1 Quantitative evaluation of beta-amyloid brain PET imaging in dementia
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Purpose: To compare two commercially available image analysis tools, Hermes BRASS and Siemens syngo. PET Amyloid plaque with clinical assessment in 18F-florbetapir PET scans of patients with Dementia.

Method: PET/CT scans of 225 patients injected with 370MBq 18F-florbetapir were reported by three experienced clinicians and quantified using two software packages. To aid reporting, scans were classified into Type A (typical features) or non-Type A (atypical features) for both positive and negative scans. Both software packages produce regional amyloid uptake ratio relative to cerebellum (SUVr). For BRASS, scans with z-score (deviations from cortical ROI SUVr) ≥ 2, in at least 2 defined regions was classed positive. For syngo, PET a positive scan was indicated when average SUVr > 1.17. The software’s ability to correctly identify positive/negative subtypes was assessed.

Results: 76% of scans were Type A, the rest (24%) non-Type A. For Type A cases, in only 6.0% of cases did BRASS and Syngo disagree with the clinical report. BRASS and Syngo agreed with the clinical report in 67% and 70% of the non-Type A cases respectively. The greatest regional disagreement between software packages occurred in the parietal lobe (109 (48.4%) scans). TPR was consistent (>98%) for both types. FPR significantly increased with non-Type A scans suggesting increased SUV in atypical scans may not necessarily indicate presence of amyloid plaques.

Conclusion: Software packages may assist with clinical reporting of more difficult to interpret cases that require a more experienced read. In the majority of scans with typical features, the quantification toolkits agree with an experienced clinical report.

2 Quantitative optimisation of brain perfusion SPECT
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Aims: The technique described by Barnden [1] was performed to determine the optimum settings for brain perfusion SPECT reconstruction.

Methods: The Hoffman brain phantom was filled with 100MBq [99mTc]exametazime and scanned with a photopeak (126–154 keV), scatter-window(111–125 keV), 120 projections with 10, 15, 20 & 30 s projection-times on a GE Discovery 670 gamma camera with LEHR collimators. A CT scan was segmented to produce a ‘control’ image C; an exact scintigraphic replica of the phantom with voxels in the ratio 0:1:4 for background:white-matter:grey-matter compartments respectively. SPECT reconstructions S were registered and normalised to the control-image C. SPECT reconstruction parameters will be optimised by minimising S-C.

Results/Discussion: By incrementing each parameter individually local minima were observed. However, when individual parameters were combined they produced a sub-standard image. This is because reconstruction techniques are inter-related, e.g. scatter- and attenuation correction have broadly opposing effects. Further investigations and clinical feedback from an experienced reader led to agreement on the best settings:

Photopeak reconstruction: OSEM with 10 iterations; post-filtered with a butterworth, cut-off = 0.6 cm⁻¹, order = 10; Chang attenuation correction, λ = 0.12 cm⁻¹.

Increasing total projection counts in range 4 million to 12 million made little difference to S-C.

Conclusion: Comparison to a CT-derived phantom image optimised individual reconstruction parameters, however combined effects of inter-related parameters must be considered. Clinical feedback is critical to ensure acceptable image quality.

3 An automated method for comparing prospective and retrospective dose distributions in 90Y-Microsphere selective internal radiotherapy (SIRT) treatments

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Study purpose: To evaluate predictive dosimetry in 99mTc-macroaggregated albumin (99mTc-MAA) SPECT and post-therapy 90Y-microsphere PET activity distributions using a novel method of comparing volumetric image data.

Methods: A retrospective analysis of 25 SIRT treatments was performed, including both glass (n = 18) and resin (n = 7) microsphere administrations and a range of diseases. Pre and post-therapy image volumes were registered using an iterative, mutual-information algorithm to align the CT localisation data. 3D dose distributions were estimated by assuming local energy deposition and normalising the SPECT data to match the total activity within the corresponding PET volumes. The aligned 99mTc-MAA SPECT and 90Y-microsphere PET volumes were cropped and re-sampled using large, 125 ml cubic voxels. Finally, the doses within each co-located pair of large voxels across the study group were compared using Bland-Altman analysis.

Results: The spread of dose differences was found to increase with increasing mean dose. 95% limits of agreement were fitted to the data by carrying out a linear regression on the absolute values of dose difference. Limits of agreement for all patients were $-0.38 + 0.07D \pm (3.8 \pm 0.75D)\text{ Gy}$ for glass-microsphere treatments and $-0.75-0.14D \pm (1.67+1.00D)\text{ Gy}$ for resin-microsphere treatments, where D is the mean dose in Gy. The level of agreement was found to differ, depending upon the disease type being treated and the treatment pharmaceutical used.

Conclusion: A method for comparing dose distributions without relying on manual segmentation methods is presented. Poor agreement was found between the pre-therapy 99mTc-MAA SPECT and post-therapy 90Y-microsphere PET data included in this study.

4 Optimising 90Y PET/CT for quantitative imaging

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Objectives: The aim of this work was to optimise PET/CT quantitative imaging in post 90Y Selective Internal Radiation Therapy (SIRT). The length of time per bed was investigated as well as the weighting of the penalisation factor (beta) when using Q.Clear (GE Healthcare) reconstruction.

Methods: A NEMA IQ phantom with an 8:1 sphere-to-background ratio was scanned overnight on a GE Discovery 710 PET/CT scanner. Datasets were rebinned into varying lengths of time (5-60 min); the 15 min rebins were reconstructed using a variety of beta values (1 to 8000) in order to determine the optimum value to use for quantification. Reconstructions were then carried out on the rest of the timing datasets using the optimised beta value; values of contrast recovery (CR), background variability (BV) and recovered activity percentage (RAP) were calculated.

Results: A beta value of 1000 produced the highest CR and RAP (76% & 73%, 37 mm sphere) without overly accentuating the noise in the image. There was no statistically significant increase ($P<0.05$) in either the CR or RAP for scan times of $>15\text{ min}$ For both the 10 min and 5 min acquisitions there was a significant decrease in RAP (28 mm sphere, $P<0.01$) when compared to the 15 min acquisition.

Conclusion: Our results indicate that an acquisition length of 15 min and beta value of 1000 (when using Q.Clear reconstruction) is optimum for quantitative 90Y PET imaging. Increasing the acquisition time to $>15\text{ min}$ reduces the image noise but has no significant impact on image quantification.

5 A quantitative comparison of PET/CT and SPECT/CT for post 90Y SIRT imaging

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Objectives: The aim of this work was to compare PET/CT and SPECT/CT for quantitative imaging of 90Y (post-SIRT therapy) for the purposes of carrying out individualised patient dosimetry.

Methods: A NEMA IQ phantom with an 8:1 sphere-to-background ratio was imaged on the GE Discovery 710 PET/CT scanner and the GE D670 SPECT/CT scanner. An anthropomorphic liver phantom (AbdoMan™) with a 4:1 ratio was imaged on the same scanners. SPECT/CT datasets were reconstructed using an optimised OSEM algorithm (5 iterations, 15 subsets, Monte Carlo collimator modelling) using Hermes Hybrid Recon (Hermes Medical Solutions AB). PET/CT datasets were...
reconstructed using an optimised BPL algorithm (Beta 1000) using Q.Clear (GE Healthcare). Contrast recovery (CR), background variability (BV) and recovered activity percentage (RAP) were calculated.

Ten patients who had had both SPECT/CT and PET/CT post-SIRT were retrospectively reconstructed using these optimised algorithms. Voxel-based dosimetry was carried out using Hermes Internal Radionuclide Dosimetry (HIRD) to compare differences in liver doses for both modalities.

**Results:** CR values for the 28 & 37 mm spheres in the NEMA phantom were 20% higher ($P < 0.01$) for PET/CT compared to SPECT/CT and 29% higher ($P < 0.01$) for the 22 mm sphere. There was also a significant increase in RAP of 6% for the 37 mm sphere for PET/CT ($P < 0.05$). For the 40 mm & 30 mm spheres in the AbdoMan Phantom, there was a significant increase in CR for PET/CT (10%, $P < 0.05$).

**Conclusions:** Results to date indicate that optimised PET/CT appears to be superior to SPECT/CT for the purposes of quantitative imaging of $^{90}$Y.

### 6 Spatial dependence of activity concentration recovery using xSpect with Siemens reconstruction presets

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 Siemens xSPECT reconstruction is available with manufacturer-defined reconstruction presets to assist with optimisation. This phantom study evaluates the impact of these presets on the spatial dependence of activity concentration recovery (ACR).

SPECT/CT scans of a 10:1 NEMA phantom were performed on a Siemens Intevo 6 (LEHR; 256 matrix; 120 views; 150 kcounts per projection; auto-contoured orbit). Three sphere position configurations, achieved by rotating the sphere mount, were used and three replicates of each configuration were acquired. xSPECT reconstruction was performed using xRecon with ‘Fast’, ‘Standard’ and ‘Best’ presets. Maximum and 50% threshold ACR were measured in each sphere. Percentage variation of ACR for each sphere within a given configuration across replicates and also alternative configurations was calculated.

Percentage variation across replicates for specific sphere configurations was <10% for all three presets across all sphere sizes, and <3% assessing only in the two largest spheres. A strong dependence of ACR on sphere position was observed and was substantially greater than the variation across replicates. Variation of up to 30%, 37% and 34% was measured for ‘Fast’, ‘Standard’ and ‘Best’ presets respectively for all sphere sizes and up to 21%, 24% and 21% respectively assessing only in the two largest spheres.

This work highlights the importance of evaluating the spatial dependence of ACR. Differences are substantially greater than appear from using a single phantom configuration. The spatial dependence observed using the manufacturer presets should strongly encourage users to evaluate user-defined parameters that may reduce this dependence, and hence provide more consistent quantification.

### 7 Harmonization in quantitative SPECT: Can it be done robustly?

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The use of Quantitative-SPECT (Q-SPECT) is expected to grow with increased requirements for patient-based dosimetry. There are currently no recommendations for harmonisation of activity concentration recovery (ACR) in Q-SPECT.

SPECT/CT scans of a 10:1 NEMA phantom were performed on a GE Optima and Siemens Intevo. Three sphere position configurations were used and three replicates of each configuration were acquired on each system. Absolute quantitative reconstructions were performed with GE Q.Metrix, Siemens xSPECT and Hermes SUV-SPECT (only GE data) using 12 to 120 image updates. Maximum ACR was measured in each sphere. Harmonisation ACR coefficients of 0.19, 0.28, 0.53, 0.76, 1.02 and 1.11 for 10, 13, 17, 22, 28 and 37 mm spheres respectively were defined based on a phantom reference. Incremental Gaussian filtering was applied to images to align ACR with the reference coefficients.

Using optimised parameters (Q.Metrix: 60 updates, 10 mm filter; xSPECT: 84 updates, 11.5 mm filter; SUV-SPECT: 120 updates 13 mm filter), agreement with reference coefficients was within 19%, 24% and 10% for Q.Metrix, xSPECT and SUV-SPECT respectively. This improved to within 9%, 19% and 7% when assessing only the three largest spheres. ACR from SUV-SPECT showed the least dependence on sphere position followed by Q.Metrix. ACR from xSPECT showed substantial dependence on sphere position, hence the worst agreement with reference coefficients.

Harmonisation of Q-SPECT seems feasible, particularly in OSEM-based algorithms, and is sufficiently robust when adequate image updates are performed. Harmonisation using other algorithms, such as conjugate gradient xSPECT appears less robust due to spatially dependent ACR.
8 Implementation of patient specific administered activities and acquisition times for ¹⁸F-FDG PET imaging
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Purpose: To assess the impact of a new protocol for reducing acquisition times and optimising activities administered for ¹⁸F-FDG PET imaging for individual patients based on their weight, height and sex. This protocol was implemented in our department in June 2017.

Method: Workload data were analysed to compare the impact of the new protocol on administered activity, scanning time and patient throughput. Doctors reporting scans were asked to identify poor quality studies.

Results: Between 1st June and 5th November 2017, 1371 half body and whole body ¹⁸F-FDG scans were performed. The total number of PET scans (including tracers other ¹⁸F-FDG) was 1852, compared to 1592 in the same period of the previous year. The mean activity administered was increased by 16% to 257 MBq when compared to the previous weight based protocol for the same set of patients.

Conclusions: Only two scans (<0.2%) were assessed as having image quality below ‘definitely adequate’. NCRI approved the protocol.

Conclusion: By tailoring administered activities to individual patients we have achieved significant reductions in scanning time and increased patient throughput. The increase in the mean effective dose per patient is less than 1 mSv. Image quality has been maintained.

9 The additional impact of SPECT/CT on the nodal staging of prostate malignancy during routine bone scan imaging
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Accurate nodal staging can significantly influence treatment options for patients with prostate malignancy, particularly in the absence of bone metastases.

The increasing availability of SPECT/CT cameras with advancing CT hardware and image reconstruction capabilities, have improved the detection of additional extra skeletal disease.

This study aims to review the additional impact of SPECT/CT on nodal staging for prostate malignancy during routine Te⁹⁹m bone scan imaging.

At our institute, SPECT/CT is selectively performed on patients after their planar bone scan for characterisation and anatomical localisation of suspicious activity identified by the Radiologist.

In this retrospective study, 154 SPECT/CTs performed for patients with prostate malignancy over a 12-month period were reviewed for nodes that were enlarged by standard size criteria. Additional supportive conventional imaging and histology was reviewed where available.

49/154 patients demonstrated nodal disease on SPECT/CT. 23/49 of these patients had metastatic retroperitoneal nodes. 8/154 patients only had retroperitoneal nodal disease with no evidence of pelvic nodal disease. 8/154 patients had metastatic retroperitoneal nodal disease, but no bone metastases (4/8 of these patients were identified during their initial staging). 7/154 patients presenting with a biochemical relapse demonstrated nodal disease on SPECT/CT with no bone metastases.

In the context of nodal staging, the additional use of SPECT/CT has affected the overall management of nearly 10% of patients. This highlights a potential benefit in its more routine use during bone scan imaging for prostate malignancy, allowing for earlier treatment decision making, while reducing additional imaging appointments.

10 Are we missing other lymph node areas when focusing on cervical sites in DTC?
F. Selençuk Simsek, Tansel A. Balci and Ibrahim H. Ozercan
F. Selençuk Simsek, Tansel A. Balci and Ibrahim H. Ozercan

Purpose: LN metastasis is an important factor for staging and treatment decision for RIA. If a patient has LN metastasis and radioiodine dose is increased, treatment is more likely to be successful. Preablative neck US is recommended for initial evaluation; and if neck US shows bulky LNs, other areas included. However, some regions of thyroid lymphatics drained directly to the upper MLNs and this area is generally not seen on ultrasound. Preablative I-131WBI isn’t recommended mostly, and staging finished with postablative I-131WBI. We assess whether routine approach is enough for LN evaluation in DTCs or not.

Methods: 420 low/intermediate risk DTC patients received RIA after surgery and postablative I-131WBI in 7-10 days. Postablative I-131WBI and/or histopathologic examination was accepted as gold standard for N staging. We used pathology reports for discriminate thyroidal extension into the upper mediastinum from MLN metastasis.
11 Diagnostic of low and high level of prostate cancer (Pca) using 68Ga-PSMA PET/CT: Evaluation in 150 patients

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Purpose: 68Ga-PSMA-11 PET/CT is used for the diagnosis of recurrent prostate cancer (PCa). The aim of this study was to analyse the effect of different variables on PSMA uptake in 150 patients.

Methods: 150 patients who enrolled for 68Ga-PSMA-11 PET/CT were scanned with one hour or delayed imaging after 3 h of injection was performed from July 2015 to November 2017 to detect low level recurrence of prostate cancer (PCa). The possible effects of different variables including PSA level, Gleason score (Gs), hormone therapy, radiotherapy and chemotherapy, patient age and radiopharmaceutical dose of injection were assessed.

Results: Tumour detection is clearly associated with PSA level and Gs. A positive PET/CT scan was associated with PSA level more than Gs, dose of injection and patient age.

Conclusion: 68Ga-PSMA-11 PET/CT detects tumour lesions in a high percentage of patients with recurrent PCa. There was no correlation between a positive 68Ga-PSMA PET/CT scan and patient age or amount of injected dose.

12 Management impact of 68Ga-THP-PSMA in high-risk and biochemically recurrent prostate cancer

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Purpose: To determine the impact on clinical management of newly diagnosed patients with high-risk prostate cancer and patients with biochemical recurrence (BCR) using 68Ga-THP-PSMA PET/CT, a new kit form of PSMA developed for clinical imaging.

Methods: 107 consecutive patients (52 pre radical treatment, 55 BCR) had management plans documented at the MDM before 68Ga-THP-PSMA PET/CT. All patients underwent 10 min dynamic pelvis, followed by 60 min half body, acquisitions after injection of 101-182 (mean 161) MBq 68Ga-THP-PSMA. Post scan management plans were then recorded after MDM discussion or clinical review. Gleason score, PSA and PSA doubling time (dt) were also recorded.

Results: High-risk pre-radical treatment: 11/42 (26%) patients prior to first radical treatment (5 to a different treatment modality, 6 intramodality) and 0/10 patients prior to radical salvage therapy had management changed. Gleason scores > 8 were associated with detection of more nodal (25% vs. 15%) or bone (13% vs. 8%) metastases.

BCR: 29/55 (53%) of scans were positive. Positivity rate increased with PSA level (PSA 0.5-1.0 ng/ml 33%, PSA 5.0-10.0 ng/ml 88%). Positivity did not depend on Gleason score but was higher in those with a PSA dt of <6 months (60% vs. 38%). Positive scans were associated with higher PSA levels (0.82-71.0, mean 6.23 ng/ml vs. 0.11-14.2, mean 1.74 ng/ml). Clinical management changed in 18/50 (36%) patients (10 intermodality, 8 intramodality).

Conclusion: 68Ga-THP-PSMA PET/CT influences clinical management compared to standard workup in significant numbers of patient with high-risk prostate cancer pre radical treatment and in those with biochemical recurrence.

13 The FALCON trial: Impact of 18F-fluciclovine PET/CT on clinical management of patients with biochemical recurrence of prostate cancer

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**Purpose:** To assess the impact of $^{18}$F-fluciclovine PET/CT on clinical management of men with biochemical recurrence (BCR) of prostate cancer following initial therapy.

**Methods:** Six UK sites recruited men with a first BCR who were being considered for curative-intent salvage therapy. Management plans were documented before and after $^{18}$F-fluciclovine PET/CT. Revisions to treatment modality (e.g., salvage radiotherapy to systemic therapy) were classified ‘major’. Within modality changes (e.g., radiotherapy field modification) were classified ‘other’.

An analysis of the first 85 patients was pre-planned to stop recruitment for efficacy if the number of treatment revisions > 45 (53%; 97.5% CI: 40–62%), or for futility if ≤8 (9.4%, 97.5% CI: 3.6–19%).

**Results:** The 85 patients (median age 67 years; median PSA 0.63 ng/ml; 85% Gleason score ≤7) were a mean 4.8 years post-initial diagnosis. Fifty-six (66%) had previously undergone prostatectomy, while 27 had received radiotherapy (± other therapy).

In this predominantly low PSA cohort, the $^{18}$F-fluciclovine scan detection rate was 52% overall, 40% for intraprostatic/prostatectomy bed disease and 22% for extraprostatic disease.

Most patients (52; 61%) had a management change post-scan; 41/52 (79%) had a positive $^{18}$F-fluciclovine scan. Thirty-one of 52 changes (60%) were classified ‘major’. Within modality changes (e.g., radiotherapy field modification) were classified ‘other’.

**Conclusion:** PET/CT imaging has substantial impact on clinical decisions for men with BCR of prostate cancer.

**14 Increased consistent reporting of FDG-PET/CT in pre surgical assessment of medically refractory epilepsy**

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**Aim:** Improve the consistency of fluorine-18- fluoro-deoxy-glucose (FDG) positron emission tomography combined with computed tomography (PET/CT) reporting for investigation of pre surgical assessment of medically refractory temporal and non-temporal lobe epilepsy. Consistent display and reporting of FDG-PET/CT will lead to improved concordance with hippocampal sclerosis (HS) on magnetic resonance imaging (MRI) and support the surgical decision to proceed to surgical intervention.

**Method:** A retrospective study of 49 patients consecutively scanned with FDG-PET/CT after reporting to a regional neurosurgical unit. Forty five patients presented with temporal lobe epilepsy (TLE). Blinded assessment of lateral temporal lobe activity in the polar, anterior third, middle third and posterior third was defined as mild, moderate or severe metabolic change. Mild changes were defined as reduced but continuous grey white matter activity. Moderate changes were consistent with reduced but discontinuous activity. Severe changes were assigned to continuous absent activity.

FDG-PET-MRI was performed with re-slicing of PET data along the long axis of the medial temporal lobe. Comparison of original PET/CT report and blinded PET/CT/PET/MRI report was made with original MRI report.

**Results:** Abnormal MRI and abnormal FDG-PET/CT/PET/MRI concordance improved from 18/28 scans (64.3%) to 27/28 (96.4%). Abnormal MRI and normal FDG-PET/CT/PET/MR discordance reduced from 10/28 scans to 1/28 scans. Normal MRI report and abnormal FDG-PET/CT/PET/MRI discordance increased from 5/21 (23.8%) to 13/21 (61.9%) scans.

**Discussion:** Consistent FDG-PET/CT/PET/MRI increased the findings of abnormality, concordance with hippocampal sclerosis, improved surgical confidence in the FDG-PET/CT/PET/MRI reporting and increased referral of patients for assessment.

**15 $^{18}$F-FDG-PET and DaTscan in imaging of corticobasal degeneration**

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**Purpose:** Corticobasal degeneration (CBD) is a rare progressive neurodegenerative 4-repeat (R) tauopathy and one of the atypical Parkinson Plus syndromes. Typically it involves asymmetrical neuronal loss in affected cortical regions and in the substantia nigra. We present a case series of 3 patients with a suspected atypical Parkinson Plus syndrome, in whom the DaTSCAN appearance was ‘normal’ but a fluorine-18-FDG-PET/CT (FDG-PET/CT) brain scan was abnormal and consistent with a diagnosis of CBD.

**Methods:** Three patients with clinical symptoms suggestive of a Parkinson Plus syndrome were referred to our
institution for investigative imaging. All 3 underwent a DaTSCAN and FDG-PET/CT.

**Result:** All 3 D were either normal visually or showed only a minor reduction in putaminal uptake but normal although slightly asymmetrical quantification ratios. In all 3 cases brain FDG-PET/CT brain scan was abnormal demonstrating asymmetrical focal areas of predominantly fronto-parietal cortical and basal ganglia hypometabolism indicative of CBD.

**Conclusion:** The DaTSCAN is the most commonly requested imaging test in the clinical setting of suspected Parkinsonism. However, CBD patients can have delayed neuronal loss in the substantia nigra and a baseline DaTscan may demonstrate normal or slightly asymmetrical appearances. Therefore, a ‘normal’ DaTscan study does not reliably exclude a diagnosis of CBD and if there is a high index of clinical suspicion of CBD, an FDG-PET/CT scan should be requested.

### 16 Role of FDG PET in refractory epilepsy with focal cortical dysplasia

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**Objective:** To evaluate the role of FDG-PET during presurgical evaluation in patient selection and predicting the outcome in patients with refractory epilepsy with focal cortical dysplasia (FCD).

**Methods:** Retrospective analysis of presurgical, surgical and post-surgical parameters in 196 patients with FCD who underwent resective epilepsy surgery and had at least 2 years post-surgery follow-up was performed. A 3T MRI of brain and FDG-PET was performed in all. The PET patterns were classified as localising, lateralising and uncertain. The PET metabolism was classified as focal hypometabolism, hyper metabolism and normal metabolism. Outcome at the end of two years was grouped as favourable outcome (ILAE class I, seizure free) and unfavourable outcome.

**Results:** The FDG PET pattern was localising in 81%, lateralising in 11% and was inconclusive in 8% patients. MRI brain showed clear cut FCD in 88%; in the rest with subtle MRI, FDG-PET helped in localising the lesion in 19 after PET/MRI fusion. The commonest type of surgery was corticectomy/lobectomy in 72% patients, commonest being frontal 58%. Histopathology was suggestive of FCD Type I in 58%. At two years follow-up 61% patients were seizure free. Sensitivity for seizure freedom was 94.4% in patients with lesion on MRI and/or localising PET pattern.

**Conclusion:** Accurate localisation of epileptogenic lesion on MRI and PET either alone or in combination improves the sensitivity of multi-modality evaluation in patients with FCD or may obviate the need for invasive monitoring in countries with limited resources.

### 17 Assessment of tumour biological parameters in \(^{18}F\)FDG-PET/CT on overall survival in patients with lung cancer

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**Aim:** Several parameters of the biological activity of tumour in PET images have been introduced based on SUV calculation and its derivatives as MTV and TLG. The aim of the study was to assess the significance of biological parameters of tumour using \(^{18}F\)FDG-PET/CT scans in patients with lung cancer.

**Material and methods:** 60 patients were enrolled to study. PET parameters including SUVmax, MTV, TLG of both primary tumour and higher mediastinum lymph nodes (SUV-s, MTV-s and TLG-s) and heterogeneity (AUC-CSH) of primary tumour and lymph node were analysed. The relationship between these parameters and overall survival was evaluated.

**Results:** Depends on stage of the disease in stage IV SUVmax, TLG, MTV and AUC-CSH (8.08 ± 3.05, 248.88 ± 390.46, 47.1 ± 84.6, 0.53 ± 0.1); for LN: (5.93 ± 2.49, 18.72 ± 20.94, 4.53 ± 3.86, 0.69 ± 0.1) respectively; in stage IIIB, SUVmax, TLG, MTV and AUC-CSH (12.74 ± 6.94, 575.68 ± 752.11, 69.11 ± 81.41, 0.55 ± 0.1), for LN: (8.22 ± 4.14, 24.71 ± 22.76, 4.21 ± 3.26, 0.67 ± 0.08) respectively, in stage IIIA SUVmax, TLG, MTV and AUC-CSH (9.73 ± 4.56, 299.73 ± 370.18, 67.28 ± 84.63, 0.52 ± 0.1), for LN (6.22 ± 4.9, 12.68 ± 11.89, 3.91 ± 4.13, 0.69 ± 0.09) respectively, in stage IIA SUVmax, TLG, MTV and AUC-CSH (8.98 ± 6.04, 35.86 ± 40.73, 6.11 ± 5.52, 0.64 ± 0.06), for LN: (4.43 ± 2.43, 25.72 ± 45.05, 6.07 ± 8.34; 0.74 ± 0.2). Significant differences between primary tumour and lymph nodes were found in SUVmax, TLG, VOL and heterogeneity in stage IIIA (P = 0.03, P = 0.003, P = 0.004, P = 0.0002), IIIB (P = 0.01, P = 0.003, P = 0.001, P = 0.0005) and IV (P = 0.002, P = 0.003, P = 0.004, P = 4.02E-08) respectively.

**Conclusion:** Our preliminary results suggest that PET metabolic parameters in lymph nodes may be the prognostic factors for OS in advanced stages in patients with lung cancer.
Acknowledgements
The present study was support by WCO grant No 18/2017(161).

18 Normal or pathologic $^{18F}$-FDG uptake within palatine tonsils - potential role of sequential delayed $^{18F}$-FDG PET/CT examinations
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Background: The aim of this study was to evaluate the utility of sequential dual-time-point fluorine-18-fluorodeoxyglucose positron emission tomography/computed tomography (DTP $^{18F}$-FDG PET/CT) in differentiating normal and pathologic palatine tonsils glucose metabolism.

Methods: We have analysed 104 structures in 90 non-treated patients: 45 physiologic tonsils and 59 abnormal palatine tonsils (malignant and non-malignant). Patients underwent sequential delayed $^{18F}$-FDG PET/CT examinations at 60 and 90 min p.i. of the tracer. We have analysed the SUVmax, SUVmean values and the Retention Index (RI) at 60 and 90 min p.i. of the $^{18F}$-FDG. To find the predictive SUV value and the RI cut-off between physiology and pathology we used the ROC analysis.

Results: The SUVmax values at 60 and 90 min p.i. within normal palatine tonsils were 1.36±0.26 and 1.31±0.26, respectively, P > 0.05. The SUVmax values at 60 and 90 min p.i. within pathologic but non-malignant palatine tonsils were 3.74±1.45, 3.80±1.47, P > 0.05 and 5.19±2.19, 5.81±2.50, P < 0.05 within malignant palatine tonsils. The RI fluctuation over time was 5%±28% within physiologic, 2%±11% within non-malignant and 13%±13% within malignant palatine tonsils. The ROC analysis showed that delayed studies increased the sensitivity and specificity of the $^{18F}$-FDG PET/CT examinations.

Conclusion: The sequential delayed $^{18F}$-FDG PET/CT examinations may improve normal and pathologic palatine tonsils differential diagnostics with the sensitivity and the specificity increased.

19 Enhancing PET/CT images with IV contrast – a multidisciplinary guide
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Purpose: The addition of IV contrast to the CT component of PET/CT aids the differentiation of anatomical structures, enables improved characterisation of lesions and improves efficiency by reducing test duplication. This additional information compliments the functional data from the PET component and is particularly useful in head and neck imaging (for example, where anatomical localisation is particularly challenging).

The addition of IV contrast is not without challenges and the purpose of this presentation is to describe solutions to the various challenges encountered when introducing contrast enhanced PET/CT from a multidisciplinary perspective including nuclear medicine technologists, radiographers, medical physicists and radiologists/physicians. Technologists in particular may be unfamiliar with the use of IV contrast.

Method: Based on our experience of contrast enhanced PET/CT we will address issues including the indications, changes in paperwork, appropriate scanning protocols, safety considerations, the impact on PET attenuation correction, practicalities of injection and reporting issues.

Conclusion: This presentation will be a handy guide to anyone already using or considering implementing contrast enhanced PET/CT.

20 Improved lesion detection with wholebody SPECT/CT over planar wholebody with $[^{99m}Tc]$HYCIN-TOC (Tektrotyd), in patients with neuro-endocrine tumours
Sara Soares, Manuela Vadrucci, Andrew Cheetham, Danielle Levart, Benjamin Corcoran, Nick Gulliver, Nicola Mulholland and Gillian Vivian
King’s College Hospital NHS Foundation Trust, London, United Kingdom

Introduction: $[^{99m}Tc]$HYCIN-TOC (Tektrotyd) is used for the imaging of neuro-endocrine tumours (NET). Imaging protocols vary across Europe and there are no official guidelines published. We aim to demonstrate the superiority of wholebody SPECT/CT over planar wholebody (P-WB) imaging.

Methods: Tektrotyd scans were performed on 20 patients (14 male and 6 female; age range from 31 to 83 years) with suspicious or confirmed NET. The mean activity administered was 530MBq. P-WB and 3-bed SPECT/CT (vertex to mid-thighs) imaging was performed 4-hours post-injection using a Symbia T16. The images were independently analysed and the number of lesions recorded.

Results: In total 49 lesions in P-WB and 42 lesions in SPECT/CT were counted. 67.5% of the lesions were present on both P-WB and SPECT/CT. In the thorax, 2 false positives were seen on the P-WB imaging with respect to SPECT/CT. In the abdominal area, 13 lesions...
were false positive and 7 were false negative. SPECT/CT provided improved reporting confidence over P-WB imaging.

**Conclusion:** A 3-bed SPECT/CT from vertex to mid-thighs provides improved image quality and better anatomical localization with respect to the planar wholebody images. The estimated effective dose from the Tektrotyd is 2.7 mSv, a low-dose CT increases this by 4.1 mSv. Whilst we do not have an independent gold-standard, based on this data it is reasonable to image the patient using a SPECT/CT without a separate planar wholebody.

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### 21 Use of an ULPA filtration system to remove airborne radioactive contamination during V/Q lung scans

**Christopher Mayes**  
**Department of Nuclear Medicine, Royal Liverpool University Hospital, Liverpool, United Kingdom**

**Background:** Diagnosis of Pulmonary Embolism is conveniently performed by V/Q lung scan using an inhaled ⁹⁹mTc-vapour such as Technegas. However not all the inhaled vapour adheres to lung tissue. A filtration system is provided in the Patient Administration System to capture the exhaled radioactivity. However if exhaled Technegas can bypass the filter and escape into the room air it may contaminate both staff and imaging equipment.

**Method and results:** A Gamma Camera was used to detect leakage of Technegas. Evidence of radioactive contamination persisting in room air for more than one hour is presented.

The use of an ULPA air filtration system is shown to effectively sequesterate airborne radioactive contamination from expired air during the ventilation process.

By measuring radioactivity trapped in the filtration system it is possible to estimate the amount exhaled by patients that leads to environmental contamination. Although some patients (35%) maintain an excellent airway seal producing little contamination (<1 MBq), others are unable to do this successfully.

**Conclusion and recommendations:** When there is leakage of exhaled activity, the use of the filtration system can successfully extract it from the environment avoiding risk of contamination for both staff and imaging equipment.

Good practice using a snorkel mouthpiece and nose-clip reduces contamination from fully cooperative patients. However, those patients who cannot maintain a near-perfect seal can produce significant contamination which may be safely sequestered by an ULPA filtration system.

It is recommended that an air filtration or extraction system is always used during the patient inhalation procedure of ⁹⁹mTc-vapour ventilation agents for V/Q lung scans.

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### 22 SeHCAT imaging - should we be doing dynamics instead of statics?

**Alexander Smout, Amber Mackley and Paul Hinton**  
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In the UK there is a lack of consensus on SeHCAT acquisition techniques, which can be influenced by the departmental layout and logistics. For example, intrinsic acquisitions may be undesirable if the camera is sited near other patients.

We perform 300 s intrinsic acquisitions of the 265 keV emission. Our camera is 6 metres from the waiting room or corridor, however we acquire this as 60 5 s frames, so that any radioactivity from other patients can be identified and excluded. A custom script was written (Aladdin code, GE Xeleris) to process this dynamic data and exclude any peaks automatically.

In this retrospective audit we looked at the incidence of count rate spikes and their effect on the resultant SeHCAT retention percentage. Spikes, defined as frames with counts more than 5 standard deviations away from the mean, were seen in 7 of 100 patient’s seven day images. The increased counts in the spikes ranged from 0.1% to 0.9% of the respective patient’s 3 h counts, additively increasing the SeHCAT retention percentage by these amounts. An incidental finding was that activity was seen moving from anterior to posterior (from gravity and peristalsis) in 20 of 100 patient’s 3 h images (but none of the 7 day images). The geometric mean was found to be robust.

This work shows that our incidence is high enough to continue acquiring SeHCATs dynamically, to protect against clinically significant spikes in future. Dynamic imaging may be particularly important if the 136 keV Selenium-75 emission is included in your energy window.

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### 23 Feet and inches: Development and testing of a bespoke positioning device to immobilise the feet during bone SPECT/CT imaging

**Andrew Cheetham**, **Stephen Anderson**, **Nick Gulliver**, **Manuela Vadrucci**, **Nicola Mulholland** and **Gillian Vivian**

**King’s College Hospital NHS Foundation Trust, London, United Kingdom and Bright Technologies Ltd, Sheffield, United Kingdom**

**Introduction:** Bone SPECT/CT is a useful tool for evaluation of the foot. However, movement during the acquisition will degrade scan quality. Additionally, the complex anatomy of the foot is more easily visualised if positioned in standard orthogonal planes.

In conjunction with a commercial supplier, a positioning device to immobilise the feet was designed. A solid baseplate of CT compatible material and recesses for
heels keep the feet parallel to the transaxial plane, whilst a central bar and straps restrict lateral rotation.

**Method:** 20 SPECT/CT studies (10 with and 10 without the foot immobiliser) were retrospectively reviewed for motion and misregistration artefacts. To assess positioning, the long axis of the foot was defined as a line bisecting the third metatarsal phalangeal joint and the posterior aspect of the talar-calcaneal joint. Degree of the foot’s flexion/extension was measured relative to the scanner’s transaxial plane, and lateral rotation relative to the sagittal plane.

**Results:** With the immobiliser, no motion is seen on the raw SPECT data, and 1 case of slight misregistration. Without the immobiliser, 2 cases of motion are seen and 6 cases of misregistration.

With the immobiliser, the average foot was flexed −23 degrees (−17 to −37) to the transaxial plane, and rotated laterally −10 degrees (−22 to 2). Without the immobiliser, flexion was −53 degrees (−31 to −74) and the rotation −10 degrees (−25 to 19).

**Conclusion:** Foot immobilisation improves imaging, by reducing motion and misregistration artefacts. Enhanced positioning relative to standard orthogonal planes helps with visualisation of the anatomy.

**24 Double speed bone scans (on patients with prosthetic replacements)**
Stuart Stirling
Guy’s & St Thomas’ NHS Foundation Trust, London, United Kingdom

As operational pressures to do more scans increase in Nuclear Medicine Departments, in parallel with more complex scans with fusion imaging, increases in the amount of referrals and more significant demographic changes to the population, the challenge is to reduce the time length of referrals and more significant demographic changes to the population, the challenge is to reduce the time length of scans without reducing adversely the diagnostic quality.

Our department routinely acquires four sets of imaging (blood pool, delayed statics, wholebody and SPECT/CT) for patients referred with pathologies related to prosthetic replacements. One way to reduce the overall time was by reducing the acquisition time for the wholebody scan, i.e. by halving the acquisition time for the wholebody scan by doubling the speed for this scan and then evaluate.

This was achieved by selecting 20 patients, gaining their consent, and acquiring the wholebody scans at both normal speed, and at the faster double speed/half scanning time. These were then compared by two experienced Nuclear Medicine consultants while evaluating the diagnostic quality of the scans.

In all but one of the cases (due to the patient’s habitus), diagnostic quality was deemed as acceptable, even though resolution decreased; these scans had the benefit of saving 10 min in one part of the scanning process with the advantage of a shorter scanning time for the patient, and more capacity for the cameras.

**25 Static and SPECT images in [99mTc]Tc-DMSA scans – should practice change?**
Marisa Botelho Cruz, Christopher Sibley-Allen, Ines Baeta, Andre Nunes, Ahmed Hasseb, Amy Eccles and Dhruba Dasgupta
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**Objective:** The purpose of this study is to determine whether there is a significant difference in the confidence of [99mTc]Tc-DMSA scans reporting between DMSA statics, SPECT images and reconstructed statics.

**Patients and methods:** Initially, a [99mTc]Tc-DMSA SPECT protocol was optimised using a Jaszczak phantom. Attenuation correction SPECT and reconstructed static images were processed using a [99mTc]Tc-lower scatter window. Following this, multiple clinical acquisitions were performed and several processing methodologies were applied to determine the optimum protocol.

The clinical images of 7 patients were used to perform an assessment of reporting confidence by two nuclear medicine doctors when using original statics, reconstructed statics and SPECT images.

**Results and conclusion:** Our assessment of reporting confidence for normal statics and reconstructed statics did not show a marked difference, with 57% of images considered of equal confidence for consultant 1 and 43% for consultant 2. On the comparison between normal statics and SPECT, statics were preferred to SPECT for consultant 1 (57%). Consultant 2 had the same confidence in normal statics and SPECT in 43% of the images.

Our assessment of split renal function on original and reconstructed statics has not shown a relevant difference. The SPECT acquisition is a much faster procedure when compared with static acquisition, making the procedure more comfortable and tolerable for patients. SPECT has clear advantages, but the limitation of attenuation correction having to be applied through scatter calculation since a CT is not performed, which reflects on a reduction of procedural uniformity.

**26 Reproducibility of the differential renal function derived from a [99mTc]Tc-meraptoacetyltri glycine (MAG3) renogram**
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Introduction: Guidelines for differential renal function (DRF) calculation recommend using the integral counts between two fixed times, or the uptake slope of the Patlak-Rutland plot before renal excretion. Background correction techniques using different ROIs have been recommended which subtract either extra-renal tissue background, or remove tissue and intra-renal vascular activity.

Aim: to calculate the reproducibility of the DRF using the different methodologies.

Method: 19 adult MAG3 renograms (Furosemide 15-minutes prior) were reprocessed by 4 experienced operators using the Hermes Hybrid Viewer PDR (v2.6A) application. For the integral method the DRF was calculated from 60-150’s using whole kidney ROIs and different background regions adjacent to each kidney, either sub-renal (INT-SUB/B), lateral (INT-LAT) or peri-renal (INT-PERI). The Patlak-Rutland method used background corrected heart or spleen vascular input regions and DRF was calculated from the best straight line slope prior to renal excretion. Data was processed 4 times, using the heart and the 3 background ROIs (PR-SUB, PR-LAT, PR-PERI) and using the spleen and a single large tissue ROI over the flank inferior to the left kidney (PR-MAN).

Results: The inter-observer variabilities given as mean standard deviation of the left kidney DRF are:

INT-SUB = 3.2, INT-LAT = 1.6, INT-PERI = 1.6, PR-SUB = 3.8, PR-LAT = 3.0, PR-PERI = 2.7, PR-MAN = 1.7.

Conclusion: The best inter-observer reproducibility was found when using the integral method with lateral or peri-renal background ROIs or the Patlak-Rutland method using the spleen as the vascular input and a large tissue ROI.

28 Harmonisation of FDG-PET uptake measures in oncology by gaussian smoothing

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New reconstruction techniques, particularly those including resolution modelling (RM) can give rise to more accurate uptake measures but with values higher than would have been obtained historically or from some other scanners. The aim of this study was to investigate the concept that measures of uptake in PET may be harmonised by application of tuned Gaussian smoothing (as used in Siemens’ EQ.PET software). In this work we look at measures of lesion uptake in oncology FDG between reconstruction on the same system with and without RM.

Work was performed on a GE Discovery 710 comparing the best available iterative reconstruction without RM to that with RM and regularisation, initially using the NEMA IQ phantom. Software was developed in-house to incrementally apply Gaussian smoothing to the RM images which were matched to the non-RM images optimising for SUVmax. The scheme was clinically validated in a series of 22 routine clinical patients with 33 lesions.

For this set-up we found a 5.0 mm FWHM Gaussian smooth to give the optimal correspondence. The recovery coefficient curve then fell within the bounds of the current EARL criteria. When applied to patient data,

27 Does The volume of distribution range in glomerular filtration rate studies correlate with ascites in ovarian cancer patients?

Holly Chapman, Clare Harrison and Abdulhakim Elmegadmi
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Glomerular Filtration Rate (GFR) is evaluated for chemotherapy. However, ascites is a common symptom for many oncology patients and a contraindication that can overestimate quantitation by plasma sampling (Murray AW et al., 2013, 41:67-75. J Nucl Med Technol). Therefore, BNMS guidelines suggest the assessment of volume of distribution (Vd) (Fleming IS et al., 2010, BNMS).

For patients diagnosed with ovarian cancer, ascites on CT (within 2 months prior to having GFR done and qualitatively evaluated by NM Consultant as none, small, moderate or large) was assessed and compared to Vd (uncorrected with tolerance of 8*BSA±25%).

For Vd within range, 57% (17/30) patients had agreement between CT and tolerance on Vd, with disagreement for 1 large (3.9l), 1 moderate (3.7l) and 5 small (0.2-4.2l), and 4 drains between CT-GFR and 2 pleural effusion.

For Vd outside range, 87% (26/30) patients had agreement between CT and tolerance on Vd, with disagreement for 4 none (0.1-3.2l), and 11 drains between CT-GFR and 5 pleural effusion.

Vd may indicate ascites, so reports query possible overestimation, if Vd is outside range. However, correlation with CT can improve the interpretation. Therefore, change in practice towards checking CT when authorising and reporting is needed.
the average positive bias went from 45% to 5.8% with the standard deviation improving from 46% to 9.3%.

Tuned Gaussian smoothing gives a route to aid in harmonisation of uptake measures between different reconstructions, as here with and without RM but also between different scanners and/or sites. Set-up using the NEMA IQ phantom has been validated with patient data.

29 Investigation into the use of quantitative uptake measures for QC of routine oncologic FDG-PET scans

Peter Julian, Elizabeth Gabriël, Chris Nottage, Michael Gornall and Andrew Harris

"The Christie NHS FT, Manchester, United Kingdom, School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom and Colchester Hospital University NHS FT, Colchester, United Kingdom"

Due to its fully quantitative nature, PET has the potential to provide absolute measure of normal uptake that may be useful as QC parameters. The aim of this work was to investigate liver SUV and total activity in the image to assist in identifying procedural problems such as unrecognised incomplete tracer administration.

127 routine FDG-PET scans for a mix of oncology indications were analysed. Most followed the commonest ‘eyes-to-thighs’ protocol with 50 patients imaging also including the whole brain and 12 patients having complete total body imaging including the legs. 3 cm spherical regions were applied in the right lobe of normal liver and expressed as the SUV (normalised to patient weight) or SUL (normalised to lean body mass). Total activity was evaluated with in-house developed software using regions encompassing the whole of the imaged patient. The acceptable ranges for these parameters was defined to be within the 95% confidence range to trigger further investigation and applied to historical cases where problems occurred.

The mean values of liver SUV and SUL were determined to be 2.24 ± 0.39 and 1.53 ± 0.23. As expected SUV, compared to SUL, is somewhat weight dependent. The upper body was determined to account for 60.8 ± 6.1% of the total dose with the brain being a further 14.8 ± 3.3% and the legs 17.1 ± 3.4%. The confidence range of parameters was found to be able to successfully identify problematic scans.

Simple uptake measures are useful QC tools of clinical data in oncology FDG-PET. Normal liver SUV will inevitably be the easiest to implement.

30 Evaluation of data driven respiratory gating for PET

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Purpose: Respiratory motion during the acquisition of PET data can reduce the accuracy of image quantification and reduce image quality. There are various methods of measuring a respiratory signal, to then gate the PET data and mitigate these effects. Here we evaluate prototype data driven gating (DDG) software which is under commercial development.

Methods: The principal component analysis based DDG algorithm was tested on an anthropomorphic phantom and a NEMA IEC Body phantom. After filling with F-18, the phantoms were positioned on a respiratory motion platform. Data were collected with the phantoms stationary and in motion. Motion signals were measured using the Real-time Position Management™ system (RPM) which is an external infra-red tracking device, and also found directly from the PET data using the prototype DDG software. The signals were compared with calculation of the correlation coefficients. PET images were reconstructed with quiescent period gating (QPG), after which the recovery percentages and background variability were measured. Testing using patient data is ongoing.

Results: The prototype algorithm performed to a similar level as the external gating system. Correlation coefficients between the two systems for the respiratory traces were > 0.97. PET images from the moving phantom had greater clarity with significantly improved contrast (P < 0.05) when respiratory gating was applied. The differences between DDG- and RPM-based gating were small and not significantly different.

Conclusions: A prototype DDG algorithm based on principal component analysis was found to provide a reliable respiratory gating signal in anthropomorphic phantom studies. Initial results from patients are encouraging.

31 Determining a normal range for tomographic counts in DaTscan

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Introduction: Poor quality DaTscan images may occur due to extravasation or drug interaction. The aim of this study is to establish a normal range for tomographic counts within the background of the brain. This can be used to assist clinicians in reporting of future DaTscan images, to give confidence that abnormal appearance of DaTscan is not due to external factors.

Method: An ImageJ program was written to determine the processed tomographic brain counts for DaTscan patients. A volume of interest was created from the
bottom of the striata to the top of the brain, to ensure that salivary glands were not included. A standard-sized striatal VOI (based on the Southampton method) was also created, and counts in this volume were set to 0. The total background brain counts were then measured on 14 patients (8 abnormal, 6 normal) after standard local imaging (GE Discovery/GE Infinia camera with LEHR collimators) and standard local processing (OSEM with 10 subsets/10 iterations, 0.6 cycles/cm BW, no AC). Extravasation had been ruled out of these patients through imaging of the injection site.

Results: The total background counts within the brain were calculated to be 420 k± 110 k (mean± SD). There was no correlation between the specific binding ratio (normal or abnormal striatal uptake) and total background brain count (P = 0.87).

Conclusion: A normal range of background brain counts has been determined. A total tomographic count of less than 200 000 or more than 640 000 using local acquisition and processing parameters may signify external factors such as extravasation or drug interaction.

### 32 Compartimental model for 223Ra-radium dichloride in patients with metastatic bone disease from castration-resistant prostate cancer

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Compartimental models of radium in the literature have been developed for healthy humans and animals. The aim of this work was to develop a compartimental model for 223Ra-radium dichloride in patients with mCRPC.

SAAM II v2.3 was employed to develop a compartimental model that best describes the retention data for 6 patients with 2 treatments (100 kBq/kg 223Ra) each. Lesion compartiments were added to the model. The model was populated with activity retention data for plasma, bone surfaces, small intestines, upper large intestines, lower large intestines and excretion data. Rate constants were subsequently extracted.

A compartimental model was developed that accurately describes the biokinetic data. A second bone compartiment was necessary for the description of the activity retention in the skeleton. The most accurate gastro-intestinal model was found to consist of three compartiments. The median rate constant from plasma to normal bone was about a factor 6 lower than from plasma to lesions. The rate constants from plasma to normal bone (mean: 4.0 l/h, range: 1.9-10.9 l/h) in the present model were higher than the respective rate constant in the ICRP 67 model (0.5 l/h).

The observation that a single bone compartiment is not sufficient to describe the retention data could have implications for lesion microdosimetry. While the available dataset is limited, the model will assist us in the design of future clinical trials (e.g. the number of scans) to improve the understanding of 223Ra treatments and potentially allow for patient tailored treatments.

### 33 A universal calculator for patient restriction calculations with a new concept for explaining restriction values

William Thomson, John Courtney, Greg James, Joe Burmiston and Joe O’Brien

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Introduction: We previously presented a calculator for 131I restrictions. The program is completely revised for flexibility and simplicity. Also, a new concept is presented, the theoretical time spent at 30 cm (‘sitting-time’) and at 1 m (‘chat-time’).

Method: The program is written in Excel with Visual Basic. The program flows through separate worksheets, helping guide the user. The radiopharmaceutical model is chosen (drop-down list). The user can also enter their own radiopharmaceutical model, up to three exponentials. Dose rates at 5 distances can be entered (0.1 m, 0.5 m, 0.5 m, 1 m and 2 m) and the model stored. The contact model is then entered. There are various pre-set examples given (for children, work etc.). User contact models can be stored. The calendar days applicable are selected (up to 7 weeks) normally with pre-selected buttons.

The program then calculates the restrictions for dose constraints of 0.3 mSv, 1 mSv, 3 mSv and 5 mSv. Daily dose figures can be viewed.

Analysis: Various models are available, for 131I thyrotoxicosis, 131I ablation, and 177Lu. However any model is easy to enter and store. A simplified concept of contact is also presented, based on the equivalent times at 0.3 m (‘sitting-time’) and 1 m (‘chat-time’). These may help explain the restrictions. E.g. for 131I thyrotoxicosis (600 MBq), the allowed daily times for 0.3 mSv are 60 min chat-time and 6 min sitting-time.

Results: An outline of the calculator will be presented including the concepts to help explain restrictions.

Conclusion: A new calculator allows restriction calculations for general therapy radionuclides. Radiopharmaceutical and contact models can be tailored by the department for the individual patient.
34 Delayed MAG3 renal measurements – A method for predicting delayed kidney counts for quantitative comparison with measured values
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City Hospital, Birmingham, United Kingdom

Introduction: A delayed image may be taken after a MAG3 study, particularly if obstruction is observed. With camera pressures, this image may be 30 min later. Quantitative interpretation of the delayed values is difficult. Our method predicts the kidney counts assuming constant physiology. This can help identify and quantify any changes.

Methods: Rutland-Patlak analysis gives the zero-excretion curve, representing the kidney with no excretion. The difference between this curve and the renal curve gives the %excretion at any time. Plotting log (1-%excretion/100) against time generally gives a straight line fit in the last 5 min Extrapolated, this gives the predicted %excretion curve for later times. The 20 s blood curve points can be interpolated between the 20 min value and the value in the delayed image. On integration, this gives the extended zero-excretion curve. From these curves, the kidney counts at the delayed time can be calculated for no change in physiology of the kidney. So any discrepancy to observed counts indicates change in kidney function (e.g. postural).

Results: Kidney curves change substantially within the 30 min after the end of the study. E.g. an obstructed kidney with 60% excretion at 20 min can have an excretion of 85% at 50 min without physiological change. Our technique gives an estimated kidney curve to the delayed time point which can be compared to the measured value.

Conclusion: Delayed images obtained after a standard MAG3 study can be difficult to interpret. Our technique estimates the kidney counts at the delayed time, allowing a quantitative comparison with the measured value.

36 Gallium-68 biodistribution and binding to transferrin: Effects of bicarbonate and anaesthesia
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Background: When administered unchelated, the gallium-67/68 3+ ion has a variable and unpredictable biodistribution. Transferrin is the major Ga transporter in blood and Ga-transferrin binding requires bicarbonate. Anaesthesia depresses respiration, potentially affecting blood [HCO3-]. We examined the effect of bicarbonate on 68Ga-transferrin binding and cell uptake, and the effect of anaesthesia on gallium-68 biodistribution.

Methods: Gallium-68-apotransferrin binding was assessed at varying [HCO3-] using PD10 size-exclusion chromatography. A375 melanoma cells were incubated with gallium-68 and human apotransferrin at different bicarbonate levels. Ten BALB/c mice (5 isoflurane-anasthetised, 5 not) were intravenously injected with ammonium-acetate-buffered 68 Ga eluted on three different occasions from an Eckert & Ziegler generator, and ex vivo biodistribution was determined 2 h later.

Results: Without bicarbonate, 11.5 ± 0.7% radioactivity was transferrin-associated, compared to 38.9 ± 2.37, 34.0 ± 1.6 and 34.1 ± 0.1% with 5, 10 and 20 mM HCO3-, respectively (n = 3). 1.7 ± 0.1% activity was cell-associated at 0 mM.
bicarbonate, compared with 3.4±0.3, 3.3±0.1 and 3.2±0.02 at 5, 10 and 20 mM, respectively (n = 4). Tissue biodistribution did not differ significantly between anaesthetised and non-anaesthetised mice (n = 5). However, liver and spleen uptake (%ID/g) was significantly higher for mice injected with the first (vs. second) generator elution (liver: 15.4±1.0% vs. 6.2±0.2%, spleen: 11.2±2.5% vs. 3.6±0.2%) (n = 4).

Conclusions: The presence of bicarbonate significantly improves [68Ga] Ga-transferrin binding and cellular uptake. Anaesthesia has no effect on the biodistribution of weakly-chelated gallium-68. Gallium-68 partitioning between liver/spleen and bones varies significantly between, but not within, generator elutions, suggesting that variable chemical composition of gallium-68, rather than variable physiology of the subject, is responsible for the variable biodistribution.

37 8-Hydroxyquinoline as an ionophore for manganese-52: Exploring applications in cell radiolabelling and liposomal nanomedicine tracking using PET
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The ionophore 8-hydroxyquinoline (oxine) facilitates the transport of radionuclides across lipid bilayers and the subsequent release of the metal ion inside cells/liposomes. The radionuclide is then trapped in cells and liposomal medicines via binding to intracellular proteins, or incorporated drugs respectively (Edmonds S et al., 2016, 10:10294-10307. ACS Nano.). [52 Mn]Mn-oxine ([1/2 = 5.6 d) was recently developed with a facile synthesis, showing promising liposome labelling properties.

The cell labelling properties of [52 Mn] Mn-oxine were investigated with various cell lines, and the cell viability and cellular retention of the isotope were evaluated. The compound was also used to track the nanomedicine DOXIL in vivo; B6CAF1 mice (n = 3) were injected with [52 Mn]Mn-DOXIL and imaged at t = 1 h, 24 h & 72 h, with ex vivo biodistribution carried out at t = 72 h.

[52 Mn] Mn-oxine was able to label MDA-MB 231 and gamma-delta T cells with moderate efficiency (>30%), however, low cellular retention of 52 Mn (<26% after 24 h) was observed. PET images of [52Mn]Mn-DOXIL at 1 h and 24 h post-injection showed a distribution consistent with previously imaged nanomedicines. However, PET images and ex vivo biodistribution at 3d post-injection showed a profile consistent with release of free 52 Mn, which may be indicative of drug release.

This work demonstrates the effectiveness of 8-hydroxyquinoline as an ionophore for 52 Mn. For cell labelling, this technique is limited by rapid efflux of the isotope. However, for liposome tracking, we propose that [52 Mn] Mn-oxine is a simple and effective means to radiolabel liposomal nanomedicines for imaging drug delivery and release.

38 Radiochromatogram linearity - replacing the decaying source method with a single acquisition
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We use a Scan-Ram radiochromatogram for radiochemical purity, which is comprised of a NaI(Tl) probe with a slit aperture, mounted on a linear motor and is capable of taking measurements every 0.1 mm.

To test count rate linearity a decaying source test is traditionally performed using a drop of 99mTc eluate of high specific activity, with multiple measurements made over 4-5 days to cover the full range.

Performing many acquisitions is not ideal and analysis is rarely simple, particularly if the eluate has significant 99Mo contamination. Furthermore, you can only take the counts in a single position as the area-under-curve is a compound measurement of multiple points along a linearity curve; the dead time across the acquired line profile varies and hence the summed profiles will not follow the true linearity curve of the system.

We have implemented a single acquisition linearity test. Eluate is assayed and a single drop dispensed. The acquisition is started at 50 MBq which is sufficient to see the maximum count rate and paralysis.

The shape of the acquired line profile is compared to a baseline profile at that activity. A full linearity curve is derived by comparing each point of the acquired data to the corresponding points of a scaled up profile from a low activity source with negligible dead time. Limits are applied to the full linearity curve and tolerances for the reference shape can then be derived from these.

This method is far easier to acquire and analyse, once a reference shape is established.

39 Ethical considerations for radiopharmaceutical administration
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Aim: This audit of Nuclear Medicine departments nationally, reviews the practices for patient information
when administering radiopharmaceuticals which may contain human/animal derived ingredients.

Method: >50 departments were contacted to ask whether they administer human/animal derived products (MAA/ Nanocoll, SeHCAT/Iodine-131 capsules) and if they were aware of the potential religious implications. They were also asked if and how they inform patients whether they had experience of patients refusing treatment on religious/ethical grounds.

Results: 20 departments responded. All 20 departments administered human derived products. 18 were aware of the human origin of the product but only 5 informed patients. 14/19 departments were aware that there was animal product in the administered radiopharmaceuticals (SeHCAT/Iodine-131 capsules) but only 2 informed the patients. Three departments had experience of patients refusing treatment on religious grounds.

Conclusion: A number of radiopharmaceuticals contain ingredients that may breach religious/ethical choices of some patients. The majority of responders were aware of the potential religious concerns, however only few informed patients. The difficulty in informing the patients without causing undue concern and anxiety was cited as one reason for not giving this information. It may be considered unethical to administer these products to patients without their prior knowledge and full informed consent. We suggest that the information should be included in the patient leaflet (such as ‘drug is administered in a standard capsule which may contain gelatine from animal products’), giving the patient an opportunity to raise any concerns.

40 Time of flight versus Q.Clear PET/CT in the assessment of lung nodules

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Purpose: To assess whether there is any difference in the SUV max value and Herder model classification for lung nodules when using Q.Clear versus Time of Flight (ToF).

Methods: Thirty nodules from twenty four PET/CT examinations were assessed and demographic and examination data was recorded on a spreadsheet. Each nodule was classified using the Herder model according to the SUV max using Q.Clear and ToF. SUV values for each nodule using Q.Clear and ToF were then compared using a paired-sample two tailed T-test.

Results: The T-test demonstrated that there was a statistical difference ($P = 0.00001$) in the SUV max values of lung nodules when using Q.Clear versus ToF. Five of the thirty nodules had sufficient differences between their SUV max values to lead to differing Herder model classifications. For all of these Q.Clear was found to upstage the nodule using the Herder classification when compared to ToF.

Conclusion: There was a significant difference in the SUV max value of nodules using Q.Clear when compared to ToF which led to up classification of five out of thirty nodules. This is important as the risk of malignancy can change significantly between classifications (particularly between faint and moderate uptake where risk can increase markedly), which in turn affects management decisions.

Further research is required to ensure that these results are reproducible.

41 Clinical staging of malignant pleural mesothelioma by $^{18}$F-FDG PET-MRI

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Aim: To examine the performance of $^{18}$F-FDG PET-MRI in the clinical staging of malignant pleural mesothelioma (MPM).

Methods: Consecutive patients with MPM undergoing pre-operative staging with $^{18}$F-FDG PET/CT who underwent a same day integrated $^{18}$F-FDG PET-MRI (DWI, axial T2 HASTE, axial T1 in and out of phase pre and post gadolinium) were studied. Clinical TNM staging (AJCC Cancer Staging Manual 7th edition) performed separately on the $^{18}$F-FDG PET-MRI and $^{18}$F-FDG PET/CT studies were compared. $^{18}$F-FDG PET-MRI and $^{18}$F-FDG PET/CT clinical stage was then compared with final pathological stage, determined by a combination of intra-operative and histological findings.

Results: 8 patients (7 male, mean age 67) with biopsy-proven MPM (7 epithelioid subtype tumours, 1 biphasic) were included. Pathological stage was I: 2 (25%); II: 1 (13%); III: 5 (63%); IV: 0. One patient underwent neoadjuvant chemotherapy between imaging and surgery and was excluded from the clinical versus pathological stage analysis. Clinical staging by $^{18}$F-FDG PET-MRI

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was concordant with 18F-FDG PET/CT in 75% (n = 6), and with pathological staging in 71% (n = 5) of patients. In comparison, 18F-FDG PET/CT staging was concordant with pathological staging in 43% (n = 3). Pathological T stage was concordant with 18F-FDG PET-MRI in 86% (n = 6), and with 18F-FDG PET/CT in 43% (n = 3) of patients. Pathological N stage was concordant with both 18F-FDG PET-MRI and 18F-FDG PET/CT in 57% (n = 4) of cases. No patients had metastatic disease.

Conclusion: Clinical MPM staging by PET-MRI is feasible, and may potentially provide more accurate clinical staging than PET/CT, particularly in determining T stage.

42 Fluorine-18 fluoro-3-deoxy-3-L-fluorothymidine (FLT) PET/CT as an early biomarker of treatment response in pegylated arginine deiminase, cisplatin, and pemetrexed in patients with argininosuccinate synthetase 1-deficient thoracic (mesothelioma and non-small cell lung) cancers
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Background: 18F-FLT-PET measures cell proliferation. Pegylated arginine deiminase (ADIPEG20) inhibits tumour growth in malignant cells lacking the enzyme argininosuccinate synthetase 1 (ASS1). In this study, 18F-FLT PET/CT was used to assess treatment response in patients with malignant pleural mesothelioma (MPM) and non-squamous, non-small cell lung cancer (NSCLC) treated with ADIPEG20 therapy combined with cisplatin (CIS) and pemetrexed (PEM).

Method: 18F-FLT-PET/CT was performed at baseline (scan 1), 24 h post first dose of ADIPEG20 on day2 (scan 2), post first cycle ADIPEMCIS on day16 (scan 3) and at end of treatment (scan 4). Scans were performed in n = 10 patients with MPM and n = 8 patients with NSCLC. Response was assessed using EORTC based criteria for changes in SUVmax: partial response (PR) if >15% decrease; progressive disease (PD) if >25% increase and stable disease (SD) in between.

Results: In MPM: at scan 2 PET response was PR 1/8; SD 6/8 and PD 1/8; at scan 3 PR was 4/10; SD 5/10 and PD 1/10; at scan 4 PR was 6/7; SD 1/7 and PD = 0. In NSCLC: at scan 2 PET response was PR 4/7; SD 2/7 and PD 1/7; at scan 3 PR was 2/7; SD 4/7 and PD 1/7; and at scan 4 PR was 4/6; SD 2/6 and PD = 0. In MPM, the rate of metabolic PR is low on scan 2, but much higher by scan 4. In NSCLC the metabolic PR rate is much higher on scan 2 and did not change substantially by scan 4.

Conclusion: 18F-FLT-PET/CT provides an early signal of response to ADIPEG20 therapy in ASS1-deficient thoracic tumours, however the highest rate of metabolic PR is at the end of treatment.

43 Optimising pulmonary embolism (PE) imaging. CT pulmonary angiography (CTPA) or ventilation-perfusion (VQ) SPECT
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Pulmonary embolism is a significant cause of mortality in the UK, accounting for 2300 recorded deaths in 2012 (British Lung Foundation, 2012), and probably more unrecorded deaths. It also imposes a significant burden on healthcare expenditure and inpatient stay (3-7 days, NHS Confederation). There are good national guidelines for PE imaging (NICE 2015). However, these are often not adhered to. Reasons include long waiting times for VQ SPECT and CTPA.

We audited the waiting times for inpatient VQ SPECT and CTPA over a 6 month period. Between March and August 2017, 43 adult patients underwent VQ SPECT and 1300 underwent CTPA. The mean average time to obtain a VQ SPECT was 26 h 41 min, compared with 12 h 34 min for CTPA.

We also reviewed the adherence to national guidelines. 89 (55%) of the CTPA patients under 40 years old had a normal chest x-ray. Therefore, according to guidelines, these patients could have undergone a VQ SPECT instead of CTPA, reducing the demand on the CT service.

The waiting time for both VQ SPECT and CTPA was longer than expected and may contribute to additional inpatient stay. As a consequence, we are reviewing the PE referral pathway to improve patient flow, optimise appropriate imaging and ultimately reduce hospital costs. With the purchase of a high specification CTPA capable SPECT/CT scanner, we are implementing a one stop service for PE imaging which would stratify patients more appropriately, optimise throughput and reduce waits for imaging.

44 Initial experience in the use of 18F-FDG PET/CT in the diagnostic pathway of infective endocarditis
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Introduction: Infective endocarditis (IE) is a debilitating disease with high mortality rates, but its diagnosis is challenging. 18F-FDG PET/CT is an established tool in a variety of infective conditions, and its role in IE is emerging.

Aim: To evaluate the IE PET/CT service introduced in 2016 in the Nuclear Medicine Department.
Material and methods: retrospective evaluation of 34 studies on 28 patients referred for an ¹⁸F-FDG PET/CT scan by the Endocarditis team for the diagnosis, staging or follow-up of patients with suspected or known IE. The PET/CT findings and clinical records before and after the scan were reviewed.

Results: Reasons for cardiac PET/CT referral included diagnosis of IE in prosthetic valve (n=15) or implantable intracardiac device (n=1), search for extracardiac source or metastatic infection (n=11), monitoring of antibiotic therapy response in proven IE (n=7).

PET/CT was positive for the diagnosis of IE in 50% (8/16), negative in 37% (6/16) and indeterminate in 13% (2/16). It identified extracardiac sources of infection and metastatic foci in 35% (10/27).

Overall, PET/CT showed at least one positive lesion in 16/27 (59%) of newly-presented patients. In the subset of patients with diagnosed IE and at least two serial scans, PET/CT results were considered in the decision to taper or escalate treatment.

Conclusion: Our preliminary data highlight the promising diagnostic role of ¹⁸FDG PET/CT in a variety of clinical settings in patients with suspected of confirmed IE. Correlation of imaging findings with the impact on clinical outcomes is needed.

45 Follow-up study of patients with ‘balanced loss’ of striatal dopaminergic nerve terminal on DaTSCAN

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Aim: To assess the clinical outcome of patients with DaTSCAN reported as ‘Balanced Loss’ (BL) of dopaminergic nerve terminals in the striata.

Method: All cases reviewed 2012 and 2015 were reviewed and those reported as BL (preserved comma appearance of striata with reduced striatal to background ratios) were selected. Minimum follow-up was 2.5 year. The selected transaxial data [processed with GE Xeleris using OSEM iterative reconstruction (10 subsets, 10 iterations), butterworth filter 0.6 cycles/cm] was exported to DaTQUANT (GE Healthcare) for quantification, and for confirmation of the initial report.

Results: There were 251 DaTSCAN studies during this period. Referrals were predominantly for diagnosis of movement disorders (238/251, 99.5%) rather than dementia related & DLB (13/251, 0.5%).

Twenty six of 251 were reported as BL. Full follow-up data was available only for internal referrals from our hospital (12/26) On quantification all 12 had reduced striatal to background ratios (mean striatal/BG Left = 1.49, Right = 1.5, normal > 1.9). 10/12 had normal putamen/caudate ratios (mean of 0.79 & 0.76 respectively), 2 had reduced putamen/caudate ratios (< 0.76) despite their visual comma appearance.

Final clinical diagnosis was PD in 8/12, DLB in 3/12, and 1/12 developed dementia with possible DLB.

Conclusion: This follow up study shows that balanced loss of dopaminergic nerve terminals in striata may be associated with final diagnosis of Lewy body disease. The apparently high number of PD in this BL study is because of our high PD patient referral pattern (only 0.5% of referrals are for dementia).

46 How common is striatal balanced loss in DaTSCAN images?

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Aim: In this study we have looked at the frequency of balanced loss in various groups of patient referrals.

Method: All scans performed between 2012 and 2016 were included in this study. DaTscans were performed and analysed according to the GE recommended parameters. Reports were issued by experienced clinicians using both images and quantification performed using DaTQUANT software (GE Healthcare). Four groups of referral reasons were identified: To establish diagnosis of Parkinson’s Disease (PD), Drug induced versus idiopathic Parkinson’s (DIP/PD), vascular versus idiopathic Parkinson’s (VP/PD) and those suspected of Lewy body dementia (DBL). The reports were categorised into one of four groups: Abnormal (with classic ‘dot’ appearance and reduced uptake), Balanced loss (preserved comma appearance but reduced uptake in quantification), striatal infarct, and normal visual and quantification.

Results: There were a total of 305 referrals. 186/251 305 had abnormal results as summarised:

<table>
<thead>
<tr>
<th>Reason for referral</th>
<th>n</th>
<th>Abnormal Balanced loss (&amp; of abnormal)</th>
<th>Vascular Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIP/PD</td>
<td>38</td>
<td>16</td>
<td>3 (16%) 0</td>
</tr>
<tr>
<td>DLB</td>
<td>13</td>
<td>4</td>
<td>5 (56%) 0</td>
</tr>
<tr>
<td>?PD</td>
<td>110</td>
<td>33</td>
<td>19 (14%) 10</td>
</tr>
<tr>
<td>VP/PD</td>
<td>8</td>
<td>11</td>
<td>6 (32%) 2</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>141</td>
<td>33 (18%) 12</td>
</tr>
</tbody>
</table>

Conclusion: Balanced loss with visually preserved striatal structure, but reduced striatal to background ratios is seen in significant proportion of all groups of patients, but particularly in patients with DLB (56%) and in those with atypical presentation (VP/DP = 32%).
47 Weight-based dosing in paediatric PET/CT: Going lower with time of flight (ToF)
Heather Williams, Ian Armstrong and Neville Wright
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**Purpose:** Growing demand for $^{18}$F-FDG PET/CT has driven efforts to increase throughput, alongside the requirement to keep patient radiation doses as low as reasonably practicable. ToF is known to increase signal-to-noise ratio (SNR) in PET images, with SNR gains maintaining lesion detectability for reduced acquisition time. Recent work at this centre has shown ToF can be used to reduce acquisition time and administered dose. The schedule of dosing and time per bed developed for adults was then extended to paediatric patients. Here we review the efficacy of this approach, using SNR in the liver as a quantitative surrogate for visual assessment of image quality.

**Methods:** Images were reviewed for 52 scans between January 2015 and April 2017 for paediatric patients with mean age 12.7 years and mean BMI 19.30 had lymphoma; 17 sarcoma; 5 another malignancy. Administered activity was compared with ARSAC and EANM prescribing schedules. SNR was measured in a 3 cm$^3$ liver VOI as the ratio of the mean to SD of voxel values within the VOI. SNR results were compared with data from 107 adult oncology patients, published previously.

**Results:** ToF has enabled dose scaling which reduced administered activity below ARSAC and EANM recommended levels by a median 32.2% and 39.2% respectively, whilst maintaining image SNR consistent with adult patients.

**Conclusion:** This retrospective study provides assurance that consistent imaging protocols for adult and paediatric oncology patients produce consistent image quality. Further work is needed to confirm imaging is optimised for the smallest patients receiving the lowest doses.

48 Concordance between dual-isotope iodine-$^{123}$I/technetium-$^{99m}$Tc sestamibi subtraction SPECT/CT & the pathology specimen confirming a single parathyroid adenoma. Are we accurately identifying the site?
Mohamed El-Sayed and Simon Hughes
Queen Elizabeth Hospital Birmingham, Birmingham, United Kingdom

**Aim:** To detect the accuracy of $^{123}$I/$^{99m}$Tc sestamibi subtraction SPECT/CT in pre-operative localisation of parathyroid adenomas leading to successful surgery. We aim to aid the surgeons in performing targeted parathyroidectomy with high cure rates.

**Method:** Retrospective analysis of 78 patients who had parathyroid localisation using $^{123}$I/$^{99m}$Tc sestamibi subtraction SPECT/CT from January 2012 to October 2017. Only the patients that had parathyroidectomy after the scan were included. We analysed the concordance between the result of the scan and the final histopathological report of the specimens excised during parathyroidectomy. We recorded the gland’s weight in addition to the levels of the parathyroid hormone and calcium pre and post operatively.

**Results:** The sensitivity of $^{123}$I/$^{99m}$Tc sestamibi subtraction SPECT/CT in our institution is 82%, the positive predictive value is 92% and the accuracy is 77%.

In the false negative group, the mean gland weight was 0.7, the mode was 0.7 and the smallest gland was 0.2 g. In the true positive group, the mean gland weight was 1.4, the mode was 0.4 and the smallest gland was 0.2 g.

There was biochemical improvement of 97% of patients after the surgery indicating surgical success.

**Conclusion:** Despite few false negative cases, $^{123}$I/$^{99m}$Tc sestamibi subtraction SPECT/CT is accurate in identifying the site of a single parathyroid adenoma even for abnormal glands of small weight. We plan to reanalyse the false negative cases to see if there is a scope for improvement.

49 Outcomes from further investigations suggested for incidental findings on FDG PET/CT
Isabel Haines, Paul Carruthers, Stewart Redman, Richard Graham and David Little
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**Purpose:** To determine whether the outcomes from subsequent investigations advised for incidental findings on FDG PET/CT correlate with the reported PET/CT findings.

**Methods:** Retrospective review of PET/CT scans performed for all indications between June 2016-2017. Patient notes were reviewed and outcomes of subsequent recommended investigations recorded and compared with the PET/CT findings.

**Results:** 479 PET/CT reports reviewed. Age range 21-89 years (mean 66 years).

124 (26%) patients had further investigations recommended for incidental findings. The most frequently recommended investigations were: colonoscopy/sigmoidoscopy (42/124 patients), ENT review (14/124 patients) and thyroid ultrasound (13/124 patients).

Of the 42 patients in whom colonoscopy/sigmoidoscopy was advised, 25 underwent colonoscopy/sigmoidoscopy.
There was an 80% correlation between the colonoscopy findings and PET/CT abnormality, mostly polyps and diverticulitis although 3 asymptomatic colonic tumours were detected.

Of 8 patients with focal prostate FDG uptake, 5 had further assessment including PSA, malignancy was confirmed in 3 patients.

Of 13 patients with focal thyroid uptake in whom thyroid ultrasound was advised, 8 underwent ultrasound with 5 reported as benign on ultrasound alone. FNA was performed in 3 patients with 2 benign and one indeterminate outcome on FNA. Further investigations were not performed for several reasons, most commonly because the patient was deceased or deemed too frail.

Conclusion: The most frequently recommended further investigation is colonoscopy/sigmoidoscopy with good correlation between the colonoscopy and PET/CT findings. PET/CT is a sensitive test and incidental findings should not be overlooked.

50 Does 18F-FDG PET/CT have a role in staging gastric cancer?
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Aim: 18F-fluorodeoxyglucose positron emission tomography–computed tomography (18F-FDG PET/CT) is valuable in the management of patients with oesophageal cancer, but its role in gastric cancer staging is debated. Our aim was to review the role of 18F-FDG PET/CT in a large gastric cancer cohort in a tertiary UK centre.

Methods: We retrospectively reviewed data from 330 patients presenting with gastric adenocarcinoma between January 2015 and December 2016 of whom 105 underwent pre-treatment staging 18F-FDG PET/CT. 18F-FDG PET/CT scans were graded qualitatively and semi-quantitatively (SUVmax) and compared with staging diagnostic CT and operative pathology results (n = 33) in those undergoing resection.

Results: Of the 105 patients (74 M, mean age 67 years) 86% of primary tumours were metabolically active (uptake greater than normal stomach) on 18F-FDG PET/CT [41/44 (93%) of the intestinal histological subtype (SUVmax 14.1 + 1.3) compared to 36/46 (78%) of non-intestinal types (SUVmax 9.0 + 0.9), $P = 0.005$]. 18F-FDG PET/CT upstaged 20 (19%) patients (13 intestinal, 5 non-intestinal), 17/105 showing distant metastases not evident on other imaging. On histology, available in 33 patients, 18F-FDG PET/CT showed low sensitivity (22%) but high specificity (85%) for nodal involvement.

Conclusion: 18F-FDG PET/CT provides new information in a clinically-useful proportion of patients, which leads to changes in treatment strategy, most frequently by detecting previously unidentified distant metastases, particularly in those with intestinal-type tumours.

51 Incremental value of PET/MRI of the spine for patients with suspected or confirmed malignancy
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Purpose: MR images suffer from susceptibility artefacts and low dose PET/CT has poor anatomical resolution for spinal cord pathology. We evaluated the incremental value of fusion of PET/MR images in patients with suspected or confirmed malignancy.

Subjects and methods: This pilot work consisted of 18 patients; 10 females and 8 males; age range 36-88 years. These patients were investigated for haematological malignancy, metastases and occult infection or malignancy. They had PET/CT to identify the site of metabolically active disease and MRI to evaluate anatomical abnormality. The MRI protocol included T1 and T2 weighted sagittal and axial sequences and in some cases STIR and post contrast sequences. Sagittal T1 and T2 images were fused with the sagittal PET/CT images. MR, PET/CT and PET/MR images were read by a Radionuclide Radiologist and lesions detected by individual modalities and discordant functional abnormalities were noted.

Results: This study included 78 lesions identified by PET/MR. Out of these 76% of the abnormalities were detected by PET/CT and 90% by MRI alone. PET to MRI discordant findings included 19 lesions. SUV, T1 and T2 values are included for all identified lesions.

Conclusion: Fusion of PET and MR is feasible and has incremental value in detection of metabolically active disease and altered morphology simultaneously. Anatomical and functional discordance exists and can present in varying forms. Combination of anatomical and functional imaging in the form of PET/MR is superior than any of the modality alone in particular for the evaluation of suspected or confirmed malignancy.

52 Role of functional imaging and PET/CT in carcinoma of unknown primary (CUP)
Radhakrishnan Jayan\textsuperscript{a,b}, Haseeb Chaudhary\textsuperscript{a}, Ranjana Dwarkanath\textsuperscript{a,c}, Rashika Fernando\textsuperscript{a}, Nagabhushan Seshadri\textsuperscript{a} and Eliyaz Ahmed\textsuperscript{b}
Purpose: Imaging and management of suspected metastatic disease without an obvious primary is challenging for clinicians and sometimes frustrating for patients. Limitation of CT and MRI in CUP mean that multimodality imaging is often needed including isotope bone scan with SPECT/CT and PET/CT using 18F-FDG and other PET tracers. NICE guidelines in 2010 recommend that investigation and management should be reviewed and guided by the CUP MDT.

Methods: We retrospectively reviewed the use of functional imaging tools including SPECT/CT and PET/CT in our regional CUP MDT from 2015 to 2017. Value of these tools in establishing a diagnosis and influencing management decisions was assessed.

Summary of results: When used selectively in an MDT setting, functional imaging tools play a valuable role in diagnosis and management of patients with suspected CUP. 18F-FDG PET/CT was found particularly useful in the following settings 1. Patients suspected of having a head and neck primary. 2. Patients suspected of having malignancies with a better prognosis such as lymphoma. 3. For guiding biopsies especially in isolated suspected skeletal metastases by choosing the metabolically active lesions and avoiding false negative histology.

Conclusion: Functional imaging tools including Technetium-99 MDP Bone SPECT/CT and 18F-FDG PET play a useful role when used selectively in assessing patients with CUP. Other tracers such as Ga-68 DOTANOC are also useful when there is suspicion of neuroendocrine aetiology. We present a series of illustrative cases with learning points.

53 Clinical impact of 18F-FDG PET/CT scans on skeletal and soft tissue sarcomas: An institutional experience
Nazia Rashid, Saima Riaz and Humayun Bashir
Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, Pakistan

Purpose: Aim of the study was to assess the impact of 18F-FDG PET/CT in management of skeletal and soft tissue sarcomas.

Methods: Retrospective review of PET/CT scans acquired from September 2010 till November 2017 using electronic Hospital information system (eHIS) in patients with established sarcoma on histopathology.

Results: A total of 39 PET/CT scans were reviewed. Age range: 8 to 66 years. The most frequent primary site of skeletal sarcoma was lower limb (n = 16) and for soft tissue sarcomas was gynaecological viscerae (n = 6). Frequent histopathology of sarcomas were: Ewing’s (n = 8), Synovial (n = 5), leiomyosarcoma (n = 6), Osteosarcoma (n = 7), Chondrosarcoma (n = 20), Rhabdomyosarcoma (n = 2), Liposarcoma (n = 2), Others (n = 7).

Clinical indications for FDG PET/CT scans identified were; Post treatment evaluation [n = 23], Restaging for recurrent disease [n = 16].

Out of 23 post treatment PET/CT scans, 65.2% (n = 15) had metabolically active residual disease, while 34.8% (n = 8) were disease free.

On restaging PET/CT scans in clinical suspicion of recurrence [n = 2], relapse was noted in 50%. In patients where recurrent disease was established on radiological imaging [n = 14], FDG PET/CT scan upstaged disease in 57% (n = 8) cases.

Overall, out of 8 cases with morphologically and metabolically unremarkable PET/CT scans, only 2 patients developed disease recurrence during the median follow-up of 12 months. While 31 cases with metabolically active disease on post treatment or restaging scans, were subjected to further treatment and management.

Conclusion: 18F-FDG PET/CT scans have significant clinical impact in restaging and post treatment evaluation of sarcomas with prognostic value in disease outcome.

54 Incidental findings on PET/CT evaluation for second primary malignancies
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Purpose: The aim of the study is to review suspicious, incidental FDG avid findings on PET/CT scan and evaluate the likelihood of a second primary malignancy.

Methods: Retrospective review of all 18F-FDG PET/CT reports acquired between January 2010 to July 31, 2017 using electronic Hospital information system (HIS) in patients with suspicious FDG avid findings which appeared unrelated to the primary malignancy.

Results: A total of 17092 PET/CT scans were done in the defined 91 months period which reveal incidental, suspicious uptake in sixty (0.35%) patients. Age range: 8 to 84 years. Among primary malignancies Gastro-esophageal = 13, Lung = 13, Lymphoma = 11, Head and neck = 8, Gynaecological = 4, Colo-rectal = 7, others = 4.

Of the 60 suspicious findings based on appropriate clinical, radiological and histopathological correlation 18 (30%) were classified as definite malignant, 34 (57%) were probably malignant but further work up was not undertaken due to disease status, 6 found out to be non-malignant process related and two were found to be related to primary disease process.
Most common sites for abnormal findings suspicious for second primary malignancy are gastrointestinal tract = 18, Thyroid = 11, Lymphoma = 4, Lung = 9, renal = 7, Head & Neck = 2, Bladder = 2, Others = 7.

SUV values of abnormal findings ranges from 2.0 to 19.3

Conclusion: Suspicious incidental findings on $^{18}$F-FDG PET/CT should be carefully assessed for the possibility of a second primary malignancy as close to 30% of such finding were proven to be synchronous second primary malignancies.

55 Detailed description of activity distribution in DOTA peptide PET/CT in clinically acquired scans

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Aim: To produce a detailed description of the normal distribution of DOTA (1,4,7,10-tetraazacyclododecan-1,4,7,10-tetraacetic acid) peptide (DOTA peptide) seen on positron emission tomography combined with computed tomography (PET/CT).

Method: Retrospective analysis of 25 neuroendocrine tumour (NET) patients with DOTA peptide PET/CT. Normal patterns and variations described. Attention to variation of normal patterns in the pancreas, a region for primary pancreatic NET but multifocal variation.

Results: Important patterns of DOTA peptide uptake on PET/CT are described with average SUVmax and any important variations. These included intravascular intracranial venous sinus pattern (average SUVmax 0.73, range 0.6-1.4), pituitary/cavernous sinus (average SUVmax 3.4, range 2.0-5.0), oral cavity (average SUVmax 0.9, range 0.3-1.3), ascending aorta (average SUVmax 0.9, range 0.5-1.3), mediastinal nodes (average SUVmax 0.9, range 0.5-1.4), and pulmonary (average SUVmax 0.4, range 0.2-0.4). Important variation seen in undiseased liver uptake (average SUVmax 3.0, range 1.6-4.4), splenic uptake (average SUVmax 13.0, range 5.0-21.0), pancreatic uptake (multifocal uptake seen in patterns from no detectable uptake to 4 sites with no disease on multiple other investigations, average SUVmax 8.2, range 3.0-15.6) and renal parenchymal uptake (excluding calyceal activity, average SUVmax 8.3, range 4.3-12.3). Other sites of normal activity include adrenal uptake (average SUVmax 7.7, range 2.9-11.8), gastrointestinal tract (variable uptake in small and large bowel, average SUVmax 1.6, range 0.7-3.1), and bone marrow (average SUVmax 0.7, range 0.3-1.0).

Discussion: This is the most detailed description of normal patterns of DOTA peptide PET/CT. Variable patterns have not been described before with impact of the use of the Krenning score.

56 Bone marrow uptake pattern on baseline FDG PET/CT predicts survival in treatment naïve B-cell derived non-hodgkin lymphoma

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Objective: Non-Hodgkin Lymphoma (NHL) is a common malignancy, accounting for ~ 4% of new cancers annually. B-cell derived being more common and aggressive variant constitutes ~ 90% of total NHL cases. $^{18}$F-FDG PET/CT has become a standard clinical tool for staging and treatment response assessment in lymphoma. We aimed to evaluate the role of bone marrow uptake (BMU) pattern in predicting the progression-free survival (PFS) and overall survival (OS) in treatment naïve B-cell derived NHL patients.

Methods: Data of 191(127 male) consecutive newly diagnosed, advanced stage (2b, 3&4), adult NHL patients (median age 55 years) was retrieved. The SUVmax values of mediastinum blood pool, liver and bone marrow were calculated. BMU was categorized into normal (SUVmax ≤ liver), diffuse (> liver) and focal (≥ 2 lesions) patterns. PFS and OS were assessed using Kaplan-Meier survival plot.

Results: Focal BMU was observed in fifty-four patients. Diffuse BMU was observed in forty-nine patients while 88 patients showed normal BMU. Disease recurrence/progression was observed in 34 (18%) patients on follow-up $^{18}$F-FDG PET/CT while 48 patients (25%) expired during a median follow-up of two years. Patients with focal BMU had a significantly inferior PFS and OS compared to patients with diffuse BMU (60.1% vs. 71.4% respectively; P-value 0.006), and diffuse BMU patients also had significantly lower PFS & OS compared to patients with normal BMU (71.4% vs. 87.8%; P < .001).

Conclusion: We conclude that patients with increased BMU (focal as well as diffuse) in initial staging $^{18}$F-FDG PET/CT had a significantly poor PFS and OS compared to patients with normal BMU.

57 A Phantom study towards quantification of tektrotyd uptake in SPECT/CT for neuroendocrine tumours

Belinda Stiles and Andy Irwin

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Aim: This study aims to take initial steps in assessing the quantification accuracy and image quality of xSPECT Quant (Siemens Healthineers) for neuroendocrine tumours using $^{99m}$Tc-Tektrotyd.
Method: A NEMA IEC phantom was used imaging using 5:1 sphere-to-background ratio of 99mTc. A range of different imaging protocols were used; each was reconstructed using the pre-sets provided within the xSPECT Quant package. The measured activity concentration was compared against the known activity concentration for each of the spheres. Image quality was initially assessed using measured noise in the uniform area of the phantom and comparison made between the current Flash3D (OSEM) reconstruction and various xSPECT (OSCG) reconstructions.

Results: The image noise changes significantly with the number of iterations and subsets (48/1S = 10% noise, 8/16S = 17% noise). However, unlike in OSEM, the product of the iterations and subsets is not correlated with noise. The accuracy of the xSPECT Quant images was also found to change with reconstruction parameters but was not affected by the image acquisition parameters. The maximum activity concentrations were found to agree within 15% for lesions with a diameter greater than 20 mm for reconstructions using 8 iterations and 6 subsets. However, this was the reconstruction with the highest level of noise.

Conclusions: This phantom study has characterised images across a range of acquisition and reconstruction parameters and established that tumours of over 20 mm can be accurately quantified. This has provided a basis on which clinical studies can be carried out to assess the clinical utility and impact of quantification.

58 Can parameters estimated by the analysis of technetium-99m-MAG3 dynamic renograms determine patient's CKD stage?
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Aim: Investigate if parameters calculated by most software tools during technetium-99m-MAG3 dynamic renogram analysis can be used to determine if the patient’s Chronic Kidney Disease (CKD) stage > 2. In particular, time to peak, percentage of total kidney uptake at 2 min and 3 min compared to uptake at 30 min (t2/30 min and t3/30 min) were explored.

Method and results: Xeleris ManRen plugin was used to analyse, via the Rutland-plot method, 20 dynamic 99mTc-MAG3 renogram studies. The background and renal regions of interest (ROI) were drawn according to an international consensus report (Prigent A. et al., 1999, 29(2):146. Semin. Nucl. Med.). The Rutland-Plot slope interval was set between 1 min and 2.5 min post-injection. The AUC of Non-Parametric ROC curves were calculated via a trapezoidal method. All parameters were found to have a performance statistically different from random: t-2 min: AUC = 0.9, 95% C.I. = (0.8, 1.0), P < 0.001; t-3 min: AUC = 0.9, 95% C.I. = (0.8, 1.0), P < 0.001; time-to-peak: AUC = 0.8, 95% C.I. = (0.6-1.0).

A pair wise comparison of each parameter revealed differences in performance, with indication that t-3/30 min might be the best classifier; however, this difference was not statistically significant. The best threshold for t-3/30 min, determined by calculating Youden’s J statistics, was <11% with sensitivity = 1, 95% C.I. = (0.67,1); specificity = 0.73, 95% C.I. = (0.39,0.94); PPV = 0.75, 95% C.I. = (0.42,1.00); NPV = 1, 95% C.I. = (0.63,1.00).

Conclusion: t2/30 min, t3/30 min and time-to-peak are promising estimators of CKD stage > 2. However, to confirm if these factors have clinically useful accuracy, we recommend repeating this study with a larger sample, to investigate its robustness with multiple operators and sites, and the influence of using alternative renogram analysis methods.

59 The role of cardiac PET/CT imaging in patients with suspected cardiac sarcoidosis: A study on quantitative resting myocardial blood flow and outcomes
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Background: As part of cardiac sarcoidosis (CS) PET/CT imaging, myocardial blood flow (MBF) is quantified using various processing tools. There is little evidence on the degree of agreement between tools, and the relationship between this agreement and operator confidence in image processing. This study compares different software tools for MBF quantification, and examines patient outcome following PET/CT.

Methods: 13N-Ammonia MBF was measured using four processing tools. Inter-software, inter- and intra-operator results were compared and classified according to operator confidence in image processing. Clinical records were reviewed.

Results: 24 patients (51±14 years; 71% male) were included. Inter-software resting MBF was similar (PMOD, 0.67±0.21; Carimas, 0.68±0.17; SyngoMBF, 0.71±0.15; and Corridor 4DM, 0.72±0.18 ml/min/g; P = 0.2). Inter-operator agreement was good to excellent (PMOD ICC, 0.93 (95% CI, 0.84 to 0.97); Carimas ICC, 0.94 (95% CI, 0.85 to 0.98); P < 0.0001; SyngoMBF ICC, 0.65 (95% CI, 0.20 to 0.85), P < 0.007); the latter improved when only results with a high confidence score were compared (SyngoMBF ICC, 0.83 (95% CI, 0.52 to 0.94)). Inter-operator agreement findings were similar. Patients were followed up for 31 (24-40) months. There were no deaths. Four patients received an ICD. Definite active CS was diagnosed or ruled out in 1 and 9 patients, and judged probable or possible in 3 and 5 patients, respectively.
Conclusion: $^{13}$N-ammonia MBF quantification is not influenced by differences in data processing tools. Patients with suspected CS, referred for PET/CT imaging, have a favourable short-term prognosis although a definite diagnosis was not reached in a significant proportion of patients.

60 Emotional dysfunction and DaTSCAN in Parkinsonism

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School of Psychology, University of Sussex, Brighton, United Kingdom, Brighton and Sussex Medical School, Brighton, United Kingdom, Brighton and Sussex University Hospital NHS Trust, Brighton, United Kingdom, University Hospital of Wales, Cardiff, United Kingdom and University of Cardiff, Cardiff, United Kingdom

Purpose: Emotional dysfunction affects patients suffering from PD undergoing dopaminergic treatment. This study aimed to assess emotional responsiveness in relation to DaTSCAN findings in patients with Parkinsonism.

Methods: 20 drug-naive patients presenting with motor symptoms typical of PD completed mood state questionnaires before undergoing diagnostic DaTSCAN. The division of patients into sub-groups was carried out by visual assessment by two independent experienced observers, determining whether patients were in the PD or Control subgroup. Dopamine transporter striatum, putamen, caudate/background (bck) and putamen/caudate ratios were semi-quantitatively measured using DaTQUANT GE software.

Result: 11 patients were diagnosed with PD, while 9 subjects had scans without evidence of dopaminergic deficit (SWEDD; Control). Mood state questionnaires demonstrated that PD group had decreased levels of negative mood, and an increased level of arousal compared to Controls, but no differences were found in positive mood state. Moreover, diminished striatal dopamine transporter was associated with lower levels of negative emotions, as higher ratings of anger ($r = 0.575; P = 0.016$), fatigue ($r = 0.746, P = 0.001$) and confusion ($r = 0.561, P = 0.019$) were positively correlated with putamen/caudate ratios ($R > L$) on DaTSCAN. The opposite was true for the level of arousal: a higher self-reported arousal was associated with a lower right putamen/caudate ratio on DaTSCAN ($P = -0.581; P = 0.014$). Only fatigue was positively correlated with putamen/bck ratio ($r = 0.564, P = 0.018$).

Conclusion: These findings point out to the importance of evaluating mood states in PD. DaTSCAN putamen/caudate but not striatum/bck ratios were associated with emotional responsiveness in patients with PD at time of their diagnosis.

61 Dose reduction in dual energy $^{123}$I/$^{99m}$Tc-MIBI SPECT/CT imaging for parathyroid adenoma localisation

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Sandwell & West Birmingham Hospitals NHS Trust, Birmingham, United Kingdom

Introduction: Local wholebody dose for Dual Energy $^{123}$I/$^{99m}$Tc-MIBI SPECT/CT is 12.3 mSv where the recommended 20MBq of $^{123}$I (ARSAC DRL) makes up a significant proportion (6.1 mSv). In this study we have examined whether if reducing the injected activity of I-123 by half would still maintain the same diagnostic accuracy of the test, while significantly reducing the patient radiation dose.

Method: Retrospective data from 25 patients (M = 4, F = 21) sequentially acquired on a GE Discovery SPECT/CT system in 2015 were selected. Raw $^{123}$I planar and SPECT data were resampled to 50% level using GE poisson resampling software to mimic half activity. Standard processing was performed using GE Xeleris and resultant mages were interpreted by one experienced viewer. Information on number of foci (if found) and precise location were recorded.

Analysis: Findings from the resampled images were compared to the published clinical report. Concurrences/differences were noted.

Results: 23/25 cases showed perfect concurrence in terms of foci number and localisation. 2/25 cases were difficult to interpret both in the full and simulated half activity studies and differed only slightly in terms of clinical interpretation, owing to uptake difficulties (low Iodine uptake, and multi-nodular). Further detailed review of these 2 cases concluded there were no significant differences between the original and resampled images.

Conclusion: Reducing I-123 activity by half from 20MBq to 10 MBq results in no changes to clinical interpretation of the images. The patient benefits with a reduction in total wholebody dose of 25% (12.3 to 9.25 mSv).

62 Gastric emptying: Establishing normal ranges for most commonly used practical and simple meals in the UK

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City Hospital, Birmingham, United Kingdom

Aim: We found a wide variation in gastric emptying meals and techniques in our recent nationwide audit (Hansrod S. 2015, 36:532 Nucl. Med. Comms.). Two relatively simple
and most commonly used meals (scrambled egg sandwich and porridge) were studied to establish normal ranges, in an attempt to propose a universally acceptable protocol.

**Method:** 25 volunteers (10 males, 15 females, age range 22-61) with no history of GI symptoms or diabetes were studied. Each volunteer consumed two meals on two separate days: gluten-free porridge (40 g in 200 ml whole milk), and scrambled eggs with 2 slices of bread. Anterior-posterior 2-minute static images were acquired with the patient standing between the detectors. Images were acquired every 5 min over a two-hour period, followed by a single image at 3-hours. Lag time, half-emptying time, peak emptying rate, time-to-peak-emptying, exponential half-life and 3-hour retention were calculated. Paired t-test was used for comparisons.

**Results:** The table below shows the normal ranges at the 95% confidence interval.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum</th>
<th>Change</th>
<th>From</th>
<th>Original</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag-time</td>
<td>10 min</td>
<td>15 min</td>
<td>20 min</td>
<td>30 min</td>
<td>60 min</td>
</tr>
<tr>
<td>Half-emptying-time</td>
<td>57%</td>
<td>157%</td>
<td>182%</td>
<td>148%</td>
<td>2134%</td>
</tr>
<tr>
<td>Peak-emptying-rate</td>
<td>3%</td>
<td>13%</td>
<td>21%</td>
<td>14%</td>
<td>130%</td>
</tr>
<tr>
<td>Time-to-peak-emptying</td>
<td>10%</td>
<td>26%</td>
<td>47%</td>
<td>63%</td>
<td>116%</td>
</tr>
<tr>
<td>Exponential Half-Life</td>
<td>4%</td>
<td>13%</td>
<td>19%</td>
<td>23%</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Conclusion:** Increasing the imaging intervals has different effects on different parameters. Half-emptying time and exponential half-life are particularly robust to increased imaging intervals. Lag-time and time-to-peak emptying are the most sensitive and require frequent imaging (interval <10 min).

**63 Gastric emptying: Does more frequent imaging add value?**

Gregory James, Shazmeen Hansrod, Joseph O’Brien, Joseph Burmiston, Bill Thomson and Alp Notghi
City Hospital, Birmingham, United Kingdom

**Aim:** Our standard gastric emptying protocol is to acquire images every 5 min over a 2-hour period. The aim of this study is to examine whether less frequent imaging is acceptable to measure accurate gastric emptying functional parameters.

**Method:** 46 datasets where images were acquired every 5 min were reprocessed as if imaging was performed in 10, 15, 20, 30 and 60 min intervals. Lag-time, half-emptying-time, peak-emptying-rate, time-to-peak-emptying and exponential half-life were derived from a power-exponential model for each dataset. The values were compared to the original to assess for differences in results due to imaging frequency.

**Results:** Half-emptying time and exponential half-life gives reliable results up to intervals of 30 min (changes of up to ±14% and ±23% at 30 min respectively). However, lag-time and time-to-peak emptying can change by more than 100% with imaging intervals greater than 10 min (change of up to ±157% and ±102% at 15 min respectively). The table below shows the maximum percentage change for each imaging interval.

<table>
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</tr>
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</table>

**Conclusion:** We have chosen the two most popular and practical meals for our study. Normal ranges for the two meals have been established. Porridge showed significantly faster transit than scrambled egg for all measured parameters. This would be a suitable alternative for patients who are unable to eat egg sandwiches (vegan/gluten sensitive).

**64 Is biliary hyperkinesia an indicator for surgery?**

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\(^a\)City Hospitals Sunderland, Sunderland, United Kingdom and \(^b\)Queen Elizabeth Hospital, Gateshead, United Kingdom

Biliary hyperkinesia is not widely recognised and neither the British Gastroenterology Society nor the American Neurogastroenterology Society currently issue guidelines for its management. We propose that a rapidly emptying gall bladder could also be responsible for patients’ pre-operative symptoms. Our previous clinical practice was to recommend immediate surgery for patients with gall bladder hypokinesia (gall bladder ejection fraction, GBEF <35%); patients with a normal GBEF (>35%) would also be offered surgery if symptoms persisted for several months or more. We reviewed 105 patients referred for a biliary scintigraphy scan and correlated their gall GBEF with their pre and post-operative symptoms. We defined biliary hyperkinesia as a GBEF of greater than 80% (Holes-Lewis \textit{et al}, JNM 50 (2) 2009). We found that 23/105 patients had a hyperkinetic GBEF and 24/105 patients had a hypokinetic GBEF. 34 patients (5 hyperkinetic, 15 hypokinetic and 14 normal) subsequently opted for surgery with 28/34 reporting an improvement in their symptoms post operatively. 4/5 of the hyperkinetic GBEF patients who underwent surgery reported an improvement in their symptoms. We conclude that whilst GBEF alone does not necessarily indicate surgical intervention, symptom improvement can be observed in patients with a hyperkinetic GBEF. Clinical
practice was reviewed and immediate surgery is now also offered to patients with a hyperkinetic GBEF.

65 Exploring quantitative parameters in defaecography
Jonathan Price and Andrew Irwin
St George's University Hospitals, London, UK

The purpose of the audit was to review the quantitative parameters calculated for nuclear medicine defaecography studies with reference to the final clinical interpretation. Quantitative parameters over a five year period were reviewed. The clinical reports were interrogated to explore the relationship between the quantitative parameters and the overall interpretation of the study. The patients were sorted into groups with reports having the clinical key words of ‘impaired’, ‘moderate’ and ‘good’ rectal excretion. These were compared with the total rectal excretion percentage value. Similarly, the calculated activity within the rectocele was compared with patients reports with the key words ‘no’, ‘small’ and ‘large’ rectocele.

The department received 201 patient referrals over the audit period. The average rectal excretion was 63% ± 17% (mean ± SD). The mean value in the three clinical interpretation scores were 49 ± 20% (impaired), 64 ± 8% (moderate) and 75 ± 6% (good). The average proportion of activity in the rectocele compared to the rectum was 20 ± 13% (mean ± SD). The average value in the three clinical groups was 17 ± 14% (no), 21 ± 11% (small) and 42 ± 17% (large rectocele). A positive correlation (rs = 0.55, P < 0.001) was observed between the calculated total rectal excretion and the fast excretion rate.

The average quantitative parameters agree with the clinical interpretation scores. However, a large variance was observed in the quantitative parameters for the abnormal patient group. This suggests that a visual interpretation of nuclear medicine defaecography is essential for accurate reporting.

66 The role of skeletal SPECT/CT in the diagnosis of active bony pain generators in patients with persistent or recurrent lumbar pain following lumbar spine stabilisation surgery
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Institute of Nuclear Medicine, University College London Hospital, London, United Kingdom, Department of Nuclear Medicine, Royal Free Hospital, London, United Kingdom, Department of Radiology, Royal National Orthopaedic Hospital, London, United Kingdom, Department of Orthopaedics, Royal National Orthopaedic Hospital, London, United Kingdom

Background: Despite recent advances in lumbar spine stabilisation surgery (LSSS), there is a high number of patients complaining of persistent/recurrent lumbar pain after LSSS.

Objective: To identify the patterns of osteoblastic activity in patients with persistent/recurrent lumbar pain post-LSSS using [99mTc]Tc-HEDP SPECT/CT.

Material & methods: One hundred eighty seven patients (median 57 years old, 70/187 male) with persistent/recurrent lumbar pain following LSSS who underwent SPECT/CT after equivocal conventional imaging were included in the study. Tracer uptake was assessed within the LSSS fused segment (FS) and/or adjacent segments (AS) and the uptake graded as (i) high, ≥ iliac crest uptake, (ii) mild, ≥ non-diseased vertebrae but < iliac crest uptake or (iii) negative, respectively.

Results: In 160/187 (85.6%) patients, SPECT/CT showed mild-to-high tracer uptake within the LSSS region. 56.7% of patients had pathological uptake within the FS, while 54.0% had abnormal activity in AS (39% high AS uptake compared to 15% mild AS uptake, P < 0.05). Positive FS findings were common at interval of <2 years post-LSSS (34.2%), but significantly decreased hereafter (10.7%, P < 0.05). High AS uptake was noted in 12.8% of patients <2 years post-LSSS, which increased to 27.8% after >6 years post-LSSS (P < 0.05). High AS uptake was more frequent in patients with 1-segment compared to multisegment LSSS (26.7% vs. 7.5%, P < 0.05). 20.3% of cases were diagnosed as likely unstable LSSS, the remaining were assigned to mechanical stress.

Conclusion: Skeletal SPECT/CT is a sensitive diagnostic tool to identify osteoblastic activity which may be a pain generator in FS and AS in patients with persistent/recurrent pain after lumbar surgery.

67 Role of technetium-99m-Methyl diposphonate ([99mTc]Tc-MDP planar scintigraphy and SPECT/CT in skeletal pathologies
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Department of Nuclear Medicine, All India Institute Of Medical Sciences, New Delhi, India

Purpose: To test the diagnostic ability and concordance between [99mTc]Tc-MDP planar scintigraphy and SPECT/CT in various skeletal pathologies.

Methods: Fifty six patients were initially included in the study. Prospective 1 year follow up was available in 50 patients. Initial diagnosis was made on [99mTc]Tc-MDP planar scintigraphy (PS). Additional SPECT/CT was acquired in 36 patients wherever diagnosis cannot be made on PS alone.

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Results: The age of the patients was 35.7 ± 15 years, range 10-76 years. There were 33 male and 17 female patients. Out of 36 patients, SPECT/CT was true positive in 30 patients, true negative in 1 patient, false positive in 4 patients and false negative in 1 patient. Planar results were uncertain in 17 patients, hence SPECT/CT showed an incremental value of 56.7% (17/30). The planar results of 13 patients was correlated with the 30 true positive patients on SPECT/CT where results of 9 PS was true positive and 4 PS was false negative. The concordance of PS and SPECT/CT for true positive patients was 69.2% (9/13) and discordance was 30.8% (4/13). Out of 4 patients which were false positive on SPECT/CT, 3 were false positive on PS and 1 was uncertain in PS. 1 true negative on SPECT/CT was also true negative on PS. 1 false positive on PS and 1 was uncertain in PS. 1 true negative on SPECT/CT was false negative on PS.

Conclusion: SPECT/CT showed an incremental value over PS with many true positive patients on follow up and also helped in accurate patient management.

68 Pre-treatment stratification of patients receiving radium-223 dichloride for bone metastases from castration-resistant prostate cancer
Lawrence Kenning, Graham Wright, Sanjay Dixita, Andy Beavis
Hull and East Yorkshire Hospitals NHS Trust, Kingston Upon Hull, United Kingdom and University of Hull, Kingston upon Hull, United Kingdom

Purpose: Identify prognostic biomarkers in hormone-relapsed prostate cancer patients with bone metastases undergoing Radium-223 dichloride (Ra-223) treatment.

Background: As a relatively new treatment, identification of patients suitable for Ra-223 dichloride (Xofigo) is still being determined. Current selection criteria utilise performance score and haemoglobin (Parker C. 2013. N Engl J Med; 369:213-223), however, this may not accurately represent the extent of disease and most suitable candidates. This retrospective audit investigated the predictive value of other pre-treatment biomarkers to help identify patients likely to benefit from Ra-223 treatment.

Methods: All patients who had received at least 1 cycle of Ra-223 were included. Administered dose, compliance, toxicity, biochemical blood profiles, performance status, pain, previous treatments and survival were recorded. Continuous variables were dichotomised using median values prior to Kaplan-Meier Survival Analysis. Cox regression analysis was performed using a Backwards-Wald methodology.

Results: 55 patients (34 patients (62%)-6 cycles, 21 patients - 1-5 cycles) had finished Ra-223 treatment between 30/12/2014 and 01/01/2017. Censor date was 20/09/2017. Significant pre-treatment predictors of improved survival were: PSA <108.3 μg/litre, ALP <146 μl, Lymphocyte <3.18. Pre-treatment Docetaxel status, PSA, ALP, Neutrophil and Lymphocyte measurements were independent predictors of survival following Cox regression analysis. Post-treatment PSA, ALP and 6 cycle completion status were significant survival predictors after Cox regression analysis. Pain scores were not documented; however, 28/37 patients reported reduced pain.

Conclusion: Docetaxel status, PSA, ALP, Neutrophil and Lymphocyte measurements were stronger predictors than performance score and haemoglobin at stratifying patients who could benefit from Ra-223.

69 Survival benefit of radium-223 therapy for bony metastatic castration resistant prostate cancer
Ganesh Vigneswaran, Peter Jarvis and Francis Sundram
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Background and Aims: The use of Radium-223 therapy for bony metastatic castration resistant prostate cancer (mCRPC) has increased due to improved access and strong evidence base. We reviewed the survival benefit of this therapy in our patient cohort.

Method: Retrospective analysis over 42 months (March 2014 – September 2017) of all patients who were administered radium therapy. Patient information was obtained from the Wessex MDT database and UHS electronic patient records. Kaplan-Meier survival curves and hazard ratios were calculated to quantify the effect of therapy on overall survival (OS) for patients who completed the recommended 6 treatment cycles versus patients who did not. We also evaluated the survival benefit in relation to the number of treatment cycles completed.

Results: 129 patients were identified. The median OS for those who completed 6 cycles (n = 65) was 802 days versus 288 days for those who completed less than 6 cycles (n = 64). There was a statistically significant OS benefit for those who completed 6 cycles (P<0.01, hazard ratio 0.31). Further analysis, using a multi-way ANOVA showed an increasing survival benefit in relation to the number of therapy cycles completed (P = 0.0008), particularly following completion of 3 cycles.

Conclusion: Radium-223 therapy has a significant survival benefit and OS increases with the number of treatment cycles completed. There may be concerns regarding patient suitability for mCRPC therapies. For patients in whom mCRPC therapy might otherwise not have been considered, the survival benefit of radium therapy is a vital consideration when appropriate patients are offered treatment.
70 Prognostic value of PSA as a marker for survival in bony metastatic castration resistant prostate cancer patients receiving radium-223 therapy

Ganesh Vigneswaran, Peter Jarvis and Francis Sundram
University Hospital Southampton NHS Foundation Trust, Southampton, United Kingdom

**Background and Aims:** Evidence for the survival benefit of Radium-223 therapy in bony metastatic castration resistant prostate cancer (mCRPC) is well-established. However, there remains no clear consensus regarding prognostic markers for survival. We investigated the relationship between PSA (prostate specific antigen) and survival and assessed whether PSA could be used as a prognostic marker in patients receiving Radium-223 therapy.

**Method:** Retrospective study over a 42 month period (March 2014 – September 2017). Data was obtained from the Wessex MDT database and UHS electronic patient records. PSA levels before and after the recommended 6 cycles of radium therapy were noted. Linear regression analysis (robust fit) was used to assess the relationship and outliers were removed from the regression analysis.

**Results:** Of 65 patients who completed 6 cycles of radium therapy, data was available for 21 patients. The median PSA after and prior to therapy was 170 ng/ml and 120 ng/ml respectively. Robust linear regression analysis demonstrates a statistically significant inversely proportional relationship between rise in PSA and survival. The resulting fitted linear regression line was given by: Survival (days) = −0.64 PSA difference + 518, (R² = 0.3, P = 0.02).

**Conclusion:** We propose linear regression to model survival based on change in PSA. A fall or less dramatic rise in PSA level is associated with a proportional increase in survival and therefore PSA could be used as a prognostic marker for survival. PSA measurements at predetermined time points should be considered in those receiving Radium-223 therapy for bony mCRPC.

71 Does prior chemotherapy affect the number of radium-223 therapy cycles completed and post radium therapy survival?

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**Background:** NICE guidelines recommend radium-223 therapy for symptomatic bony metastatic castration resistant prostate cancer (mCRPC) patients who had previous chemotherapy or when chemotherapy is contraindicated or not suitable. The full course of 6 radium therapy cycles improves overall survival, however not all patients are able to complete 6 cycles. We investigated whether prior chemotherapy affected both the number of radium therapy cycles completed and also survival following radium therapy.

**Method:** Retrospective study of all patients undergoing radium therapy over a 44 month period (January 2014–September 2017). Clinical notes were reviewed to determine prior chemotherapy status. The number of radium therapy cycles completed and survival duration post first cycle were evaluated.

**Results:** 123 patients had radium therapy; of whom 66 (54%) had no previous chemotherapy and 57 (46%) had previous chemotherapy. A greater proportion of patients with no previous chemotherapy (43/66 = 65%) completed 6 cycles of radium therapy, when compared to patients who had previous chemotherapy (26/57 = 46%) (P = 0.029). There was however, no significant difference in survival between these 2 groups (median survival: previous chemotherapy = 518 days vs. no previous chemotherapy = 590 days; P = > 0.05).

**Conclusion:** Patients who did not have chemotherapy prior to radium therapy were more likely to complete the full 6 cycles of radium therapy. These patients may be fitter and more likely to tolerate treatment. However, there was no significant difference in survival duration following radium therapy, whether or not they had received previous chemotherapy.

72 radium-223 therapy at a tertiary referral centre: Review of referral and treatment trends over a 4 year period

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**Background:** Radium-223 therapy for bony metastatic castration resistant prostate cancer (mCRPC) prolongs overall survival, improves quality of life, is NICE approved and commissioned by NHS England. The course of treatment consists of 6 cycles, administered intravenously every 4 weeks. We introduced the nuclear medicine led radium service at our centre in 2014. We evaluated our referral and treatment trends over a 4 year period.

**Method:** Retrospective review of our departmental radium database, with analysis of referrals and treatments over a 44 month period (January 2014 to September 2017).

**Results:** In total, there were 179 referrals and 589 treatments to date. Referral volumes increased from 31 in 2014, 58 in 2015, 45 in 2016 and 45 in 2017 to date (65 projected for entire 2017). Treatment volumes also
increased from 67 in 2014, 194 in 2015, 186 in 2016 and 142 in 2017 to date (213 projected for entire 2017). The 2016 dip was due to uncertainty around NICE appraisal outcomes and commissioning approval. The increased demand has resulted in increased time from referral to first clinic appointment (2014 = 14.6 days vs. 2017 = 19.0 days).

Conclusion: Radium-223 referrals and treatments have increased over the past 4 years. To address the increased demand and to maintain high quality, timely service provision, it is vital to ensure adequate workforce and resource planning. The increased time between referral and first clinic appointment may result in treatment commencement delays, which could negatively impact on patients who already have limited survival.

73 Molecular radiotherapy with $^{67}$Ga-trastuzumab
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Previously, we showed that Auger electron emitter Gallium-67 (Ga-67) causes DNA damage in cell-free systems and cell kill in non-targeted cell studies. Here, we target Ga-67 to breast cancer cells using trastuzumab and compare toxicity to well-described Auger electron emitter, Indium-111 (In-111).

Methods: THP- and DOTA-trastuzumab were prepared and labelled with Ga-67 and In-111, respectively. Radiopharmaceuticals (0.19 MBq/μg) were tested for their internalisation and effects on viability (dye exclusion) and clonogenicity of Her2-positive (HCC1954) and –negative (MDA-MB-231) cell lines. Microautoradiography of cells in 18% gelatin was also performed.

Results: Radiopharmaceuticals specifically bound Her2-positive HCC1954 cells. At 4 nM, $^{67}$Ga-THP-trastuzumab showed significantly higher cell binding uptake (10.69 ± 1.32%) than $^{111}$In-DOTA-trastuzumab (6.15 ± 1.64%; $P = 0.01$) although internalised fractions were equal as were cell-binding percentages at 100 nM. Microautoradiography showed radioactivity bound individually to varying degrees (from 10 to 90 silver grains per cell). Viability and clonogenicity decreased with increasing radiolabelled trastuzumab concentration. In HCC1954 cells, the surviving fraction after treatment at approximately 0.1 Bq/cell $^{67}$Ga-THP-trastuzumab (average) reduced to 0.38 ± 0.13, with fewer cells surviving than for $^{111}$In-DOTA-trastuzumab (0.55 ± 0.16; $P = 0.03$). Radiopharmaceutical treatment of MDA-MB-231 cells or non-internalised activity in HCC1954 cells did not affect cell viability or clonogenicity.

Conclusion: $^{67}$Ga-THP-trastuzumab and $^{111}$In-DOTA-trastuzumab both specifically bind HER2-positive cells and reduce their viability and clonogenicity. This shows Ga-67 holds promise as a therapeutic radionuclide as a targeted radiopharmaceutical however non-homogeneous uptake amongst cells needs further investigation.

Acknowledgements
Part-funded by the Academy of Medical Sciences and Malaysian Ministry of Education.

74 Impact of intravenous contrast enhanced SPECT/CT on diagnostic confidence in parathyroid adenoma localisation
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Purpose: Accurate localisation of parathyroid adenomas enables minimally invasive parathyroidectomy. In 2015 we introduced IV contrast to our 99mTc-MIBI SPECT/CT protocol. Our aim was to determine the impact of contrast on diagnostic confidence in identifying parathyroid adenomas.

Method: Retrospective review of 30 patients undergoing SPECT/CT without IV contrast and 30 patients undergoing SPECT/CT with IV contrast.

Results: In the non-contrast group an adenoma was identified in 70% of patients on the CT imaging alone (average confidence level 1.8). An adenoma was identified in 68.9% of patients on the fused SPECT/CT (average confidence level 2.9). $P < 0.05$ comparing confidence between non-contrast CT alone and fused.

In the IV contrast group an adenoma was identified in 64.4% of patients on the CT imaging alone (average confidence level 2.2). An adenoma was identified in 70% of patients on the fused SPECT/CT (average confidence level 3.0). $P < 0.05$ comparing confidence between IV-contrast CT alone and fused.

Comparing non-contrast CT alone with IV contrast CT alone did not demonstrate a significant difference ($P = 0.08$). Comparing fused non-contrast with fused IV contrast did not demonstrate a significant difference ($P = 0.60$).
75 PRRT improved survival in patients with neuroendocrine neoplasm and carcinoid heart disease treated surgically in a centre of excellence
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Hypothesis: Peptide Receptor Radionuclide Therapy (PRRT) with 177Lu-Dotatate can be used safely in patients with neuroendocrine neoplasms (NEN) with carcinoid heart disease (CHD) and may be associated with survival advantage by reducing exposure of the valves to high doses of vasoactive peptides.

Method: A retrospective case notes review of 18 NEN patients (mean age 60 years, 9 male, 9 female) between 2003-2017 with carcinoid syndrome and surgically treated CHD.

Results: All patients were treated with sandostatin receptor antagonists and underwent cardiac valvular surgery, 3 additional CABG. 9 were treated with PRRT (mean 3 cycles), 6 underwent surgery with PRRT on progression. Time to progression from surgery to first PRRT was mean 25.1 months. 2 patients had PRRT pre- and post-operatively, after one cycle PRRT, undergoing surgery 68 and 101 days post PRRT. One patient received PRRT, surgery planned. All PRRT included 5% arginine plus 5% lysine, 1 litre over four hours. No patients developed peri-treatment cardiac complications.

Discussion: PRRT is safe in the setting of carcinoid heart disease. The overall survival of those having both surgery and PRRT is greater than surgery alone. This supports the hypothesis that valve protection with PRRT results in improved outcome following surgery. Further evidence for PRRT in the neo-adjuvant setting prior to cardiothoracic surgery is required. In early stage CHD PRRT can be used safely.

Conclusions: 99mTc-MIBI SPECT/CT with contrast offers no statistically significant advantage over non contrast imaging in terms of diagnostic confidence. However, the addition of SPECT significantly improved the diagnostic confidence over CT alone.

76 Investigating clinical relevance of semi-quantitative statistical parametric mapping data for 18FDG PET/CT brain imaging in Alzheimer's disease
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Method: 50 participants were retrospectively selected from the hospital PET/CT database. 25 were confirmed normal, and 25 confirmed Alzheimer’s disease after a minimum 4 months follow up. Cortex ID 3D-SSP Regional Hypometabolism (Z-score) data was collected for all participants. Regional and average Z scores were compared using a standard T-test.

Result: Statistically significant differences were found in all regions except: Pons ($P = 0.7195$), vermis left ($P = 0.0845$), cerebellum right ($P = 0.2148$), cerebellum left ($P = 0.2639$). The global average, cerebral average, average association left and right, were all highly significant ($P < 0.0001$). Parietal, temporal, frontal and occipital associations, were all also highly significant ($P < 0.0001$). As were the posterior cingulate and medial parietal regions ($P < 0.0001$). Temporal and parietal regions show greater distinction between the groups.

Conclusion: The Z score data shows clear differences between AD and normal studies. Temporal and parietal regions demonstrate this best. Z scores should be considered when reporting 18FDG PET/CT brain studies.

Posters
P1 Appropriate use of bone scintigraphy in staging prostate cancer?
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Aims: Appropriate use criteria (AUC) for bone scintigraphy in prostate cancer have been recently published
by a joint-committee of the SNMMI, EANM and ASCO (2017). The purpose of this audit was to review referrals for bone scintigraphy performed for initial staging of prostate cancer in our institution and evaluate their concordance with the consensus-formed AUC.

Methods: Referrals for bone scintigraphy over a 12-month period for the initial staging of prostate cancer were retrospectively reviewed for the inclusion of clinical information specified by the published AUC (presence of bony symptoms, PSA level, Gleason score, alkaline phosphatase level, local staging or presence of indeterminate findings on prior imaging requiring characterisation).

Results: Two hundred thirty three bone scans (planar +/− SPECT/CT) were performed for the staging of prostate cancer patients in our institution. 62 scans (27%) were positive and 165 (70%) negative for bony metastases. 6 scans (3%) were indeterminate. Overall 91% of all referrals could be justified based on clinical information provided against the AUC. 20 referrals (9%) provided insufficient clinical information although 14 of these could be justified following review of the electronic patient records i.e. inadequate clinical information provided on the referral. Only 6 cases (3%) would be considered as rarely appropriate for bone scintigraphy according to the AUC.

Conclusion: This audit confirms excellent concordance between referrals for bone scintigraphy in the initial staging of prostate cancer and internationally agreed AUC. Further improvement could be achieved with more detailed clinical information in a small number of cases.

P2 Validation and implementation of the klarity vaccum cushion for immobilisation in musculoskeletal SPECT/CT
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Background: The number of musculoskeletal referrals for SPECT/CT imaging of extremities is increasing in our department. Immobilising these patients is critical to ensure fused data sets are registered with minimal translation or rotation errors. A potential solution was identified from a cushion used for immobilising patients receiving external beam radiotherapy. The cushion moulds to the patients’ limb by applying a vacuum to remove air from the inner compartment.

Aims: to assess the potential use of the Klarity vacuum cushion in visualising lesions in musculoskeletal SPECT/CT.

Methods: Two hundred thirty three bone scans (planar +/− SPECT/CT) were performed for the staging of prostate cancer patients in our institution. 62 scans (27%) were positive and 165 (70%) negative for bony metastases. 6 scans (3%) were indeterminate. Overall 91% of all referrals could be justified based on clinical information provided against the AUC. 20 referrals (9%) provided insufficient clinical information although 14 of these could be justified following review of the electronic patient records i.e. inadequate clinical information provided on the referral. Only 6 cases (3%) would be considered as rarely appropriate for bone scintigraphy according to the AUC.

Conclusion: This audit confirms excellent concordance between referrals for bone scintigraphy in the initial staging of prostate cancer and internationally agreed AUC. Further improvement could be achieved with more detailed clinical information in a small number of cases.

P3 Partially calcified lungs metastases on [99mTc] Tc-MDP bone scan mimicking rib metastases in breast cancer
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Bone scintigraphy (Bone Scan) using technetium-99 labelled methyl diphosphonate ([99mTc]Tc-MDP) is a regularly utilised imaging modality to detect osteoblastic bone metastases owing to its high sensitivity.

Differentiating and identifying uptake caused by calcified soft tissue metastases from genuine osseous metastases is emphasised by correlating the positive bone scan with other cross-sectional modalities such as CT scan or PET/CT.

We report, a rare case for the first time in the UK (the second reported case in literature), a patient who was initially diagnosed with stage III locally invasive metastatic carcinoma and stage II invasive ductal carcinoma of the left breast and was treated with mastectomy. The patient subsequently presented with shortness of breath with deranged liver function and a raised ALP. A bone scan showed multiple foci in bilateral anterior and posterior ribs. A subsequent CT Chest, Abdomen and Pelvis, however, showed numerous partially calcified bilateral pulmonary nodules with no osseous lesions within the ribs.

The case showed abnormalities detected on bone scan that resemble metastatic rib lesions from partially calcified pulmonary metastatic nodules in a patient with breast cancer.
We propose, that caution should always be taken when interpreting the highly sensitive but non-specific bone scan and correlating the findings with other cross sectional modalities such as CT or PET/CT to achieve an accurate diagnosis and improve patient management.

P4 VQ SPECT positive rates from 2012 to 2016
Tom Chance, Amit Parekh, Richard Graham, David Little and Stewart Redman
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Purpose: VQ SPECT is an increasingly common study to investigate potential pulmonary embolism, a leading cause of patient mortality. The purpose of this study is to determine if there has been any significant change in the amount of ‘positive’ studies in our department, over 4 years as demand has increased (2012-2016).

Methods: 1,081 VQ SPECT studies were performed between 2012 and 2016. These reports were retrospectively analysed and assigned to ‘positive’, ‘negative’ and ‘indeterminate/not performed’, by year. These were further analysed and a percentage of positive results compared to the total number of studies performed was calculated.

Results: Over 4 years, 229 out of the 1,081 VQ SPECT studies were positive for pulmonary embolism. This ranged from 18.1% (50/277) in 2013, to 23.6% (76/322) in 2014. A similar result was demonstrated in 2015, when 23.1% (57/247) were positive. In 2012, 235 scans were performed, with a positive rate of 19.6%.

Conclusion: The results demonstrate no-significant difference between years with regard to positive rates of VQ SPECT. This is reassuring as the prevalence of pulmonary embolic disease (PE) is unlikely to have changed during this period. The true positive rate is impossible to determine but these data compare favourably with other studies in our department, over 4 years as demand has increased (2012-2016).

P5 Improving a ventilation/perfusion single-photon emission computed tomography service through continuous service evaluation
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Aim: To identify the positive rate, negative predictive value (NPV), and indeterminate rate of our V/Q single-photon emission computed tomography (SPECT) service over a one year period, as respective markers of overcalling (false positives), undercalling (false negatives), and overall scan quality. Comparison was made with the results of our previous 5-year service evaluation covering 2011-2016.

Methods: V/Q SPECT studies carried out between 01/09/2016 and 01/09/2017 were classified into positive, negative and indeterminate results. Patients who had died from pulmonary emboli, or had pulmonary emboli diagnosed on subsequent imaging within 3 months of a negative V/Q SPECT were identified as false negatives. This allowed the NPV to be calculated. The total number of positive and indeterminate studies as a proportion of all studies was calculated as the positive and indeterminate rates.

Results: The positive rate, NPV and indeterminate rates were 24%, 100% and 1.3%, respectively (n = 225). The rates from our previous service evaluation were 21.5%, 99-100%, and 3.4% respectively (n = 1173). We suspect that, with the knowledge that the indeterminate rate is being audited, reporters have been more decisive but this has not had a detrimental effect on our negative predictive value.

Conclusion: The positive rate and NPV for patients were similar to the published literature. This suggests that we continue to provide a safe service. The indeterminate rate was lower than our previously published rate from 2011 to 2016.

P6 Investigation into the contamination hazard associated with technegas administration
Anthony Cartwright, Tim Watts, Malcolm Foley and Peter Turner
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The breakdown of a pre-existing fume extraction system led to a review of safety provisions surrounding the administration of Technegas. Previous literature has identified a hazard from airborne radioactive contamination (Lloyd JJ et al., 1994, 14:435-440. Nucl. Med. Comms.). An opinion poll of Technegas users suggested the potential hazard may vary depending on patient training and adherence.

Preliminary measurements of surface swabs, large area samples and glove samples were performed after administrations of Technegas. Surface swabs were collected over 100 cm² with varied results. Large area samples showed significantly higher counts compared to background (P << 0.05). Glove samples from both patients and staff also showed significantly increased count rates. The mean activity and standard deviation for patient and staff gloves were 4.0 ± 5.5 kBq and 0.5 ± 0.6 kBq respectively.
Air was passed through the Technegas generator and a fume extractor collected the particles. Count rate from the fume filter was compared with the volume of air used. A single compartmental model was fitted to the graph to characterise the curve. Approximate capacity of the Technegas generator was found to be 2.6 ± 1.5 litres.

A portable air filtration system was recommended for use during Technegas administration to minimise the risk associated with the airborne radioactive contamination. Specification of the filtration system should include a filter to capture the fine Technegas particles (Lemb M et al., 1993, 20:576-579. Eur j Nucl Med).

P7 The utility of siemens low-penetration high-resolution collimators for simultaneous 81Kr/99mTc ventilation/perfusion scintigraphy

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Purpose: To experimentally evaluate Siemens Low-Penetration High-Resolution collimators (designed for 123I imaging) for the purposes of simultaneous 81Kr/99mTc V/Q imaging.

Methods: Images of a line source containing 81Kr were used to assess spatial resolution and septal penetration using three different collimators: Low-Penetration High-Resolution (LPHR), Low-Energy High-Resolution (LEHR), and Medium-Energy Low-Penetration (MELP). An index of septal penetration was calculated by considering the relative count rates either side of the line profile. Image quality was also assessed using a novel V/Q image quality phantom with matched and unmatched defects and an open cell matrix. Images obtained with different collimators and protocols were compared allowing the evaluation of simultaneous imaging with 99mTc and 81Kr.

Results: The FWHM and FWTM of the line source acquired using the LPHR collimators were 12.0 mm and 132 mm respectively. MEGP collimators gave a larger FWHM (14.5 mm) but smaller FWTM (91.1 mm). By our measure the MELP collimators (given a relative index of 1) suffer the least septal penetration and LEHR collimators the most (1.29), with the LPHR collimators’ index approximately halfway between the two (1.16). SPECT images of the V/Q image quality phantom allowed successful qualitative comparison of SPECT V/Q images obtained with dual isotope scanning in a clinically relevant configuration.

Conclusion: The LPHR collimators were found to have improved spatial resolution and reduced septal penetration in comparison to LEHR collimators when imaging with 81Kr.

P8 Respiratory gating in PET/CT – are prettier pictures worth the price?

Sian McGhee, Stewart Redman, Richard Graham and David Little
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Purpose: Respiratory gating software requires an increased scanning time with the aim of increasing image quality. This time increase impacts on both scanner throughput and patient comfort. The purpose of this study was to evaluate the value of respiratory gating on PET/CT image quality and to determine whether gating is worth the extra time involved.

Methods: Retrospective review of 30 consecutive anonymised PET/CT patients. For each patient a respiratory gated and non-respiratory gated reconstruction was produced (randomly labelled ‘Scan A’ or ‘Scan B’). These were independently compared side-by-side by three consultant radionuclide radiologists and a preference made for Scan A, Scan B or no preference, and whether the difference between reconstructions was clinically significant. Results were collated and a consensus meeting held to discuss any potentially clinically significant cases.

Results: The pooled preferences were as follows:
- *0% Non-Gated Preferred, Clinically Significant
- *22.2% Non-Gated Preferred, Not Clinically Significant
- *36.7% No Preference between Gated and Non-Gated
- *41.1% Gated preferred, Not Clinically Significant
- *0% Gated Preferred, Clinically significant

Conclusion: Although respiratory gating images were generally preferred, in 22.2% the non-gated images were preferred, possibly because of reduced noise in the ungated images. No clinically significant cases were identified. As a result of these findings, we have stopped using respiratory gating on our patients to improve efficiency and patient experience.

P9 PET/MRI for the assessment of suspected cardiac mass: Role of simultaneously acquired MRI for motion correction of PET images

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PET/MRI hybrid capabilities are developing with emerging methods for motion correction. We describe a

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case study of how PET images with MRI motion correction can aid in imaging an intracardiac mass.

A 48-year-old woman with a suspected cardiac mass underwent cardiac PET/CT (GE Discovery 710) followed by PET/MRI (Siemens Biograph mMR) scans. 350 MBq 18F-FDG was injected after prolonged fasting and a low-carbohydrate diet to suppress normal physiological myocardial uptake. PET/CT was performed 90 min after injection. PET/MRI was started after 120 min and consisted of a 20-minute PET scan saved in list mode so cardiac/respiratory gating plus MRI motion correction (Body Compass) could be assessed to determine possible improvement in image quality. A cardiac tumour MRI protocol was also performed.

PET/CT and PET/MRI cardiac gated attenuation-corrected PET images were comparable. There was a higher 18F-FDG signal intensity in the basal-to-mid lateral wall of the left ventricle (SUV max 4.4 on PET/CT), the use of cardiac/respiratory gating reduced the number of counts and the SNR of the images. The Body Compass motion correction reduced respiratory motion but maintained the signal thus enhancing contrast and SNR between the region of high 18F-FDG signal in the LV and background. The location of the mass was identified on fused PET and the multi-planar cardiac MRI imaging.

This case study illustrates the usefulness of cardiac PET/MRI for mass characterisation. The body compass motion correction can potentially enhance image quality with a reduction in respiratory motion using MRI derived data.

P10 The role of integrated slice-by-slice shimming (iShim) diffusion weighted imaging in whole body PET/ MRI scanning
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PET/MRI is a promising new hybrid modality that combines the functional information of PET with the anatomical information and high contrast resolution of MRI. As new sequences are developed and optimised, higher imaging standards and capabilities will result. We present a case study in which a new diffusion-weighted (for PET/MRI) sequence utilising integrated slice-by-slice shimming (iShim) with dynamically updated central frequency (pre-set from previous built-in 2D gradient-recalled echo sequence) and retrospective B0 inhomogeneity correction results in a significant reduction in distortion, artefacts and better fat saturation. This leads to accurate registration with PET and other MR imaging.

A 65-year-old man with newly diagnosed asymptomatic/smuelling myeloma and elevated serum IgG paraprotein underwent 18F-FDG PET/CT immediately followed by a PET/MRI acquisition (performed as part of a trial protocol). PET/CT was performed 90-minutes after injection of 350 MBq of 18F-FDG. PET/MRI was performed after 150-minutes and comprised of axial PET, DWI (B = 0, 600 and 900 s/mm2), T1-Dixon, T2-HASTE and single-phase T1-W contrast enhanced sequences from vertex to knees.

Imaging revealed mild diffuse increase in axial bone marrow 18F-FDG activity (slightly greater than normal liver). This can be seen on the precisely registered fused images of the high B value DW and the apparent diffusion coefficient images with the attenuation corrected PET images.

This poster will discuss how a new DWI sequence with different modes of fat saturation and shimming (ishim) can help improve whole body PET/MR imaging. We will also discuss how to optimise the scanning parameters to improve diagnostic quality.

P11 PET acquisition time optimisation using Q.clear and time of flight reconstructions
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"Medical Physics and Bioengineering, Royal United Hospitals Bath NHS Trust, Bath, United Kingdom and Nuclear Medicine, Royal United Hospitals Bath NHS Trust, Bath, United Kingdom"

"Aim: To investigate optimisation of PET imaging protocols by reducing the acquisition time per bed position, without significantly compromising clinical image quality.

Method: Data from whole body 18F-FDG scans were acquired in list-mode then retrospectively replayed to simulate scans with acquisition times between 1.5 and 3 min per bed position. The image quality was visually assessed by three experienced clinicians who stated whether the reduced acquisition time images were of adequate diagnostic quality. To cover all of the scan positions and reconstructions we use clinically, we reviewed Q.Clear and Time of Flight (TOF) reconstructions both with arms up and arms down.

Results: All images acquired with 2.5 to 3 min per bed position (n = 64) were graded as clinically
acceptable. On average 5% of Q.Clear reconstructions \((n = 10)\), and 13% of TOF images \((n = 4)\), acquired with 2 min per bed position were graded as clinically unacceptable.

**Conclusion:** The results of this study have demonstrated that whole body PET/CT acquisition times can be reduced from 3 to 2.5 min per bed position without significantly reducing the diagnostic quality of the clinical images. Alternatively, the activity of 18F-FDG could be reduced from 4 MBq/kg to 3.3 MBq/kg to reduce the radiation burden to the patient. The results of this study indicate that acquisition times could potentially be reduced to 2 min per bed position if all images were reconstructed with Q.Clear. Additional data would be required in order to confirm this result.

**P12 Comparison Of Q-clear (Bayesian penalise likelihood (BPL) reconstruction) and VPHD (TOF Ordered subset expectation maximisation (OSEM) reconstruction) reconstruction algorithms in evaluating metastatic prostate cancer on 11C-Choline PET/CT studies**

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**Introduction:** 11C-choline PET/CT is being increasingly used for imaging of prostate cancer with biochemical recurrence and for staging. There have been recent advancements in different reconstructive algorithms, however there remains controversy over which to use.

**Methodology:** We scan patients on a GE discovery 710 PET/CT scanner. We are provided with Q-clear (Bayesian penalise likelihood (BPL) reconstruction) and VPHD (Vue Point High Definition - TOF ordered subset expectation maximisation (OSEM) reconstruction) reconstruction algorithms.

Two experienced radionuclide radiologists retrospectively evaluated the 11C-choline PET/CT scans acquired over 6 months using both algorithms. After excluding follow up and incomplete scans, we analysed 41 patients scanned between 01/01/2017 to 31/06/2017.

**Results:** We were confident in diagnosing disease recurrence in 32 patients on Q clear reformat compared to 29 patients on VPHD. 7 patients were reported as negative on Q clear reformat versus 10 on VPHD.

Two patients’ scans were reported as indeterminate disease on both the reformat; one called indeterminate on VPHD was confidently called as disease on Q-clear reformat; another called negative on VPHD was reported as indeterminate on Q-clear reformat.

The number of lesions reported on the Q clear images was higher than on the VPHD.

**Conclusion:** Using the Q clear images for reporting increases the number of patients in whom recurrence is detected, the confidence of the reporter and the volume of disease when compared to conventional processing algorithms.

**P13 The imaging of prostate cancer using 18F-Choline-PET**

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Prostate cancer is predominantly diagnosed with a combination of clinical examination, serum prostate specific antigen measurement and transrectal ultrasound guided (TRUS) biopsies. High risk patients are often imaged further for metastases. All imaging techniques have their limitations – early lymph node metastases are not necessarily morphologically abnormal on CT and MR, TRUS is limited in examining extracapsular extension and FDG-PET is hampered by the lack of 18F-FDG avidity in most prostate cancers (Jadvar 2009). 18F-choline is now becoming widely available in the UK and offers the potential to localise previously difficult to identify prostate cancer metastases.

**Table 1 Normal distribution of 18F-choline versus 18F-FDG (Garcia-Vicente et al., 2013)**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Normal distribution of 18F-choline</th>
<th>Normal distribution of 18F-FDG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary glands, liver, spleen, pancreas, renal cortex</td>
<td>More intense</td>
<td>Less intense</td>
</tr>
<tr>
<td>Brain</td>
<td>Choroid and pituitary</td>
<td>Throughout the brain variable</td>
</tr>
<tr>
<td>small bowel, muscles</td>
<td>variable</td>
<td>variable</td>
</tr>
<tr>
<td>Myocardium</td>
<td>no activity</td>
<td>no activity</td>
</tr>
</tbody>
</table>

However, increased uptake of 18F-choline does not always mean prostate cancer – particularly pertinent because the majority of patients are elderly, with co-existing comorbidities. Incidental findings or abnormal distribution of tracer not related to prostate malignancy include infection, pulmonary nodules, pleuritis, thyroiditis, oesophagitis and otomastoiditis (Garcia-Vicente et al., 2013). The aim of this study is to present the common appearances of prostate cancer, key differences between the imaging appearances of 18F-choline and 18F-FDG, and pitfalls of 18F-choline-PET imaging.

A literature review was performed and illustrative examples collated to demonstrate the diagnosis of prostate cancer and normal findings of 18F-choline-PET scans.

Recognition and familiarity with the physiologic distribution of 18F-choline activity is crucial for accurate diagnosis and subsequent management of prostate cancer.
P14 The thigh's the limit
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PET/CT imaging in the UK, including at our institution, is carried out using a field of view from the skull base or vertex to the proximal third of the femur, the so-called 'eyes-to-thighs' or 'lips to hips' protocol. This is partially as a result of the co-scan range for combined CT and PET being approximately 145 cm for most PET/CT scanners offered by the majority of medical imaging manufacturers. The extension of the scan range caudally to the level of the thigh has the disadvantage of a minimal increase in patient dose from the CT portion of the study leading to some debate as to the utility of the scan range chosen. Here we present examples of cases where visualisation of the thigh has provided additional clinically significant information.

PET/CT is now firmly established and well known in clinical practice for its sensitivity in detection of occult metastatic disease. Furthermore, routine extension of the field of view to include the upper thigh results in detection of lesions, both benign and metastatic, which would not be identified on archetypal imaging.

P15 Pictorial representation of the causes of 18F-fluorodeoxyglucose (FDG) uptake on positron emission tomography-computed tomography (PET/CT) within the spinal canal
Debbie Owen a, Vincent Lam a, Meri Angeljeleska b, Jasmina Simjanovska b and Rakesh Ganatra a
aUniversity Hospitals of Leicester, Leicester, United Kingdom and bUniversity Institute of PET, Skopje, Macedonia

Due to the non-specific nature of FDG in PET/CT, many pitfalls and image artefacts have been described. It is important therefore to distinguish physiological from pathological activity, in order to prevent misdiagnosis.

Physiological activity in the spine is a common finding on FDG PET/CT. It is frequently seen within the distal cervical spine and at the thoracolumbar junction and should not be mistaken for pathological activity due to neurological disease (Padma et al., 2010, Nakamoto et al., 2012, Bhatt et al., 2013, Lim et al., 2015).

There are instances, however, when spinal activity is seen in pathology. This occurs in spinal metastases, particularly in breast cancer, CNS lymphoma, intramedullary spinal cord lesions and in inflammatory disease, such as meningitis or discitis.

Our poster will outline a few explanatory theories described in the literature for physiological FDG uptake within the spinal canal (Padma et al., 2010, Greenspan et al., 2012, Bhatt et al., 2013). We will also illustrate a few examples of both physiological and pathological intraspinal FDG uptake, both from within the literature and from our own institutions.

P16 Use of 18F-fluorodeoxyglucose PET/CT imaging in the investigation of multiple myeloma (MM)
Debbie Owen, Yvette Griffin, Mantta Garg and Rakesh Ganatra
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Myeloma is an aggressive malignancy, accounting for 2% of UK cancer deaths in 2014 (Cancer Research, UK). The International Myeloma Working Group published their recommendations in April 2017 for the use of 18F-FDG PET/CT in the diagnosis of MM. They outlined the high sensitivity and specificity of this functional imaging modality. However, PET/CT is not widely available in all institutions and is an expensive test for the NHS. Its use is only advised in certain circumstances, when MRI is unavailable, the skeletal survey (SS) is negative or to assess therapy response.

We are unable to perform DWI MRI as per NICE recommendations. We therefore commenced PET/CT imaging for MM in June 2017, with an audit completed 6 months later. 34 patients were imaged between June and mid December 2017. 8 of these patients had undergone a SS, 3 demonstrating no lytic lesions. 12 patients underwent a MRI, 7 revealing no myelomatous disease. 6 patients underwent both investigations (3 positive on both, 2 negative on both, 1 negative on MRI but positive on SS).

10 patients demonstrated FDG avid disease, 7 of these underwent a prior MRI, 5 of which were positive. 4 of these patients had undergone a prior SS, all demonstrating lytic lesions. No patients demonstrated FDG avid disease when both the SS and MRI were negative.

PET/CT is useful in myeloma and has the potential of changing clinical management. Larger studies are needed however, to assess its role in the imaging pathway and assess cost benefit.

P17 Myocardial suppression in FDG PET/CT in infective endocarditis: A single site experience in patient preparation
Sara Soares, Nick Gulliver, Andrew Cheetham, Manuela Vadrucci, Nicola Mulholland and Gill Vivian
King's College Hospital NHS Foundation Trust, London, United Kingdom

Aims: To describe our experience in patient preparation for FDG PET/CT in work-up for infective endocarditis (IE) in native and prosthetic valves.

Introduction & Background: IE is a serious, potentially life-threatening condition. PET/CT has previously been
shown to be of use in diagnostically challenging cases of IE, particularly in prosthetic valve endocarditis, and in detecting clinically relevant extra-cardiac foci of infection. Suppression of physiological FDG uptake in the myocardium is necessary to optimise diagnostic quality with several protocols described in new EANM recommendations on multimodality imaging in IE.

**Methods:** Between April 2016 and October 2017, 38 inpatient FDG PET/CT scans for IE were performed in our centre (32 male, 6 female, age range 38-92). A standardised patient preparation protocol for cardiac FDG PET/CT was utilised, with a prolonged (12 h) fast preceded by a low carbohydrate high fat (LCHF) diet from a list of permitted foodstuffs. Images were retrospectively reviewed and assessed qualitatively for suppression of FDG uptake.

**Results & Discussion:** 29 (76%) cases complied with 18 h fast (of which 7 demonstrated inadequate suppression). While an extensive list of suitable foodstuffs for dietary preparation has been used compliance is variable and a LCHF meal substitute (Calogen) is currently being trialled. Close communication with cardiovascular teams and ward staff are required to ensure optimum patient preparation.

**Conclusion:** Prolonged fasting and dietary preparation are required for ensuring adequate myocardial suppression but sometimes difficult to achieve. Further studies are required to optimise timing and content of patient meals prior to FDG PET/CT for IE.

**P18 The influence of metformin on physiological bowel uptake of \[^{18}F\]FDG-FDG, and the effect of its withdrawal prior to PET/CT scanning**

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*King’s College Hospital NHS Foundation Trust, London, United Kingdom, King’s College Hospital NHS Foundation Trust, London, United Kingdom and King’s College Hospital NHS Foundation Trust, London, United Kingdom*

**Aim:** To investigate the effect of metformin on physiological bowel \[^{18}F\]FDG-FDG uptake in PET/CT in type 2 diabetic patients. To determine the clinical significance in the duration of metformin withdrawal prior to scanning.

**Methods:** 89 \[^{18}F\]FDG-PET/CT scans were retrospectively reviewed. Group-A included 22 non-diabetics. 67 patients treated with metformin were divided into three groups depending on when they last took a dose of metformin. Group-B1 patients who took metformin that morning \((n = 20)\), Group-B2 metformin withdrawal duration \(>12 \text{ h} \ (n = 25)\), Group-B3 duration \(>24 \text{ h} \ (n = 22)\). Images were independently assessed by two experienced observers. Bowel uptake was visually graded \((1 = \text{less than liver to 4 significantly greater than liver})\) and the SUV\(_{\text{max}}\) recorded.

**Results:** Visual Scoring of bowel uptake: the number of patients graded 1-2 = Group-A = 14, Group-B1 = 1, Group-B2 = 2, Group-B3 = 4, and the number of patients graded 3-4 = 8, 19, 23, 18 respectively (diabetic vs. non-diabetic \(P < 0.0005\), between metformin subgroups B1, B2, B3 \(P = 0.553\)).

Bowel SUV\(_{\text{max}}\) (mean +/-SD) for each group: 5.7 ±3.5, 13.7 ±5.9, 11.0 ±4.4, 10.5 ±4.0, respectively (diabetic versus non-diabetic \(P < 0.0005\), between metformin subgroups B1 vs. B2 \((P = 0.114)\), B1 vs. B3 \((P = 0.065)\), B2 vs. B3 \((P = 0.940)\)).

**Conclusion:** Bowel uptake of \[^{18}F\]FDG-FDG is significantly increased in type 2 diabetic patients treated with metformin compared to non-diabetics. No evidence of statistically significant difference seen in either the visual scoring or SUV\(_{\text{max}}\) in those patients who have withdrawn metformin use prior to scanning, including those refraining from metformin for greater than 24 h compared to those who took metformin on morning of the scan.

**P19 Nodal metastases, lymphoma or just sarcoid-like reaction? FDG-PET/CT findings of the great granulomatous imitator**

Louise Hartley

*NHS Greater Glasgow and Clyde, Glasgow, United Kingdom*

**Introduction:** Sarcoid-like reaction (SLR) to malignancy must be differentiated from nodal metastatic disease to prevent needless oncological therapy.

**Aims:** A pictorial case series to demonstrate the FDG-PET/CT imaging findings (typical and atypical) of SLR in cancer patients to improve awareness of this important diagnosis.

**Methods:** A 9 year (January 2008 to November 2017) retrospective analysis of staging and re-staging FDG-PET/CT examinations was performed in a UK tertiary referral centre. Cases of suspected SLR were identified and the diagnosis confirmed or disproved via histological correlation or radiological follow-up.

**Results:** SLR was suspected in 142 FDG-PET/CT examinations with confirmed diagnosis in 64 cases (68% histological and 32% radiological follow-up). 82% of confirmed SLR was demonstrated on re-staging rather than initial staging examinations. The primary malignancies associated with SLR included colorectal (34%), lymphoma (22%), oesophageal (16%), head and neck (12%), lung (8%), germ cell (4%), penile (2%) and the rarely documented spindle cell sarcoma (2%). 98% of
cases presented with FDG-avid mediastinal lymphadenopathy; 84% of which had uptake in both mediastinal and bilateral hilar nodes. Extra-thoracic SLR (8%) was additionally seen in the spleen, liver, upper abdominal lymph nodes and peritoneal nodules.

Conclusion: SLR is seen in many solid-organ and haematological malignancies, both at initial diagnosis and several years after. All PET/CT reporters must be aware of this entity to avoid false-positive interpretation of metastatic disease.

P20 Assessment of organ specific involvement in systemic sarcoidosis by functional multi-modality and correlative imaging
Guglielmo La Torre a, Victoria Parish b, Steven Coombs b, Janice Bush b, Deborah Pencharz b and Sabina Dizdarevic a,b
bBrighton and Sussex Medical School, Brighton, United Kingdom and 0Brighton and Sussex University Hospital NHS Trust, Brighton, United Kingdom

Purpose: Sarcoidosis is a multi-system inflammatory condition leading to granulomatous inflammation of possibly any organ. We aim to demonstrate a role of multimodality and correlative imaging in diagnosis and assessment of extent and activity of sarcoidosis as illustrated by a case report.

Methods: We report a case of a 59-year-old gentleman presenting with ventricular tachycardia (VT), subsequently found to have imaging features of mediastinal (CXR, CTPA, 18F-FDG-PET/CT), cardiac (MRI) and splenic sarcoidosis (18F-FDG-PET/CT).

Results: A calcified small non-dominant right coronary artery and hilar lymphadenopathy were noted on CTPA and CXR. Cardiac MRI demonstrated delayed enhancement indicating granulomatous infiltration/fibrosis indicative of cardiac sarcoidosis. Interestingly, PET/CT did not demonstrate abnormal cardiac FDG uptake, but heterogeneous multifocal splenic uptake, indicative of splenic involvement and avid bi-hilar and pulmonary ligament nodes and scattered pulmonary nodules. The clinical spectrum of the disease is varied ranging from asymptomatic (50%) to severe multi-organ failure. The respiratory tract is involved in 95% of cases, the heart (up to 25%) and spleen (up to 40%). An ICD was successfully fitted. MDTM review was arranged. The array of differentials e.g. lymphoma, other granulomatous disease/mycobacterial infection, hypereosinophilic syndrome, connective tissue disorders and metastases were considered.

Conclusion: There is no single gold-standard test used for diagnosis of sarcoidosis. Our case demonstrates that multi-modality and correlative imaging play a pivotal role in assessment of organ specific involvement in determining extent, activity and pattern of disease.

P21 Semi-structured interviews for assessing patient experience in PET/CT
Stewart Redman, Liddy Ellis, David Little, Sarah Cade and Richard Graham
Royal United Hospitals Bath NHS Foundation Trust, Bath, United Kingdom

Purpose: In May/June 2017 we noticed a decline in the scores from our ongoing Patient Experience Survey in our PET/CT Department. We choose a semi-structured Interview format as the best method for obtaining some qualitative information to try to explain the change and to obtain suggestions for improvement.

Method: Patients were consented prior to injection with a time arranged for a few days later when they would receive a 15 min telephone call. A questionnaire with 17 opening questions was developed along with the Hospital Patient Experience Team. Following the question there was the opportunity to follow the conversation into different areas. Answers were recorded using a Dictaphone and transcribed verbatim.

Results: 15 patients were consented with 10 patients interviewed. Useful insights were gained in many areas. Patients had all received a phone call prior to the appointment and were happy with it. Patients were happy with their letter but one commented that we could put more detail about the very small volume injected as he had anticipated a lot more. Our security rating had declined on the written survey but on discussion the patients were happy with the arrangement and thought lockers would be a waste of money. Useful insights were gained in many areas including how to make the scan more comfortable.

Conclusion: The semi-structured Interview format is a useful adjunct to patient surveys, particularly in sense checking planned changes and for new ideas for improvement.

P22 The use of FDG-PET/CT in the diagnosis and stratification of non-Hodgkin's lymphomas in paediatric patients: The experience of a single centre institution
Maria Gavra a, Kondylia Antoniad i b, Mirella Abatzi d, Ioanna Sevastidou c, Vassilis Lyra a, Ioannis Nikas d, Vassilis Papadakis e, Ekaterini Stypanelli d, Christiana Hadjegeorg i d and Sophia Polychronopoulou e
aNuclear Medicine Department, ‘Agia Sophia’ Children’s Hospital, Athens, Greece, bDepartment of Paediatric Hematology-Oncology, ‘Agia Sophia’ Children’s Hospital, Athens, Greece, cDepartment of Paediatric Hematology-Oncology, ‘Agia Sophia’ Children’s Hospital, Athens, Greece, dCT-MRI Department, ‘Agia Sophia’ Children’s Hospital, Athens, Greece, eDepartment of Paediatric Hematology-Oncology, ‘Agia Sophia’ Children’s Hospital, Athens, Greece, fDepartment of Paediatric Hematology-Oncology, ‘Agia Sophia’ Children’s Hospital, Athens, Greece

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Objective: The presentation of PET/CT results in the diagnosis, monitoring and outcome of non-Hodgkin's lymphomas (NHL), in paediatric patients, comparison with the corresponding CT results and investigation of complementarity between two methods.

Method: 107 patients with NHL (median age 7 years) underwent whole-body primary stage CT. The CTs of the initial sites followed 3 chemotherapy cycles as well as at the end of chemotherapy, in order to estimate imaging response. In addition, 13/107 patients were evaluated with PET/CT: in the initial study, after 2 chemotherapy cycles and after the end of treatment, in order to assess the metabolic response.

Result: 6/7 of patients, were PET/CT positive during the initial diagnosis. In 4/6 PET/CT positive patients, PET/CT revealed additional initial disease localizations undetectable with initial CT. In 2/13 patients, PET/CT revealed additional residual disease sites undetectable by re-staging CT. Finally, in 8/13 patients with PET/CT at the end of chemotherapy, 2/8 patients had positive metabolic activity, in areas described in the CT evaluation of the imaging response. None of the patients has been upgraded, due to detection of additional PET localizations, since they were already stratified as high risk, due to CT. All PET/CT positive patients are in remission.

Conclusions: The use of PET/CT as a diagnostic tool for baseline and restaging of NHL can be exploited in the diagnosis and course of treatment, in addition to the existing imaging methods available, by detecting additional disease localizations. In our study, the use of PET/CT did not result in therapeutic improvement in patients.

P23 Utility of PET/CT in multiple abdominal extra-adrenal paragangliomas: A 13 year old adolescent case with positive PET/CT paraganglioma and negative MIBG

Maria Gavraa, Ioanna Sevaslidoub, Ekaterini Stypanelliç, Dimitris Verganelakisd, Kleoniki Rokkae, Antonis Kattamise and Christiana Hadjgeorgif

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We report the case of a 13- year- old boy, presented with abdominal pain as the predominant and only symptom. Abdominal MRI showed two solid, enhancing pre-vertebral lesions with smooth borders, at the level of L3-L4 (maximum diameter 3,4 cm) and L5-S1 (maximum diameter 5 cm). Measurements of urinary VMA (8, 3 mg/g, normal values <6, 7 mg/g) and plasma normetanephrine (1370 n.P <129) were elevated. The boy was tested for neuroblastoma with I-123 MIBG. The MIBG was positive for the presence of a neuroendocrine tumour, only for the prevertebral abdominal mass located at the level of L5-S1. The CT-chest was negative for secondary metastases. The tumour at L5-S1 was surgically removed and the histological examination showed a low grade paraganglioma. Post-operative, hematologic testing, after a two-month period, showed increased values prices of 24-hour urinary VMA 7.4 mg/g and plasma free normetanephrine 1510 mg/l. Due to remaining high levels of catecholamines, a [18F]FDG -PET/CT was performed, and showed significant hypermetabolism in the right pre-vertebral lesion at the level of L3-L4 compatible with paraganglioma. The histological analysis confirmed the PET/CT diagnosis.

Conclusion: This case revealed that [18F]FDG -PET/CT is a superior tool compared to MIBG in detecting multiple extra-adrenal abdominal paragangliomas, whereas MIBG missed one paraganglioma despite the centimetre size.

P24 Pulmonary neuroendocrine tumours and variable FDG uptake: A case and review of the literature and the recent WHO histological re-classification

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Purpose: The aim is to present a case and interesting image of initially unsuspected metastatic pulmonary carcinoid. Its presence was first proposed following FDG PET/CT. We have also reviewed the histological classification of pulmonary neuroendocrine tumours and the pattern of FDG uptake within the different subtypes and biological correlates.

Method: Case: A 64 year old man was referred for a PET/CT for characterisation of a pulmonary lesion suspected as lung carcinoma. Review of the new 2015 WHO classification of neuroendocrine tumours and a literature review of FDG uptake within the different histological subtypes and biological correlates of the uptake are also presented.

Results: 18F-FDG-PET/CT showed low grade uptake in a left lung primary lesion, moderate- intense uptake in hepatic metastasis and low grade uptake in sclerotic bone lesions suggestive of metastatic pulmonary neuroendocrine tumour. Previous WHO classifications had classified carcinoid tumours, small cell lung carcinoma (SCLC) and large cell neuroendocrine carcinoma (LCNEC) separately. However, in the new classification they are grouped together. Carcinoid tumours are
subdivided into typical (TC) and atypical (AC). The intensity of FDG avidity within the different subtypes is: TC < AC < SCLC and LCNEC. FDG uptake correlates significantly with Glut1, HIF-1α, VEGF and CD34 expression.

**Conclusion:** Pulmonary neuroendocrine tumours include a broad range of histological subtypes with variable biological characteristics and FDG uptake and hence FDG-PET can complement somatostatin receptor imaging for better characterisation of disease phenotypes throughout the body. Understanding this can be helpful for those reporting PET/CT.

**P25 Indium-111 pentetreotide avid diffuse bone metastases mimicking the appearance of free indium**

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\(^a\)Hull and East Yorkshire hospitals NHS Trust, Kingston Upon Hull, United Kingdom and \(^b\)University of Hull, United Kingdom

**Purpose:** Investigate bone uptake of Indium-111 pentetreotide mimicking the appearance of Indium-Chloride

**Background:** A patient with a history of lung carcinoid was referred for Somatostatin Receptor Scintigraphy after presentation of dyspepsia and elevated gut hormone profiles. Indium-111 pentetreotide imaging performed at 4 and 24 h revealed discrete areas of intense activity within the liver and diffuse activity throughout the skeleton. Given typical carcinoids rarely metastasise to bone (Van Loon. 2016, 4:1: 9–17 Endocrine Connections) and the extensive distribution, appearances were considered sufficiently unusual to question the validity of the scan.

**Methods:** A literature review on the physiological distribution of Indium-Chloride was performed and images sent for external review. Reconstitution of the radiopharmaceutical kit was reviewed and MRI and CT investigations ordered.

**Results:** Radiopharmaceutical manufacturer feedback advised labelling failure as the probable explanation, however, internal review of the reconstitution process revealed no concerns. Given interval increased uptake between 4 and 24 h imaging, and the uptake pattern within the pelvis and femora, the radiologist considered the scan suspicious for diffuse bone metastases. CT investigations confirmed sclerotic bony lesions throughout the skeleton, suspicious for diffuse bony metastases and numerous liver lesions. MRI demonstrated marrow infiltration with SPECT-MRI fusion confirming the co-localisation of bone abnormalities. Ultrasound-guided liver biopsy confirmed the liver lesions as metastatic deposits of typical carcinoid.

**Conclusion:** For patients with suspected or known neuroendocrine tumours, pathological bone uptake of In-111 Pentetreotide should be considered in the diagnostic differential. Hybrid imaging can improve the diagnostic confidence in such cases.

**P26 1.1GBq I-131-NaI post-therapy imaging audit**

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Following the ‘HiLo’ clinical trial, many low risk ablation patients are now receiving 1.1 GBq of radiiodine, resulting in an inpatient stay of only one night. Consequently, the post-therapy imaging, ideally performed prior to patient discharge, is performed significantly earlier. An audit of 40 patients, scanned on day 1 (14 patients), day 2 (13 patients) or day 3 (13 patients), was performed to determine whether there were significant differences in the images acquired. There were no other differences between the three cohorts.

Planar images were reviewed as part of the audit. A spherical ROI was placed around the thyroid bed (uptake) and the mid-sternum (background). Lymphatic nodes noted in the clinical report were also measured. The uptake-to-background ratios were compared statistically using a two-tailed t-test, P-value of 0.05, and visually using a boxplot.

The ratios were found to be 23 ± 32, 36 ± 47 and 118 ± 53 for day 1, 2 and 3 imaging respectively.

A significant difference in the ratios was found between the day 1 and day 3 cohorts (P < 0.001), as well as the day 2 and day 3 (P < 0.001) cohorts. However, the difference between day 1 and day 2 were not found to be statistically significant (P = 0.41). This relationship is also visible in the boxplot.

This result suggests that day 3 imaging should be performed. However, further work will be performed evaluating the SPECT images.

**P27 Sodium iodide symporter (NIS) expression in solitary plasmacytoma mimicking a bone metastasis from thyroid cancer**

Guglielmo La Torre\(^a\), Michelle Wong\(^b\), Nicolas Efrychiou\(^b\), Nitaisha Singh\(^b\), Joanna Simpson\(^b\) and Sabina Dizdarevic\(^a,b\)

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**Purpose:** Sodium iodide symporter (NIS) mediates uptake of iodide into follicular cells of the thyroid gland. Breast cancer is the only malignancy other than thyroid cancer to

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have been shown to functionally express NIS endogenously. However, we report a case of plasmacytoma/myeloma expressing NIS, which mimicked thyroid cancer metastasis.

**Methods:** Case: 72-year-old patient underwent 131-iodine treatment for papillary thyroid carcinoma. Imaging and histology revealed a co-existing NIS-expressing solitary spinal plasmacytoma. We present the imaging findings and review the literature on NIS-expression in plasmacytoma/myeloma.

**Result:** Post ablation 131-I WB-scan showed high grade uptake within thyroid bed and a focus of low to moderate uptake within the chest at the level of T8. MRI showed a suspected metastatic lesion with vertebral body collapse, anterior wedging of T8 and suspected bilateral pedicle fractures. Follow-up 131-I scan demonstrated minimal residual uptake in the thyroid bed, and a reduced, but persistent uptake within the spinal lesion for which a biopsy was suggested. Histology revealed a plasma cell neoplasm with no evidence of metastatic thyroid carcinoma. The lesion was further treated with radiotherapy. A post-vertebroplasty 18F-FDG-PET/CT scan showed artefactual activity at T8/9 and no FDG avid disease. A review of the literature indicates a new promising strategy using oncolytic viruses expressing the human NIS for the targeted destruction of disseminated myeloma but no previous case of endogenous expression of NIS in plasmacytoma/myeloma has been identified.

**Conclusion:** Myeloma/plasmacytoma cells may rarely express NIS and therefore be visualised and potentially treated by radioactive iodine, or radioiodine therapy.

**P28 Safe hospital discharge of day-case patients treated with low dose (1100 MBq) radioiodine**

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Increasingly many UK hospitals now treat low-risk differentiated thyroid cancer (DTC) patients using 1100MBq radioiodine (RAI) on a day-case basis (i.e. no overnight hospitalization). Despite obvious benefits to this approach (reduced cost/staff dose/patient isolation), determining appropriate hospital discharge time is challenging and, consequently, variability exists between hospitals in how this is implemented.

At our centre, 42 DTC patients were treated with RAI in either capsule or liquid form (n = 31, n = 11 respectively) and sequential, external DR measurements were performed at 2 m distance. Curve fitting was employed to extrapolate time taken post-administration for DR to reach 10 µSv/h. Mean [Maximum] calculated time was 5.85 [13.64] hours. There was no statistically significant difference in median measured DR (immediately prior to discharge) compared to thyrotoxic outpatients treated with 600MBq RAI (n = 9). No statistically significant difference in uptake/retention, assessed by DR and ROI measurement of whole body post-administration imaging, was found when liquid or capsule forms of RAI were administered.

This study additionally presents various challenging clinical scenarios encountered, together with practical advice for standardising monitoring/discharge of 1100 MBq RAI patients – highly relevant given the imminent changes to the Regulations, e.g. consideration of carer and comforter doses will be required of duty holders under IR(ME)R 2017.

**P29 Setting up a new radiosynoviorthesis paediatric service**

Georgina Rooneya, Leanne Pricea,b, Elizabeth Morrisa,b, Gemma Heathc, Pippa Mashforda, Ben Thurlowd, Sam Stuarta, Samantha Chippingtona, Mary Mathiasa, Nicola Huberta and Lorenzo Biassonic

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**Aim:** Aim of this work is to present our experiences, and provide guidance on, development and implementation of a novel radiosynoviorthesis (RSO) service as an alternative treatment option for patients with haemophilia who are resistant to routine treatments and clotting factors.

**Method:** The RSO team formed of members of the Haemophilia Unit and radiology. Patients treated present with repeated episodes of bleeding into joints but no evidence of bony erosions on pre-procedure MRI. Sites of synovial inflammation and hemosiderin deposition are identified on MRI. Rhenium-186 is used to minimise potential damage to the epiphyseal growth plate due to the smaller joint volume in paediatrics.

**Results:** The radionuclide injection, carried out in IR, under fluoroscopy and ultrasound guidance with the patient under GA. Joint is immobilised using a splint immediately post injection. A SPECT/CT of the affected joint together with a whole body sweep is performed within 1 h and at 24 h. The SPECT/CT determines distribution of the radionuclide and aids in dosimetry. Physiotherapy under the haemophilia team allows monitoring of patient progression.

**Conclusion:** The setting up of the RSO service has been a collective effort between various modalities resulting in a multidisciplinary approach. The substantial post therapy imaging allows visualisation of possible extravasation/migration of tracer as well as allowing dosimetry to be
carried out in order to reduce administered dose in pediatrics. Future work is to be done in scaling the administered activity based on the synovial size; calculated from pre-procedure MRI.

**P30 Radiation synovectomy for treatment of haemophilic synovitis in paediatric patients: An approach to scaling administered activity**

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**Purpose:** An approach is required to scale the administered activity for paediatric patients from the recommended levels in the European Association of Nuclear Medicine (EANM) procedural guidelines (2003, 30: BP12-6. Eur. J. Nucl. Med.).

**Methods:** Based on existing evidence, our primary approach is to administer activity within 50-100% of the EANM guidelines. A method is proposed to scale the activity within the constraints of 50-100% that utilises absorbed dose factors (cGy cm\(^{-2}\)/MBq.s) (generated from Monte Carlo radiation transport in a mathematical joint model) and the patient’s synovial surface area (Johnson L.S. et al., 1995, 22:977-988. Eur. J. Nucl. Med.). The prescribed activity is scaled to deliver a target absorbed dose of 120 Gy to the synovial surface (Stefan, G. et al., 1999, 26:6;1242-1248 J. Rheumatol).

**Results:** An activity of 74 MBq (37-74 MBq, 50-100% EANM) of Rhenium-186 Sulphide was prescribed for an ankle target joint of 13 year old.

A volume of interest (VOI) was outlined around the joint capsule on a 3D T2 weighted magnetic resonance image (isotropic voxels 0.6 mm\(^3\)). The surface area was 130 cm\(^2\), which would result in a prescribed activity of 88 MBq, supporting the decision to prescribe 100% of the EANM recommended activity level in this instance. Further work is required to test the operator variability and the absorbed dose delivered.

**Conclusion:** The result shows a proof of concept that the concurrent scaling method could be utilised to prescribe activity within the bounds of the primary method.

**P31 Optimisation of radiation protection techniques during SIRT**

Peter Hay, Robert Harris, Lee Evans and Jayesh Dave

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**Purpose:** Ours was one of ten centres selected by NHS England to evaluate SIRT (\(^{90}\)Y microsphere therapies). Staff involved in this procedure routinely handle high levels (GBq) of radioactivity. As experience at our centre increased, new equipment and procedures were introduced to optimise the safety of the process of preparing, administering and disposing of Yttrium-90 (Y-90).

**Method:** To shield the beta radiation, several items were made of Perspex including a contamination shield; a vial holder which attaches to the lead L-shaped body shield when drawing up the spheres and a Perspex rod attachment to be used in the intervention room for shielding part of the administration line. A check sheet was written for the administration, which included monitoring the delivery line and catheter for leaks and ensuring the radiation protection equipment was in place before administration.

**Results:** Dose rates on the surface of an unshielded sharps bin containing Y-90 waste can have hotspots measuring tens of mSv/hr. A 5 mm thick aluminium box was made in which to put the waste bin. Maximum dose rates measured on the surface of this box containing the bin are a few µSv/h.

**Conclusion:** With the help of a skilled engineering workshop, simple equipment can be made to reduce the radiation exposure to staff and minimise risk during the procedure.

**P32 Investigation into lung shunt fraction calculations from SPECT/CT and planar scintigraphy for pre-therapy SIRT patients**

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**Purpose:** Selective Internal Radiotherapy (SIRT) patients have a pre-therapy \(^{99m}\)Tc-MAA scan to assess shunting of activity from liver to lungs. Current practice for lung shunt fraction (LSF) assessment utilises whole body planar scintigraphy. SIRT patients routinely have SPECT/CT for the purpose of clinical assessment and this study aims to quantify the difference between planar and SPECT/CT LSF.

**Methods:** Fifty patients from January 2016 to November 2017 were retrospectively analysed to calculate planar and SPECT/CT LSF. LSF is calculated as the lung activity as a percentage of total activity.

Two-dimensional outlines of the liver and lungs were drawn on the planar images using HERMES Hybrid Viewer (Hermes Medical Solutions AB) and the area and total
counts recorded. Planar LSF was calculated using the background-corrected geometric mean of anterior and posterior images. Three-dimensional outlines of the liver and lungs were acquired using HERMES Hybrid3D and the volume and total counts recorded and used to calculate a SPECT/CT LSF.

For patients where no full CT of the lungs was available, the visualised lungs were outlined and an estimate of total lung volume was made, dependent on gender, and the total lung counts scaled to reflect this.

Result: Results indicated a definitive correlation between LSF calculations using planar scintigraphy and SPECT/CT. Regression analysis resulted in a correlation coefficient of $R = 0.950$ (95% confidence interval, CI = 0.913-0.972, $P < 0.001$).

Conclusion: LSF is higher when utilising planar compared to SPECT/CT. Further investigation is required with full lung CT images.

P33 An analysis of $^{99m}$Tc-MAA and $^{90}$Y bremsstrahlung SPECT/CT dose volume histogram agreement for liver selective internal radiation therapy

Nathan Dickinson
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In a previous liver Selective Internal Radiation Therapy (SIRT) imaging study, it was found that the mean activity ml/l and mean absorbed dose for tumour volumes of interest (VOIs) predicted during $^{99m}$Tc-MAA work up agreed poorly with post-treatment Yttrium-90 ($^{90}$Y) bremsstrahlung SPECT/CT scans, while good agreement was seen for healthy liver VOIs. However, mean absorbed dose is a crude metric for the dose to a given volume, as multiple dose distributions may provide a given mean value. Therefore, the use of dose volume histograms (DVHs), a common tool in external beam radiotherapy, has been of some interest in the literature (e.g. Dieudonne et al., 2011, 52:1930-1937, JNM). While some research has focussed on construction of SIRT treatment DVHs and their use in dose-response relationship studies (e.g. Kao et al., 2013, 3:57, EJNMMI), the question of whether $^{99m}$Tc-MAA workup dose volume statistics predict microsphere treatments more accurately than VOI mean doses remains open; understanding this is important in light of the growing need for personalised treatment planning and optimisation of molecular radionuclide therapies. A MATLAB program was therefore written to generate DVHs and calculate the cumulative doses to 50%, 70% and 90% of the tumour and healthy liver VOIs. The agreement in the dose volume statistics in $^{99m}$Tc-MAA work up and SIRT bremsstrahlung SPECT/CT scans studied previously was quantified using Bland-Altman statistics. A preliminary analysis echoed the findings of the previous study, i.e. the $^{99m}$Tc-MAA healthy liver DVHs predicted the microsphere DVHs well, but failed to represent the eventual tumour dose distributions.

P34 Renograms: A comparison of cardiac and spleen vascular background regions

Eleanor Hesketh
Sheffield Teaching Hospitals NHS FT, Sheffield, United Kingdom

Purpose: The Rutland-Patlak method for processing renograms requires a vascular ROI (Rutland MD. 1985, 6:11-20, Nucl. Med. Comms). This is subtracted from the kidney ROIs to negate the effect of decreasing blood activity and calculate the real renogram curve. Either the spleen or heart are recommended as the vascular ROI (Lawson R. 2010, Radionuclides in Nephrourology, Mikulov). Where the heart does not fit into the FoV, an alternative ROI around the aorta is often chosen, however this is not always well visualised. This study investigated differences in relative renal function using a heart or spleen vascular ROI.

Method: Ten patients’ renograms were processed using the Rutland-Patlak method with a cardiac vascular ROI, then reprocessed replacing the heart ROI with a spleen ROI. Quantitative results were recorded, and background subtraction of the renogram curves visually assessed. Percentage differences in relative renal function between both methods was calculated.

Results: The mean percentage difference in relative renal function was -0.1% (std. dev. = 2.2%, range = $-3.4$ to $4.8$%). The maximum value corresponded to an absolute difference in relative renal function of just 2%; $42\%$ for the left kidney using the heart ROI, and $44\%$ using the spleen. Visual assessment of renogram curves found that background subtractions were mostly correct (intercept = 0), with only two slight over-subtractions (negative Y intercept) found for those using the spleen ROI.

Conclusion: As an initial assessment, results indicate that there is no significant difference between renograms calculated using the heart or the spleen as the vascular region. Therefore when the heart cannot be included in the FoV, the spleen is a reliable substitute.

P35 Logistical considerations of doing a different GFR protocol for patients with oedema

Alexander Smout, Jamie Grey, Amber Mackley and Paul Hinton
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Oedema can cause significant errors in GFR measurements. Samples at later time points (12 to 24 h) are generally recommended in oedematous patients, however this creates logistical issues in scheduling outpatient GFR tests.
In a retrospective audit of 200 patients, we looked at whether we knew in advance whether the patient had known oedema from other imaging (CT, ultrasound, MRI), where available, and from the GFR worksheet, where patients are asked directly.

We checked correlation against the volume of distribution over BSA statistic (VD/BSA), which is used in QC checks to identify when the tracer has been diluted within a larger than expected volume of fluid. The BNMS guidelines recommend a normal range of 6-10 for VD/BSA.

Oedema was noted on the GFR worksheets of 23 of 200 patients, and in recent imaging of 29 of the 200. The total from the two methods combined was 45 of 200. Of the 29 patients with fluid accumulations noted on recent imaging, only 7 patients mentioned this when asked at the GFR appointment.

The median VD/BSA was 8.52 in the known oedema group and 8.06 in the other ($P = 0.03$). 6/45 patients with known oedema exceeded the tolerance of 10, compared to 11/155 patients with no prior knowledge of oedema ($P = 0.105$).

This work therefore questions the utility of the VD/BSA statistic at identifying where a result has been affected by oedema, and highlights that asking patients about their oedema is not a robust way of deciding which time points to take blood samples.

P36 A reference range for the terminal half-life in glomerular filtration rate calculations
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St George’s University Hospitals NHS FT, London, United Kingdom

The GFR calculation software at this centre incorporates several quality control parameters which help to assure confidence in the results. One of these is the comparison with a typical range for half-lives of the terminal phase (100-120 min) taken from BNMS guidance. A substantial number of otherwise normal investigations do not lie within this range and so a new reference range was calculated using the extensive local GFR data set.

GFR results from 879 patients (aged 20-75) were included in this work. The data for every patient included height and weight (including BSA and BMI), absolute GFR, BSA-corrected GFR, and volume of distribution. Only results that fall within the locally defined BSA-corrected GFR normal range were used to define the new reference range. The reference range is taken to be the 95% confidence interval of the half-life distribution. As the distributions had a strong positive skew, log transformation was performed. Correlation between terminal half-life and age, volume of distribution, BSA and BMI was assessed.

The typical range of 100-120 min as it is currently defined is insufficient. A new, age-based, reference range for the half-life of the terminal phase was determined:

- 20-29 years: 71–125 min
- 30-39 years: 77–136 min
- 40-49 years: 80–147 min
- 50-59 years: 81–161 min
- 60-69 years: 89–201 min
- 70-75 years: 100–217 min

The terminal half-life was found to be not or only poorly correlated with volume of distribution, the BSA and the BMI.

P37 Relationship between estimated GFR and slope-intercept and single-sample $^{51}$Cr-EDTA GFR
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*Department of Radiology, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom and *Department of Oncology, University of Oxford, Old Road Campus Research Building, Oxford, United Kingdom

Aim: In light of the proposition that a single-sample technique replace the method currently recommended by the BNMS guidelines for expected results >30 ml/min/1.73 m² (McMeekin H et al., 2016, 37:743-755, Nucl Med Comms), to determine the utility of eGFR in predicting which studies will yield a measured $[^{51}$Cr]EDTA GFR of <30 ml/min/1.73 m².

Methods: GFR values, calculated using slope-intercept (90, 150, 210 min post-injection) and single-sample (210 min post-injection) methods, for 1394 patient studies were obtained. 110 studies fulfilling the following criteria were selected: a $[^{51}$Cr]EDTA GFR measurement of <50 ml/min/1.73 m² and an eGFR calculated from serum creatinine on the same day.

The percentage difference between the eGFR and the two $[^{51}$Cr]EDTA GFR values were calculated. It was further noted that the number of studies in which the eGFR was in agreement with the $[^{51}$Cr]-EDTA GFR, regarding whether a value was <30 ml/min/1.73 m².

Results: For eGFR results between 30-39 ml/min/1.73 m², the mean percentage difference between slope-intercept and single-sample GFR was 23% (SD = 19%). Between 40-49 ml/min/1.73 m², the mean percentage difference was 13% (SD = 6%).
In 61 out of the 110 studies, the eGFR value was <30 ml/min/1.73 m². In 41% of these cases, the single-sample $[^{51}Cr]$EDTA GFR measurement also yielded a result less than 30 ml/min/1.73 m².

**Conclusion:** The mean percentage difference between single-sample and slope-intercept GFR is significantly greater ($P = 0.01$) in the eGFR range 30-39 ml/min/1.73 m² than the range 40-49 ml/min/1.73 m².

The eGFR is only able to predict which single-sample GFR values will be <30 ml/min/1.73 m² in 41% of studies. Work is ongoing regarding whether 40 ml/min/1.73 m² might be a more appropriate threshold.

**P38 Gastric emptying: Does the distribution of activity in the stomach affect function?**

Shazmeen Hansrod, Gregory James and Alp Notghi

*City Hospital, Birmingham, United Kingdom*

**Aim:** There can be a wide variation in activity distribution within the stomach for gastric emptying studies. For some subjects, the dominant accumulation of activity is in the fundus (top portion of the stomach) rather than distributed evenly throughout the entire stomach (fundus and antrum). The aim of the study was to assess whether an accumulation of activity in the fundus has any effect on the functional parameters.

**Method:** 25 normal volunteers (10 males, 15 females, age 22-61) were given a porridge meal. 25 anterior-posterior 2-minute static images were acquired with the patient standing between the detectors over a two-hour period, followed by a single image at 3-hours. Lag time, half-emptying time, peak emptying rate, time-to-peak-emptying and 3-hour retention were calculated. Two patterns of distribution were seen; activity accumulating in the fundus (group 1, $n = 10$) or distributed evenly though the stomach (group 2, $n = 15$). Gastric function parameters were compared using unpaired $t$-test.

**Results:** No significance was found between the two groups (all $P > 0.05$).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group 1 ($n = 10$)</th>
<th>Group 2 ($n = 15$)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag Time (min)</td>
<td>4.1 ± 3.1</td>
<td>6.6 ± 6.7</td>
<td>$P = 0.28$</td>
</tr>
<tr>
<td>Half-Emptying Time (min)</td>
<td>39.8 ± 10.8</td>
<td>49.7 ± 17.5</td>
<td>$P = 0.13$</td>
</tr>
<tr>
<td>Peak - Emptying Rate (%/min)</td>
<td>$-1.8 \pm 1.1$</td>
<td>$-2.0 \pm 2.2$</td>
<td>$P = 0.78$</td>
</tr>
<tr>
<td>Time-to-Peak Emptying (min)</td>
<td>15.0 ± 10.4</td>
<td>23.2 ± 15.9</td>
<td>$P = 0.16$</td>
</tr>
<tr>
<td>Exponential Half-Life (min)</td>
<td>29.1 ± 8.2</td>
<td>33.7 ± 9.4</td>
<td>$P = 0.21$</td>
</tr>
<tr>
<td>3-hour Retention (%)</td>
<td>1.1 ± 1.1</td>
<td>3.7 ± 4.1</td>
<td>$P = 0.07$</td>
</tr>
</tbody>
</table>

**Conclusion:** Although distribution of activity varies amongst normal volunteers, the appearance of the images did not influence the quantitative functional parameters. It is impossible to predict stomach function from the appearance of the images.

**P39 Red Cell Survival Study for Transfusion Reaction without Detectable Antibody**


*Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle upon Tyne, United Kingdom*

A case of intravascular haemolytic transfusion reaction without detectable antibodies occurring in a 64 year old female is reported. Multiple attempts to transfuse type specific compatible blood resulted in intravascular haemolysis. Standard transfusion reaction investigations were negative. Extended phenotyping of patient and donor blood highlighted that the consistent mismatch of the reacting units was C antigen.

Modified red cell survival studies were performed with Tc-99m using a method based on the *in-vitro* techniques described by Benedetto et al., 1984 (9:561-564 Clinical Nuclear Medicine). Two separate studies were performed using two different units of washed donor red blood cells. The first study was performed with C-negative blood and the second study was performed with C-positive blood. Imaging and sample counting were performed at multiple time points between 0.5 h and 24 h following administration.

In the C-negative study the fraction retained at 4 h was 50% and at 24 h it was 18%. The survival fraction at 4 h for the C-positive study was 2%. Imaging demonstrated more renal activity for the C-positive blood than for the C-negative blood.

The red cell survival curves demonstrated a more rapid fall in retention for the C-positive blood than the C-negative blood. The renal activity for the C-positive cells was in keeping with renal excretion of Tc-99m labelled Haemoglobin. This suggests a reaction to the C-positive blood.

The patient stabilised after transfusion with C-negative red cells. Extended phenotyping and the red cell survival study were found to be useful in this situation.

**P40 Improving reporting confidence by ruling out extravasation in DaTscans**

Susana Fernandes da Cunha, Joseph O’Brien and Alp Notghi

*Sandwell & West Birmingham Hospitals NHS Trust, Birmingham, United Kingdom*

**Introduction:** There is local concern that variation in the quality of DaTscans (some with low counts and apparent high background) could have been caused by tracer extravasation.

We audited our extravasation rate and level to assess the frequency and effect.
A total of 5 different operators were involved in the injections of these patients.

A planar acquisition was performed of the injection site (100 s, 256 × 256 matrix) prior to brain imaging. The image was assessed for the presence of tracer and if indicated quantified using standard sensitivity calibration factor for I-123.

Results: In 14/15 cases, no extravasation was seen in the injection site image, ruling it out. In one case, the vein of the patient’s arm was evident which was attributed to the injection sticking to the vein, but there was no tissue extravasation. The inclusion of an injection site image was deemed helpful in reporting in 8/15 cases where low striatal uptake was seen.

Conclusion: A simple single planar view of the injection site is quick and easy to perform helping the reporting team to provide more confident reports when low striatal uptake is seen. This has now become standard practice allowing continuous monitoring of the data. This audit also confirms that the injection technique using cannula is a robust method.

P41 Assessment of reliability of communication via post for nuclear medicine bookings
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Aim: In an effort to improve patient experience and assess the reliability of communication via post, this study aims to evaluate the quality and effectiveness of communication with patients for booking of Nuclear Medicine appointments.

Methods: 56 test letters were sent out to 10 individual postcodes. These were chosen taking into consideration the location of our departments and the most common geographical referral patterns. 50 letters were given to reception staff and included in the daily post to be sent from the department to the post room. 6 letters were given directly to the post room. Dates of reception of the letters were communicated to the department by the individuals.

Results: The average number of days between letter sent and letter received was 4.48 (SD = 1.38). The control letters were received at the same time as the letters handed to reception staff. 11% of letters sent were never received. The distance between the Trust and the individuals did not have an impact on the results distribution.

Conclusion: Corrective measures were put into place in order to reduce DNAs and also improve patient satisfaction with the booking system. These measures included phone calls to the patients before their appointment date and use of the text message service. Data shows that letters take longer to reach their destination than empirically perceived in the past, and therefore appointment letters should be sent at least 7 days in advance of the appointment date.

P42 Molybdenum breakthrough validation using a gamma sample counter
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Purpose: Validate molybdenum (99Mo) breakthrough measurements.

Background: 99Mo contamination (>0.1%) in technetium-99m (99mTc) based pharmaceuticals is potentially harmful due to long lived beta emissions (EANM. 2016. The Radiopharmacy - A Technologist’s Guide). Therefore, it is crucial to validate radionuclide calibrator (RNC) Mo-99 breakthrough measurements.

Methods: Five samples of 99Mo/99mTc eluate were assayed in a gamma sample counter (GSC) for 1200 s, starting >90 h after elution and repeated at 3.5 h intervals over 139 h. Bi-exponential fitting (BEF) of background corrected Tc-99m counts was performed with the half-life of each exponential constrained to those of Tc-99m and Mo-99:

Counts = [(1-Mo-99 fraction) × exp(-λTc-99m×time)] + [(99Mo fraction) × exp(-λ99Mo ×time)].

The component of 99mTc counts decaying with the half-life of 99Mo was assumed to be from 99mTc produced from 99Mo contaminants in transient equilibrium. The fraction of Mo-99 was corrected to account for decay emissions outside of the 99mTc window (12.4%) (Morillon C. 2012. LNHB - Mo-99 Decay Scheme). Mono-exponential fits for 99mTc and Mo-99 were extrapolated back to elution time and 99Mo/99mTc calculated.

Comparison of the results with those from the standard RNC method was performed. Two other eluates were also compared.

Results: Mean 99Mo/99mTc for the five samples was 2.2 × 10^-4% (CoV = 0.39%) using the BEF Method versus 4.6 × 10^-4% (CoV = 13.40%) for the RNC method, both significantly lower than the 0.1% EANM limit.

Mean 99Mo/99mTc from two other eluates were 6.1 × 10^-5 and 3.3 × 10^-5% using BEF versus 8.14 × 10^-4 and 8.34 × 10^-4% using RNC.
Conclusion: Bi-exponential modelling of elution samples provides a reproducible method of measuring $^{99}$Mo breakthrough and suggests RNC overestimate the percentage.

P43 To Flush or not to flush?
Amie Mitchell, Sue Doyle, Jasmine Cheesewright, Helen Davison and Laura Martin
Royal United Hospitals Bath NHS Foundation Trust, Bath, United Kingdom

Purpose of the study: Most patients having a Nuclear Medicine procedure will have an injection prior to their scan. In order to improve practice an audit was performed to assess the activity that is being injected. Activity maybe left in the syringes if they are not flushed out with saline after the initial injection.

Methods: Over a period of 4 weeks, the pre and post injection dose measurement was recorded for each injection. The percentage of injection left in the syringe was then calculated. A comparison was then made between the amount of activity left in the syringe with and without a flush.

Results: We have found that if the injection syringe is not flushed with saline there is a significant percentage of the dose left in the syringe. This could result in patients receiving an administration significantly lower than the Diagnostic Reference Level recommended by ARSAC. We also found that certain radiopharmaceuticals are more likely to attach to the plastic of the syringe.

Conclusions: There is significant residue of dose left in the syringe if not flushed with saline. Therefore, flushing out the injection syringes with saline means that the patient gets the correct dose to optimise high quality images. This allows the radiologist to report with the highest confidence in the images. There are also implications for radioactive waste management, where the residual activity disposed of in each syringe should be known.

P44 Dose reduction techniques used in a busy nuclear medicine, PET/CT and radionuclide therapy department
Renee Bertrand, Gerry Gillen, Caroline Findlay, Mary Dempsey, Colin Brown, Mary Milligan and Elaine Renwick
NHS, Greater Glasgow and Clyde, Glasgow, United Kingdom

Purpose: To reduce operator doses to as low as reasonably achievable

Summary: A number of innovative procedures have been implemented in high dose procedures at the hospital, to ensure radiation dose levels are as low as reasonably achievable.

This has included use of an Automatic Dose Dispenser (Amercare Ltd.) for Fluorine-18 (18 F), Radium-223 (223Ra), Phosphorous-32 (32 P) and Yttrium 90 (90Y) in PET and therapy treatment rooms. This has limited the handling of radiopharmaceutical vials and time taken to draw up patient doses which reduces finger and full-body doses.

Mobile lead shielding 20 mm thick is situated beside PET/CT scanners and in inpatient therapy rooms. Operators stand behind these to attenuate the radiation whilst positioning and communicating with patients.

Electronic Personal Dosimeters have been issued to all staff alerting them when they are receiving an instantaneous high dose. This prompts them to step back or seek assistance for these tasks.

Cannulae are the preferred choice when administering Fluorine-18, decreasing the amount of time spent in the vicinity of radioactive patients. Where poor venous access is encountered, a policy of ‘second-opinion’ is employed, with butterflies being the final choice and assistance provided whilst injecting.

The use of three-way taps on a primed line has been introduced in the 223Ra therapy clinic. The operator may stand farther away and inject more quickly.

Staff rotation is employed between clinics and between tasks within clinics to ensure even distribution of work load and dose. Each technique has resulted in a reduction of staff dose.

Conclusion: Efforts are ongoing to reduce staff radiation doses in this multi-faceted department.

P45 First experience of an automated dispensing and administration unit in PET/CT
Ellie Knowler*, Lee Bartleya and Matthew Talboysb
aUniversity Hospital of Wales, Cardiff, Cardiff, United Kingdom and bPETIC, Cardiff University, Cardiff, United Kingdom

Purpose: With PET/CT patient numbers increasing there has been a significant increase in body and extremity doses to operators dispensing, administrating and scanning patients. A 2016 audit of staff doses highlighted the need for an automated dispenser and administration unit to achieve operator dose optimisation. A detailed tendering process resulted in a Posijet v3 (Lemer Pax) being purchased and installed in early June 2017. As this is the first Posijet v3 system installed in the UK, an assessment was undertaken to determine the effectiveness of the unit to reduce operator doses.

Method: During commissioning, the unit was loaded with a 13GBq FDG vial and dose rate measurements (Hp(10)* were taken at the surface and 30 cm from the surface) both pre and post dispensing of a 300MBq dose.
Following a comprehensive training programme, the unit entered operational use. Personal dosimetry results were audited 6 months pre installation and 5 months post installation.

Results: Surveyed areas complied with the manufacturers’ dosimetry with the exception of a weak spot on one side of the unit. Staff were advised to avoid this area during the training programme.

Electronic Personal dosimetry demonstrated a lowering of body dose (avg = 2.1 mSv) for 90% of staff.

Finger dosimetry has significantly reduced with results falling from 8 mSv/month to less than 2 mSv/month.

There has been no operational downtime. The unit design support activities up to 37 GBq/vial which will accommodate an increase to our scanning capacity.

Conclusion: A reliable and functional system providing a significant reduction in staff dose.

P46 Evaluating the effectiveness of different types of syringe shields using a SPECT/CT gamma camera
Clare Jacobs
Nottingham University Hospitals, Nottingham, United Kingdom

Purpose: It can be difficult to compare the effectiveness of different syringe shields from product information leaflets alone as the information presented is limited and inconsistent. In addition, there is no way of determining if there are weaknesses in the construction of the syringe shield.

The purpose of this work was to use SPECT/CT imaging to evaluate different types of syringe shields for their relative effectiveness.

Method Used: SPECT/CT images of a selection of different syringe shields used in our department were obtained; all containing the same source of Tc99m. The effectiveness of different shield types was evaluated from the raw projection count data. Acquisitions were obtained for a narrow energy window of 140 keV ± 10%, and also for a wide window 140 keV ± 95%, so that a comparison of the effectiveness both for primary and scattered radiation could be obtained. CT data was used to localise hotspots.

Summary of the results: SPECT/CT imaging proved to be an effective method for evaluating syringe shields. It successfully revealed the weaknesses in designs and differences in scatter produced for different types of syringe shields.

Conclusion: The protection factors can vary considerably between syringe shield designs. One type of shield tested showed a reduction in the primary Tc99m penetration by a factor of ~80, whereas other shields demonstrated reduction by a factor of ~300.

One type of shield design was seen to have a weakness at the location of the join between the lead glass window and the metal barrel of the shield.

P47 Effect of EPI heating on PET scanner performance for brain research studies using siemens mmr scanner
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Geoff Charles-Edwardsa,b, Paul Marsdena and Paul Schleyerd
aKing’s College London & Guy’s and St Thomas’ PET Centre, School of Biomedical Engineering and Imaging Sciences, King’s College London, London, United Kingdom, bMedical Physics, Guy’s & St Thomas’ NHS Foundation Trust, London, United Kingdom, cImanova Centre for Imaging Sciences, Hammersmith, London, United Kingdom and dSiemens Medical Solutions USA Inc, Molecular Imaging, Knoxville, Tennessee, United States

The PET ring in the Siemens mMR scanner is constructed from magnetic field insensitive avalanche photodiode (APD) modules. These solid state devices are temperature sensitive. Cooling channels in the detectors, circulate water around the APDs, to try to maintain a constant operating temperature. The PET modules are located next to the MRI gradient coil. This can heat up during the MRI acquisition, particularly with sequences such as echo planar imaging (EPI) that apply rapidly switching gradients with large amplitude, often used in fMRI. We have assessed the effects of gradient coil heating by comparing PET listmode data of a uniform Ge-68 cylinder with/without applying a 16 min EPI-fMRI sequence (TR/TE = 2040/13 ms, 80 slices). For a 2 min PET frame acquired after 14 min of EPI, we: (1) measured a decrease of 4.27 ± 0.18% in PET true coincidence events; (2) saw no change in image quality of a reconstructed PET image; (3) measured a small decrease from 5.60 ± 0.251 Bq/ml to 5.50 ± 0.335 Bq/ml in activity concentration for a large region of interest (ROI) at the centre of the Ge-68 cylinder. Throughout these measurements, the cooling liquid surrounding the APDs increased in temperature from 22 to 31°C due to gradient heating. The small decrease in activity concentration recorded of 1.8% implies that the temperature compensation methods, which include an APD gain correction, are largely effective, making it possible to quantify changes in PET uptake during the application of an extended fMRI sequence.

P48 GE discovery MI DR PET/CT performance evaluation
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The PET ring in the Siemens mMR scanner is constructed from magnetic field insensitive avalanche photodiode (APD) modules. These solid state devices are temperature sensitive. Cooling channels in the detectors, circulate water around the APDs, to try to maintain a constant operating temperature. The PET modules are located next to the MRI gradient coil. This can heat up during the MRI acquisition, particularly with sequences such as echo planar imaging (EPI) that apply rapidly switching gradients with large amplitude, often used in fMRI. We have assessed the effects of gradient coil heating by comparing PET listmode data of a uniform Ge-68 cylinder with/without applying a 16 min EPI-fMRI sequence (TR/TE = 2040/13 ms, 80 slices). For a 2 min PET frame acquired after 14 min of EPI, we: (1) measured a decrease of 4.27 ± 0.18% in PET true coincidence events; (2) saw no change in image quality of a reconstructed PET image; (3) measured a small decrease from 5.60 ± 0.251 Bq/ml to 5.50 ± 0.335 Bq/ml in activity concentration for a large region of interest (ROI) at the centre of the Ge-68 cylinder. Throughout these measurements, the cooling liquid surrounding the APDs increased in temperature from 22 to 31°C due to gradient heating. The small decrease in activity concentration recorded of 1.8% implies that the temperature compensation methods, which include an APD gain correction, are largely effective, making it possible to quantify changes in PET uptake during the application of an extended fMRI sequence.
Aim: To evaluate and benchmark three of the first GE Discovery MI DR PET/CT systems installed in the UK by Alliance Medical. The MI DR has an analogue PET detector, and its performance was additionally compared to the MI digital system featuring SiPMs to assess potential benefits of system upgrade. Finally, the system was compared to current analogue systems from each of the three major vendors of PET/CT scanners.

Methods: System performance was evaluated according to the NEMA NU-2012 specification and compared across three Discovery MI DR systems to assess inter-model variability.

Summary of results: All three systems exceeded the manufacturer’s NEMA specification. However, performance between the systems varied; specifically, one scanner demonstrated sensitivity 9% lower than the average of the other two scanners. The IEC phantom results were found to be much better for all three systems than the specification. The Discovery MI DR demonstrated similar performance to GE Discovery 690 and Phillips Ingenuity scanners, but lower sensitivity, spatial resolution and count rate performance than the Siemens Biograph Flow PET/CT system. However, the Discovery MI DR outperformed the Biograph and Ingenuity scanners in terms of contrast recovery, providing improved quantification of smaller sized lesions.

Conclusion: Acceptance results demonstrate reasonable agreement between the three MI DR systems tested, with the exception of sensitivity. The Discovery MI 4-ring digital system has improved sensitivity and count-rate performance over both the 3-ring digital and MI DR. Overall the Discovery MI DR performance is comparable to other state-of-the-art analogue PET/CT systems.

P49 Variation of contrast recovery with tangential and radial position within a NEMA image quality phantom
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With the increased interest in quantitative SPECT and the use of SPECT data to plan therapeutic treatments, an understanding of the consistency and uniformity of quantitative parameters throughout an imaged volume is essential.

A NEMA image quality phantom was imaged in three sphere configurations using a GE Optima 640 with LEHR collimators. The corresponding attenuation maps, rotation radii and acquisition parameters were used to generate noise free SIMIND simulations to which Poisson noise was added. Data were reconstructed using OSEM with resolution recovery (RR), both with attenuation correction (AC). These were validated against the acquired data. The digital NEMA phantom was extended to include 60 replicates of each sphere size at various radial and tangential positions. Contrast recovery (CR) was measured at each location.

In acquired data, a clear variation in contrast recovery was seen between the sphere locations, specifically for the 22 mm sphere. This was confirmed in the validation simulation, although discrepancies in absolute CR values between acquired and simulated data were seen. The multiple sphere simulation demonstrated a radial dependence of CR, with variations of up to 20% with the 22 mm diameter sphere. There was a linear trend in recovery in the tangential direction, increasing towards the periphery of the phantom.

Contrast recovery of spherical lesions is strongly dependent on tangential and radial position, with variations of up to 20% demonstrated for a 22 mm sphere within a simulated NEMA image quality phantom. Discrepancies in absolute values between acquired and simulated data require further evaluation.

P50 Validity of sensitivity calibrations with $^{57}$Co
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Introduction: XSPECT Quant (Siemens) is a quantification package on Intevo SPECT/CT systems that allow quantification of uptake akin to SUV (standard uptake value) from tomographic imaging. The initial provision for calibrating systems is with $^{57}$Co sources against reference source details, without regard to local radionuclide calibrator accuracy for $^{57}$Co.

Aim: To assess the clinical SUV accuracy by calibrating with $^{57}$Co sources and with $^{99m}$Tc measured on a local radionuclide calibrator.

Method: XSPECT was calibrated extrinsically with LEHR collimators with a $^{99m}$Tc point source of about 80 MBq in 0.1 ml. A fillable NEMA 94 PET cylindrical phantom (Siemens) was filled with about 200 MBq of $^{99m}$Tc and scanned using a clinical XSPECT SPECT/CT protocol (20 s per view, 64 views, 1800 rotation, using non circular orbit, step and shoot). SUV analysis was performed using 10 large spherical ROIs placed within the imaged volume. This was repeated after re-calibration with $^{57}$Co sources.

Results: The mean SUV from 10 spherical ROIs placed randomly within the imaged phantom volume were 1.03 and 1.00 after calibration with $^{99m}$Tc and $^{57}$Co respectively.

Applying the same rationale established for PET SUV, where a tolerance of 0.90 –1.10 is acceptable, validates the use of $^{99m}$Tc to calibrate XSPECT.

Conclusions: Calibrating XSPECT Quant against the ‘system apparent’ $^{57}$Co source reference details yields an acceptable SUV as confirmed against $^{99m}$Tc calibrations and clinical
SUV analysis. However, calibrating with $^{99m}$Tc represents a viable cost effective means of maintaining XSPECT for local users, without the need for costly $^{57}$Co sources.

**P51 The impact of phantom geometry on SPECT calibration**

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Activity quantification in SPECT imaging is vital if patient dosimetry is to be performed. To do this the number of counts detected in a region must be related to the activity in that region. This is done using a calibration factor, calculated by imaging a known activity distribution. Typically a single spherical activity distribution is used. Recent work has demonstrated that a single calibration factor is not suitable for all patient-representative activity distributions. The volume dependence of calibration factor is more pronounced for small volumes due to the greater impact of partial volume effects. The calibration factor also depends on the position of the activity within an attenuating and scattering medium.

SPECT images of inserts, including 3D printed organ models, in different positions were acquired and calibration factors calculated for them. Images of a uniform activity distribution were also acquired. Images were acquired using $^{99m}$Tc and $^{177}$Lu. The acquired data were reconstructed on a clinical system.

Monte Carlo simulations of the SPECT imaging were carried out in GATE to examine the impact of attenuation and scatter correction on the calibration. Monte Carlo simulations allow a closer estimate of the true number of scattered events in an energy window than solely imaging-based techniques. A comparison of the simulated images and the experimental images demonstrates the impact of phantom geometry on image quantification.