artery disease (CAD) over perfusion alone images, but its widespread utilization is limited in areas without appropriate flow tracers. This study investigates the diagnostic value of a dynamic SPECT/CT (dSPECT) method as a potential utility for flow quantification.

#### METHOD AND MATERIALS

Fifteen patients who underwent clinically indicated dipyridamole-stress/rest Tc99m-sestamibi myocardial perfusion SPECT were enrolled to evaluate both perfusion and dSPECT MBF/CFR. Coronary angiography for all patients confirmed 9 CAD with  $\geq 50\%$  stenosis (5 one-vessel, 1 two-v, 3 three-v). In addition, 5 low-likelihood (LL) patients with normal perfusion were included to obtain the range of LL MBF/CFR. dSPECT images were quantitatively reconstructed and analyzed for MBF/CFR with 1-tissue/2-kinetic compartmental flow model, tracer extraction correction and rest heart rate/pressure product correction using FlowQuant program. Traditional perfusion images were interpreted visually with a 17-segment model to create summed stress scores (SSS). Receiver-operating characteristic (ROC) analysis was used to evaluate the diagnostic performance of stress MBF (SMBF), CFR and SSS in detecting CAD.

#### RESULTS

Global SMBF and CFR of CAD group ( $1.31 \pm 1.03$  ml/min/g and  $1.61 \pm 0.94$ ) were significantly lower than those of non-CAD ( $2.42 \pm 0.51$  ml/min/g,  $p=0.016$  and  $3.06 \pm 0.66$ ,  $p=0.0038$ ) and LL groups ( $2.81 \pm 0.38$  ml/min/g,  $p=0.0023$  and  $2.78 \pm 0.67$ ,  $p=0.02$ ). No significant difference was noted between non-CAD and LL groups for global SMBF and CRF ( $p=0.18$  and  $0.51$ ). For vessel-based CAD (prevalence: 16 of 45 vessels, 36%) detection, area under the ROC curve (AUC) for territorial SSS ( $0.548 \pm 0.091$ ) was significantly smaller than that of SMBF ( $0.812 \pm 0.063$ ,  $p=0.009$ ) or CFR ( $0.815 \pm 0.063$ ,  $p=0.011$ ).

#### CONCLUSION

Our preliminary results suggest that dSPECT is a simple and effective method for the quantitation of MBF and CFR that can enhance the accuracy for CAD diagnosis without adding extra radiation burden to patients.

#### CLINICAL RELEVANCE/APPLICATION

Traditional MPI likely underestimate the extent and severity of perfusion abnormality in multi-vessel CAD, dSPECT MBF/CFR quantitation is clinically feasible and can enhance the diagnostic performance

### SST12-06 • A Comparative Analysis of Myocardial Perfusion on Gated SPECT vs Coronary Atherosclerosis and Coronary Calcium Score on 64-slice CT

**Parul Mohan MBBS, MD (Presenter) ; Harsh Mahajan MD, MBBS ; Upendra Kaul MBBS, MD**

#### PURPOSE

. Currently both gated SPECT and multislice CT are available for functional imaging i.e. assessing the haemodynamic consequences of CAD and anatomical imaging i.e. visualizing the coronary artery tree respectively. The aim of the current study was to compare the results of 64-slice CT and gated SPECT on a regional basis (per vessel distribution territory) in patients with known or suspected CAD.

#### METHOD AND MATERIALS

One hundred and fifty patients underwent both gated SPECT for myocardial perfusion imaging and 64-slice CT for coronary calcium scoring and coronary angiography. The coronary calcium score was determined for each coronary artery. Coronary arteries on multislice CT angiography were classified as having no CAD, insignificant stenosis ( $\leq 0\%$  luminal narrowing). Gated SPECT findings were classified as

normal or abnormal (reversible or fixed defects) and were allocated to the territory of one of the various coronary arteries.

#### RESULTS

In coronary arteries with a calcium score of 10 or less, the corresponding myocardial perfusion was normal in 94 %. In coronary arteries with extensive calcifications (score > 400), the percentage of vascular territories with normal myocardial perfusion was lower, 52%. Similarly, in most of the normal coronary arteries on 64-slice CT angiography, the corresponding myocardial perfusion was normal on SPECT in >94%. In contrast, the percentage of normal SPECT findings was significantly lower in coronary arteries with obstructive lesions

#### CONCLUSION

Although a relationship exists between the severity of CAD on multislice CT and myocardial perfusion abnormalities on SPECT, analysis on a regional basis showed only moderate agreement between observed atherosclerosis and abnormal perfusion. Accordingly, 64-slice CT and gated SPECT provide complementary rather than competitive information, and further studies should address how these two modalities can be integrated to optimize patient management.

#### CLINICAL RELEVANCE/APPLICATION

The comprehension of the data derived by the use of coronary angiography and cardiac radionuclide imaging is of paramount importance

### **SST12-07 • Inter-platform Reproducibility for Quantitative Assessment of Arterial [18F] Fluorodesoxyglucose (FDG) Uptake in Large Peripheral Vessels: A PET/CT Study**

**Birgit Langhans** (Presenter) ; **Axel Rominger** ; **Markus Hacker** ; **Peter Bartenstein** ; **Maximilian F Reiser MD** ; **Tobias Saam MD \***

#### PURPOSE

FDG-PET/CT is able to quantify arterial wall inflammation and is increasingly used in clinical trials to assess effects of new anti-atherosclerotic therapies. The objective of this study was to analyse inter-platform reproducibility of FDG uptake.

#### METHOD AND MATERIALS

20 cancer patients were examined by whole-body FDG-PET/CT on two different platforms (platform 1: GE Discovery 690; platform 2: Siemens Biograph 64) with a median time between the first and second scan of 3.6 [2.8, 5.0] months. The maximum standardized uptake value (SUVmax), the mean venous blood-pool (SUVbp) and the target-to-background ratio (TBR=SUVmax/SUVbp) were determined in the aortic arch, ascending, descending, and abdominal aorta and both iliac and carotid arteries.

#### RESULTS

Mean SUVmax, averaged across all arterial territories were significantly higher on platform 1 compared to platform 2, with a mean difference of  $0.25 \pm 0.31$  (SUVmax1: 2.86 vs. SUVmax2: 2.61;  $p=0.002$ ). However, mean TBR values did not differ significantly between the platforms (TBR1 2.25 vs. TBR2 2.10;  $p=0.2$ ). When the vascular territories were assessed separately, SUVmax was significantly higher on platform 1 in the aortic arch, ascending, descending and abdominal aorta. No significant differences in SUV values were found in iliac and carotid arteries. TBR values for the different vascular territories did not differ significantly, except for the aortic arch.

#### CONCLUSION

SUVmax measurements differ significantly across different platforms, but not the TBR values. For serial assessment of vessel wall inflammation we therefore recommend to use the identical platform or alternatively to use TBR measurements instead of SUV measurements.

#### CLINICAL RELEVANCE/APPLICATION

Hybrid imaging by PET/CT is a promising technology for the localization of vulnerable plaques based on the uptake of various molecular imaging agents indicative of inflammatory processes.

### **SST12-08 • Optimizing 18F-FDG-PET Imaging of Vessel Wall Inflammation - The Impact of 18F-FDG Circulation Time, Dose, Uptake Parameters, and Fasting Blood Glucose Levels**

**Jan Bucerius** (Presenter) ; **Venkatesh Mani PhD** ; **Colin Moncrieff** ; **Josef Machac MD \*** ; **Valentin Fuster MD** ; **Michael E Farkouh** ; **Ahmed Tawakol MD \*** ; **James Rudd MD, PhD** ; **Zahi A Fayad PhD \***

#### PURPOSE

<sup>18</sup>F-fluorodeoxyglucose (FDG) positron emission tomography (PET) is increasingly used for imaging of vessel wall inflammation. However, limited data is available regarding the impact of methodological variables, i. e. patient's pre-scan fasting glucose, the FDG circulation time, the injected FDG dose, and of different FDG uptake parameters, in vascular FDG-PET imaging.

#### METHOD AND MATERIALS

195 patients underwent vascular FDG-PET/CT of the aorta and the carotids. Arterial standard uptake values ( $\text{meanSUV}_{\text{max}}$ ) as well as target-to-background-ratios ( $\text{meanTBR}_{\text{max}}$ ) and the FDG blood pool activity in the superior vein cava (SVC) and the jugular veins (JV) were quantified. Vascular FDG uptake classified according to tertiles of patient's pre-scan fasting glucose levels, the FDG circulation time, and the injected FDG dose was compared using ANOVA. Multivariate regression analyses were performed to identify the potential impact of all variables described on the arterial and blood pool FDG uptake.

#### RESULTS

Tertile analyses revealed FDG circulation times of about 2.5 h and pre-scan glucose levels of less than 7.0 mmol/l showing favorable relations between the arterial and blood pool FDG uptake. FDG circulation times showed negative associations with the aortic  $\text{meanSUV}_{\text{max}}$  values as well as SVC- and JV FDG blood pool activity but a positive correlation with the aortic- and carotid  $\text{meanTBR}_{\text{max}}$  values. Pre-scan glucose was negatively associated with aortic- and carotid  $\text{meanTBR}_{\text{max}}$  and carotid  $\text{meanSUV}_{\text{max}}$  values, but correlated positively with the SVC blood pool uptake. Injected FDG dose failed to show any significant association with the vascular FDG uptake.

#### CONCLUSION

FDG circulation times and pre-scan blood glucose levels significantly impact FDG uptake within the aortic and carotid wall and may bias the results of image interpretation in patients undergoing vascular FDG-PET/CT. FDG dose injected was less critical. Therefore, circulation times of about 2.5 h and pre-scan glucose levels less than 7.0 mmol/l should be preferred in this setting.

#### CLINICAL RELEVANCE/APPLICATION

Standardization of vascular FDG-PET/CT imaging methodology and protocols to non-invasively assess vascular inflammation.

### **SST12-09 • FDG PET CT To Evaluate Response of Cardiac And Extracardiac Sarcoidosis to Immunosuppressive Therapy**

**Kavitha Yaddanapudi DMRD, MBBS** (Presenter) ; **Donald R Neumann MD, PhD** ; **Culver Daniel** ; **Richard Brunken MD \***

#### PURPOSE

To evaluate the response to immunosuppressive therapy in patients with active cardiac and extra cardiac Sarcoidosis on serial FDG PET CT scans. To assess differences in response of cardiac and extra cardiac disease to immunosuppressive therapy.

#### METHOD AND MATERIALS

Retrospective evaluation of eighteen patients with biopsy proven Sarcoidosis who underwent serial FDG PET scans (twenty nine data sets) to assess disease activity in response to therapy. The interval between serial scans ranged between three and twelve months. Patients received immunosuppressive therapy including prednisone, methotrexate or both. The response of cardiac disease was categorized as progressive if there was increase in inflammation or scar, stable if no change was noted and response if decrease in disease activity was noted. The extracardiac disease was graded as response, resolution, stable and progressive disease.

## RESULTS

The extracardiac disease showed resolution or partial response in 11 patients, progression in 3 patients, stable disease in 2 patients and negative scan in 2 patients. Cardiac disease showed response in 7 patients, progression in 5 patients and stable disease in 6 patients. In 7 patients extracardiac disease showed treatment response or resolution, whereas cardiac disease progressed or remained stable. In 3 patients who had progression of extracardiac disease, cardiac disease also progressed or remained stable. In all patients response to therapy of both cardiac and extracardiac disease correlated well with a self-perceived response to therapy.

## CONCLUSION

Serial FDGPET CT scans are a good objective indicator of response to therapy and correlate well with clinical well-being in patients who respond to therapy. Cardiac disease is more resistant to treatment compared to extracardiac disease.

## CLINICAL RELEVANCE/APPLICATION

Response to therapy is a very important guiding factor in optimizing dosage of toxic immunosuppressive agents in patients with Sarcoidosis and FDG PET CT is probably the most reliable tool available.

## Disclosure Index

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**S**

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