Abstracts

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1. Emerging role of [18F]florbetaben-PET/CT in assessment and management of people living with HIV and subjective cognitive impairment.

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Aim: To assess value of [18F]florbetaben (FBB) in people living with HIV (PLWH) and subjective cognitive impairment (SCI), when HIV associated neurodegenerative disorders (HAND) and other types of dementia are considered as differential diagnoses, and its impact on management.

Method: FFB-PET/CT imaging was prospectively performed in 20 (Male=18) PLWH with SCI [median age 59 (13)]. Objective cognitive impairment was defined using the Frascati criteria (fCI). Images were visually assessed by 2 different imaging centres. Semi-quantitative analysis was performed using Hermes BRASS Florbetaben software and by obtaining a composite cortical to cerebellar cortex standardised uptake value ratios (SUVRs) using cerebellum as reference region [SUVR>1.35 (>mv+2SD of healthy controls)]. Clinician diagnostic confidence before and after (scale 1 to 10, 1=no confidence and 10=complete confidence) was assessed.

Results: Fourteen/20 PLWH (70%) had objective fCI; in total, 4/14 (29%) had visually and semi-quantitatively positive scan; 2/4 (50%) were clinically diagnosed with AD type dementia; 2/4 (50%) had mild CI and remained under close clinical follow up. Six/20 (30%) had no fCI and negative FFB scan.

Regionally the greatest SUVRs were observed in the posterior cingulate and superior temporal and frontal superior lobe. FFB significantly increased clinical confidence in all 14 fCI but did not change in 6 neg fCI patients. (Mean 6.9 to 8.1; p<0.005)

Conclusion: FFB can identify amyloid plaque deposition in PLWH. It increased clinical confidence in 70% of cases. Negative scan is reassuring for AD type dementia. FFB role in differentiating HAND from AD type dementia needs to be established.

2. Interobserver Variability in the Qualitative and Quantitative Analysis of Cardiac MIBG Scintigraphy for the Diagnosis of Lewy Body Disorders

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Introduction: [123I]-MIBG cardiac scintigraphy is a tool to detect cardiac sympathetic denervation, which can be helpful to differentiate between different Parkinsonian syndromes. Images can be assessed visually and quantitatively. The aim of this study was to review cardiac MIBG studies at 2 nuclear medicine departments.

Methods: Planar images were acquired in the anterior view at 15 minutes and 4 hours using a double-headed gamma camera (GE Healthcare) and a low-energy collimator. The heart: mediastinal ratio (HMR) was measured by 6 different scorers including radiologists and technologists, we also subsequently recalculated HMRs for a medium-energy collimator, using a published formula. The visual and final interpretations (normal, abnormal or borderline) were recorded in each patient.

Results: The cohort consisted of 10 patients. On visual interpretation only, there was a near-perfect agreement between 2 consultant’s interpretation of the scan, $\kappa = .82$, (95% CI, .510 to 1.00), p<0.01. However, the final interpretation, with the addition of low-energy HMR, led to fair agreement, $\kappa = .37$, (95% CI, .023 to .727), p=0.06. Conversion to a medium-energy HMR led to a significant increase in mean HMR, (1.79 vs 1.36, p=0.02) and when utilised in reporting, resulted in perfect agreement, $\kappa = 1.0$, p<0.01.

Conclusion: Agreement on the visual interpretation of cardiac MIBG is near-perfect, however the use of quantified heart: mediastinal ratios can lead to important differences in the final report. After correcting for the use of a low-energy collimator there was perfect agreement in the interpretation of these studies amongst 2 consultant radiologists.
3. Quantification for DaTSCAN: can it change your reports and add confidence?
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Aim: Evaluate to what extent quantification can change DaTSCAN reporting.

Method: 35 consecutive DaTSCAN™ studies were selected. These were acquired on either GE Infinia or Discovery 630 cameras, 3.5 hours after [123I]Ioflupane injection. Images were processed using recommended parameters (OSEM, Butterworth filter critical frequency 0.6, power-factor 10). Specific Binding Ratio (SBR) was calculated using DaTQUANT™ software package (GE Healthcare). The randomised scans were reviewed by three reporters (R1=consultant, R2=registrar, R3=experienced physicist) twice; with and without quantification.

Reporters had to choose: A) Scan report (1:normal, 2:PD/DL, 3:striatal infarct, 4:technical problem, 5:don’t know). B) Reporting confidence (1 to 5). Wilcoxon Rank test was used for paired matched data, and ANOVA for multiple related data. Chi-square test was used to compare between reporters.

Result: There was a significant difference in report with and without quantification (p<0.001). 20/105 reports changed following quantification (4, 11, 5 by R1, R2, R3 respectively). Reporting confidence increased significantly (p<0.001). There was no significant difference between reporters with least change in reports by consultant (p=0.25), then experienced physicist (p=0.031) and most changes by junior reporter (p=0.005). Interestingly, the reporting confidence of the two clinicians was higher with or without quantification than the experienced physicist (p<0.001). The increase in reporting confidence with quantification only occurred with clinicians but remained the same with the physicist. Reporting confidence in cases where quantification affected the report was significantly lower than in cases where the report did not change.

Conclusion: Quantification has significant positive effect on the DaTSCAN interpretation and reporting confidence.

4. Improvement of [18F]FDG PET/CT and MRI concordance in Temporal Lobe Epilepsy Pre-surgical Assessment using Statistical Parametric Mapping Z-scores
2nd Place Student Prize
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Objectives: This study evaluates the diagnostic performance of statistical parametric mapping (SPM) analysis of [18F]FDG PET/CT in temporal lobe epilepsy (TLE). Our aim is to increase consistency in image reporting and increase confidence in surgical evaluation.

Methods: Thirty-eight patients with TLE who underwent MRI and [18F]FDG PET/CT imaging at the Queen Elizabeth Hospital Birmingham were included. Images were interpreted by visual assessment by radiologists. Quantitative analysis for [18F]FDG PET/CT was performed using SPM. Statistical analyses performed include Kruskal-Wallis and Game Howell tests, analysis of ROC curve and Cohen’s κ statistics.

Results: The standardised uptake value (SUV) ratio for left temporal epilepsy, non-epilepsy and right temporal epilepsy were -1.06±0.101, 0.08±0.79, 0.39±0.73 respectively, exhibiting significant difference between the three groups (p<0.01). In the left/non-left group, the area under curve (AUC) was 0.881 while the cut-off value to separate left temporal epilepsy from non-epilepsy and right temporal epilepsy was -0.305 with 89.7% sensitivity and 89.9% specificity. In the right/non-right group, the AUC was 0.792 while the cut-off value to separate left temporal epilepsy from non-epilepsy and right temporal epilepsy was 0.19 with 83.3% sensitivity and 81.3% specificity. When patients were divided into three groups based on SUV ratio (left temporal epilepsy, non-epilepsy and right temporal epilepsy), there was good inter-method agreement between MRI and SUV ratio (κ = 0.63, 95% CI, 0.42–0.85).

Conclusion: These results indicate that PET/CT-based SUV ratios may have promising diagnostic value in future clinical practice.

5. Approaches of PET metallomics for the study of metal trafficking in vivo
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Essential trace metals such as copper, zinc and manganese play crucial roles in the human body. A disruption to the homeostasis of these metals is implicated in several diseases, most notably prostate cancer, Alzheimer’s disease and diabetes. There is an unmet need to non-invasively study metal trafficking in vivo, with PET metallomics emerging to address this need. We have access to an ever expanding range of radiometals with different imaging properties and relevance to different diseases.
The in vivo distribution of $^{52}$Mn ($t^{1/2} = 5.6$ d; $\beta^+ = 30\%$), $^{62}$Zn ($t^{1/2} = 9.3$ h; $\beta^+ = 3\%$) and $^{64}$Cu ($t^{1/2} = 12.7$ h; $\beta^+ = 18\%$) was investigated in healthy BALB/c mice over a day. All radiometals were rapidly cleared from the blood and localised to major organs such as the liver, kidneys and intestines. Interestingly, $^{52}$Mn and $^{62}$Zn demonstrated significantly higher uptake in the pancreas compared to $^{64}$Cu. Although $^{62}$Zn has previously been considered a poor choice for PET imaging due to its unfavourable decay to $^{62}$Cu ($t^{1/2} = 10$ min; $\beta^+ = 97\%$), our data suggests that $^{62}$Zn administered as a citrate complex is handled in vivo primarily as zinc citrate and not copper citrate. Tracking $^{52}$Mn and $^{62}$Zn in diabetes, cancer and dementia in mice and later in humans will be important areas for future research. Together these radiometals set the foundation for the study of essential metals in clinical diseases where metal trafficking is disrupted.

6. Maximum acceptable delay in processing $[^{99m}Tc]$ \textit{Tc-DTPA} GFR plasma samples

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**Introduction:** Plasma samples for GFR studies must be counted before radioactive decay reduces activity concentration below detectable limits. Since moving from $[^{51}Cr]$ Cr-EDTA to $[^{99m}Tc]$Tc-DTPA for GFR studies the maximum delay between injection and sample counting has decreased due to the difference in physical half-life. The risk of non-diagnostic studies due to equipment downtime for faults and planned maintenance is increased.

This work aimed to establish the maximum delay possible between administration and sample counting which maintains accuracy of the GFR result.

**Method:** GFR was performed using 10 MBq $[^{99m}Tc]$ Tc-DTPA with blood samples taken at 2 and 4, 6 or 24 hours post administration. 1ml plasma samples were counted using a Perkin Elmer 2480 Wizard gamma counter for 10kcts or 45mins. GFR was calculated using the Slope-Intercept method (Fleming JS et al. 2004, 25(8):759-69. Nucl.Med.Commun.). The plasma samples were repeatedly re-counted up to 86 hours post administration. GFR values were re-calculated and compared to the original value.

**Results:** The plasma samples from 76 patients were included with a mean 4.8 (range 2-10) re-calculations per patient. A total of 364 GFR results were analysed. The change in GFR exceeded ±5% for all samples counted beyond 56hours post administration. The change in GFR was less than ±5% for 99.1% samples counted within 37hours post administration.

**Conclusion:** Clinically we have implemented a maximum acceptable delay in processing of GFR samples of 37 hours. Our local guidelines require all counting to be completed by 5pm on the day after the patient was injected.

7. Can patient age be used to decide the optimum sample time for single sample GFR studies?

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The 2018 BNMS GFR guidelines require the expected GFR to determine the optimum sampling time. McMeekin et al (BNMS2019) discussed that this is chosen as a balance of accuracy and precision of single-sample GFR results (SS-GFR) versus multi-sample results.

This presents logistical issues, leading some centres to explore a fixed sampling time of 4 hours for all patients. We performed analysis on 16203 of our patients’ data with samples at 2, 3 and 4 hours to determine whether the optimum sampling time could be chosen by patient age. The accuracy and precision of our calculated SS-GFR results using an age-based threshold approach were compared to a fixed sampling time of 4h and also to the BNMS2018 eGFR-based approach.

The fixed sampling time of 4h has reasonable precision and accuracy for GFR 40-80ml/min, above which the precision and accuracy progressively worsen. Performing 2 hours sampling for patients under age 70 and 4 hours sampling for older patients gave the same accuracy as the BNMS guidelines from GFR 50-150ml/min, but worse precision across this range. Interestingly, an age-based method with threshold of age 60 was significantly more accurate than the fixed 4 hours for-all method, and had equivalent precision.

The BNMS guideline method for optimum sampling time had better overall precision and accuracy than either method.

We propose that a reasonable protocol for deciding the optimum sampling time of non-oedematous patients would be to use the eGFR where available (following BNMS guidelines), otherwise taking a 2 hours sample for patients under age 60 and a 4 hours sample for older patients.

8. A feasibility study for half time $[^{99m}Tc]$Tc-MDP whole body bone imaging

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Purpose of study: A blinded small sample study to determine whether half time \([^{99m}Tc]\)Tc-MDP whole body bone imaging provides diagnostic image quality for a range of clinical indications. Standard and Pixon half time processed images were assessed.

Methods: Whole body images of 11 patients were acquired with a Siemens Symbia Intevo XL using half time and full time acquisition protocols for referrals of: prostate cancer (n=7), breast cancer (n=3), and sarcoidosis (n=1). The full time images were reported and the half time data was reconstructed with and without using the Pixon algorithm. The three image types were re-processed into anterior and posterior statics by one user. The processed images were anonymised and the order was randomised before being scored on PACS by four radiologists following scoring criteria including Clinical Reportability [CR], Lesion Conspicuity [LS], Noise [N] and Confidence [C]. Percentage agreement of the full time scores between the four radiologists was calculated to determine inter-reporter agreement. The correlation between full time scans and the two processing types for half time were assessed using percentage agreement scores and two-way kappa statistics in R.

Results: The percentage agreement between reporters was 90.9% for all criteria except noise. The percentage agreement between full and half time imaging for CR was 84.1% (κ=0.25) and between full time and Pixon imaging was 95.5% (κ=0.66).

Conclusions: Preliminary analysis has found a greater correlation between full time and Pixon imaging compared to full time and half time imaging, further analysis will determine whether half time imaging is feasible.

9. Dual-isotope Infection SPECT/CT Imaging: A study on the optimisation and impact of clinically available artefact reduction techniques
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Purpose: The aim of this project is to improve the quality of dual-isotope \([^{99m}Tc]\)Tc/\([^{111}In]\)SPECT/CT images by optimising available acquisition and reconstruction parameters, to minimise artefacts and increase clinicians' confidence in the reporting of these studies. The main area of focus is the effect that crosstalk between \([^{99m}Tc]\)Tc and \([^{111}In]\) has on image quality.

Methods: A Jaszczak phantom was modified to hold three small sources of clinically relevant activities (one \([^{99m}Tc]\)Tc source, one \([^{111}In]\) source, and a mixed source) in a water background. This phantom was imaged using a Siemens Symbia T16 SPECT/CT camera. The reconstruction parameters were varied, and the images analysed to find the extent of the crosstalk and the optimal parameters for artefact reduction by comparing the counts in the mixed source to those in the single isotope sources.

Results: The current clinical reconstruction utilising 8 iterations and 8 subsets with resolution recovery (Flash3D) and no scatter correction gave a 10.6% overestimation of the \([^{99m}Tc]\)Tc activity. The optimal reconstruction settings were Flash3D with 16 iterations and 16 subsets with a triple energy window scatter correction which resulted in an underestimation of the \([^{99m}Tc]\)Tc activity by 0.7%. The effect of \([^{99m}Tc]\)Tc crosstalk to the \([^{111}In]\) windows was found to be negligible.

Conclusions: In this phantom study, a triple energy window scatter correction has been found to minimise artefacts in dual-isotope \([^{111}In]/^{99m}Tc\) SPECT/CT images. An audit is planned to evaluate the impact of these optimised reconstruction settings on clinical image quality and reporting confidence.

10. The impact of SiPM PET/CT scanners. A step change in practice?
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Aim: The introduction of new PET/CT scanners with large axial field-of-view and SiPM readout promise to deliver a step-change in PET performance. The aim of this study is to explore both the image quality and practical impacts of introducing such a scanner into clinical practice.

Methods: A Siemens Vision 600 PET/CT scanner with 26.3 cm axial field-of-view and SiPM readout was introduced into our practice. Acceptance testing was completed and results were compared to those from a previous generation scanner (GE Discovery 710).

Following commissioning/protocol setup, the optimal parameters and resultant image quality were compared between the systems for several study types. The impact of the new scanner on operations was also assessed.

Results: NEMA acceptance testing results showed improved performance in all areas compared to the previous generation scanner, particularly in spatial resolution (3.7mm vs 4.4mm), sensitivity (15kcps/MBq vs 7.5kcps/MBq) and time-of-flight timing resolution (213ps vs 560ps). This has translated into reduced dose (e.g. a reduction of 1.2 MBq/kg for \([^{18}F]\)FDG studies)
and reduced scan times (typically ~10 minutes compared to 16-18 minutes previously), while still demonstrating improved clinical quality. Importantly, this has had a substantial impact on staffing, staff dose and uptake area requirements to fully realise the benefits of the reduced scan time.

**Conclusions.** New SiPM PET/CT scanners offer a step change in performance, with the improved specifications allowing for substantial reductions in scan time and dose. This however gives rise to operational challenges in order to achieve the higher throughput.

### 11. Bayesian Penalised Likelihood (Q.Clear) reconstruction of [68Ga]DOTATATE PET/CT in neuroendocrine tumours: a comparison with standard image reconstruction methods

**3rd place Student Prize**

Rachna Prem, James Temple, Wei-Shern Chen, Krokos Georgios, Gary Cook

Krokos Georgios, Gary Cook

**GKT School of Medicine, London, United Kingdom.**

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**Objective:** The aim was to determine if Q.Clear (GE Healthcare) Bayesian Penalised Likelihood (BPL) reconstruction algorithm of [68Ga]DOTATATE PET scans at different penalisation factors (b) could improve qualitative and quantitative image parameters compared to standard Ordered Subsets Expectation Maximisation (OSEM) with time-of-flight, VPFX reconstruction.

**Methods:** 25 PET/CT scans, performed 60 minutes after injection of 110-224MBq (mean 153MBq) [68Ga]DOTATATE on a GE Discovery-710 PET/CT scanner, were reconstructed using VPFX (2 iterations, 24 subsets) and Q.Clear using b values ranging from 200-1200. A representative neuroendocrine tumour (NET) lesion and 3 reference regions (liver, spleen, L3 bone marrow) were measured for standardised uptake values (SUVmax/mean/peak/sd), signal-to-noise ratio (SNR-SUV max/liver SUV sd) and signal-to-background ratio (SBR-SUV max/liver SUV mean).

Blinded qualitative assessment by a PET specialist scored image quality on a 5-point scale and for the presence and severity of artefacts.

**Results:** Lesion SUVmax and SNR for BPL were significantly higher than VPFX for all bs (p<0.05). Although BPL lesion SBR was also higher than VPFX, no b reached statistical significance. Similar patterns were seen for reference organ comparisons. Qualitative analysis showed a preference for b800 image quality with a lower artefact score.

**Conclusion:** BPL reconstruction of [68Ga]DOTATATE PET data in patients with NETs improves SNR in tumour lesions and normal organs and increases SUVmax in tumours. Combining these results with the preferred image quality, b800 BPL reconstruction should be considered as an alternative for future reconstruction methods when assessing NETs.

### 12. Looking at [18F]FDG PET with 2020 Vision

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The Siemens Biograph Vision has been used at our Manchester Royal Infirmary since October 2018 and [18F]FDG PET images have been reconstructed using TOF. Recent work demonstrated that an optimised PSF+TOF reconstruction retained quantification, improved lesion detection and reduced image noise. Following this, the clinical protocol was revised in January 2020, which included a 30% reduction in scan time. This work evaluates the impact of these changes on image quality and scan time.

In 2019, 50 consecutive reference studies were reconstructed using OSEM+TOF (4i5s, 5.0mm filter, 3.2mm voxels) and UHD (OSEM+PSF+TOF; 3i5s, 4.5mm filter, 1.6mm voxels) for comparison. Signal-to-noise ratio (SNR) within a spherical 3cm VOI in the liver was used as a measure of image quality. The updated protocol was evaluated for a further 99 consecutive patients in order to assess the time saved per patient and changes in SNR.

The 50 reference studies had a median (inter-quartile range) scan time of 10m 45s (9m 40s–12m 24s) and a median (IQR) liver SNR of 10.3 (9.3–12.1) for TOF and 15.2 (13.2–17.4) for UHD. Following the change of protocol, the 99 studies had a median (IQR) scan time of 8m 48s (7m 47s - 10m 22s) with a median (IQR) liver SNR of 14.9 (13.9–15.9), which did not exhibit any relationship with patient weight or BMI.

Moving to UHD reconstruction with carefully selected parameters has further refined our scanning protocol with reduced scanning time, increased image quality and preserved quantification.

### 13. Development and characterisation of a PET “painting” robotic phantom to generate pseudoanthropomorphic brain and geometric test objects under digital computer control

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**Introduction:** Moving radioactive source systems have been used for gamma camera and small PET test objects in air (Forgacs et al., 2019, PLoS ONE 14(1): e0207658). This work extends the capability to in-water objects to produce pseudo-anthropomorphic brain and geometric phantoms.
Method: A computer controlled electro-mechanical system positioned a point source (< 5 MBq [18F]FDG) in a 8x13x13 cm volume in a water filled cylinder. The relative distribution of activity was “painted” by varying the source dwell time at each location, the dwell time derived from MRI images or geometry files. Basic performance was characterised. A geometrical phantom was defined representing part of the cerebellum and inferior temporal lobe with a clinically relevant SUVR of 1.8, observed in Alzheimer’s patients imaged with novel tau tracer [18F] PI-2620 (Life Molecular Imaging). A 28 mm IEC sphere was digitally defined. All imaging was with GE Discovery 710 series scanners.

Results: Spatial accuracy (+/- 1.2 mm) and timing accuracy was confirmed (97% r² over 0.5 s to 2.5 s). The IEC sphere image matched the set 28 mm diameter. Temporal lobe SUV was in agreement with the set value. Acquisition took 40-60 minutes. Phantoms were changed in a few minutes, requiring only change of digital control files and no handling of radioactivity.

Conclusion: This first in-water robotic “painting” phantom has shown the potential to produce pseudo anthropomorphic and geometric shape test phantoms, under highly flexible digital control. Inclusion of random counts is required, and the painting speed must be increased.

14. Variation of software platforms including the use of in-house analysis in Nuclear Medicine – results from a UK survey

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This survey aimed to establish the national variation in software platforms used clinically to calculate quantitative values. In-house developed software was of particular interest.

The survey was developed by the IPEM Nuclear Medicine Software Quality Group (NMSQG). The main section of the survey gathered information on examinations involving quantitation and the software platforms involved.

A total of 67 responses were received. The responses cover services provided by 140 gamma cameras and 31 PET scanners. The largest variation in software platforms used for an examination were, SeHCAT (for non-imaging) and HIDA/cardiac MIBG/gastric emptying (for imaging) tests. Less variation was observed for PET imaging analysis where this is carried out either by manufacturer (77%) or commercial (23%) software.

Of the 38 nuclear medicine exam types that centres recorded as being quantified, 28 were found to include some element of in-house software. Of these 28 exam types, it was found that 14 exam types were quantified using in-house software in the majority of centres surveyed.

Of the sites that use in-house written software, 25% report having a software quality management system (SQMS) in place. The results of this novel survey will be used by the NMSQG to target future audits to the area of greatest software variation. Clinical in-house software quantitation is widespread. However, the use of SQMSs are not routine, although this may increase with the updated Medical Devices Regulations coming in to force.

15. Development of a Bespoke Cardiac Prototype Phantom for Dynamic Imaging

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Introduction: Our department operates two cardiac gamma cameras: the IS2 CDC PULSE, a double headed anger camera and GE’s NM530C, a newly installed solid-state camera. Comparing the two cameras using clinical data can be difficult, therefore, this project aimed to develop a prototype dynamic cardiac phantom which could be used to accurately compare dynamic imaging between the two gamma cameras. As there were no commercial phantoms that met requirements, the phantom would be produced in-house.

Method: For the phantom to be used for radionuclide ventriculography and myocardial perfusion imaging, three fillable and moving components were required, two ventricles and a myocardial wall. These components mimic heart motion with known and adjustable filling and emptying volumes; providing adjustable and known ventricular ejection fractions. Several designs were considered and a literature review assessed similar phantom designs.

The final design included a crank shaft mechanism and adjustable speed rotating motor to operate three syringes connected to the three moving heart components.

Results: The prototype phantom was successfully designed and manufactured in-house. As there was no ECG signal for gating, ungated images were acquired using the NM530C. The manufacturing process highlighted the difficulty in resourcing appropriate tools which resulted in the phantom being less robust than desired.
**Conclusion**: Further work will explore adding a pulse generator component to allow for gated imaging. Despite the phantom being fully functioning, a more robust model would be desired and could be manufactured by the local engineering department which will be further ventured.

16. **The use of Radionuclide Ventriculography in assessing Herceptin treatment in Breast cancer**

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Breast Cancer as a group of diseases is relatively common, affecting approximately 12% of women, of whom about 25% will be HER2 positive, i.e. will have over-expression of human epidermal growth factor receptor 2 which causes out of control reproduction of breast cells.

Treatment for breast cancer is increasingly effective and recurrence is less likely if treated with targeted therapy such as Trastuzumab and Pertuzumab. In a proportion of patients, these drugs have recognised cardiotoxicity, resulting in left ventricular dysfunction.

We have used sequential radionuclide ventriculography (RNV), with a reproducibility and repeatability of 5% (normal being left ventricular ejection fraction (LVEF) greater or equal to 40%), for the early recognition and subsequent expedited treatment of cardiotoxicity.

Between 2006 and 2019, 2547 scans were performed in 746 patients, 2 of whom were male. In 1807 scans there was a normal LVEF. In 681, it was moderately reduced (between 40% and 30%) and in 55 (2.2%) the left ventricular function was poor, with a LVEF less than 30%.

There was no correlation between whether patients were dead or alive with either the initial or final LVEF, as seen in the graph below.

In summary, it would appear that patients are dying of their intercurrent disease, rather than of cardiotoxicity, and early treatment of reduced LVEF attenuated the cardiotoxic effect of Herceptin in comparison to the 8 to 30% reported in the literature.

17. **Evaluation of adverse cardiac event rates in the 5 years following normal myocardial perfusion imaging using the Digirad Cardius X-ACT.**

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Aims: Multiple studies have reported a ≤1% annualised cardiac event rate (non-fatal myocardial infarction or cardiac death; AER) following a normal myocardial perfusion scan (MPS). This study aims to establish the 5-year AER following a normal MPS in our Southmead Hospital since the installation of the Digirad Cardius X-ACT (a small footprint, solid state, triple head, dedicated cardiac gamma camera) in 2014.

Methods: Consecutive patients with a normal \[^{99mTc}\]Tc-sestamibi SPECT MPS were identified. Regional hospital electronic records were retrospectively reviewed to establish the incidence of cardiac events and cardiac death within 5 years of a normal MPS.

Results: 100 patients (42 male, 58 female; age range: 32-87) were included. 7 patients were deemed to be high risk (with a significant cardiac history). 2 high-risk patients had an NSTEMI and one of these patients subsequently died of a cardiac cause (congestive cardiac failure). 1 of the 93 low-risk patients (with no prior cardiac history) had an NSTEMI. Overall, we identified 4 adverse cardiac events, giving an AER of 0.8%.

Conclusion: To our knowledge, this is the first published data of 5 years of clinical follow up on patients imaged with the Digirad Cardius X-ACT camera. Our 0.8% AER is comparable to those described in the literature. This result provides evidence that myocardial perfusion imaging with this next generation dedicated cardiac gamma camera can provide a useful tool in risk stratifying patients who present with cardiac symptoms.

18. **Coronary artery \[^{18F}\]-sodium fluoride positron emission tomography and USPIO-enhanced magnetic resonance angiography identifies culprit lesions in myocardial infarction**

Marwa Daghema, Rishi Ramaesh, Gillian Macnaught, Scott Semple, Edwin J R van Beek, Marc Dweck, Dave Newby, Michelle Williams
Purpose: Previous studies have established that $^{18}$F-sodium fluoride positron emission tomography and computed tomography (PET/CT) can identify culprit lesions in patients who have undergone myocardial infarction. Magnetic resonance imaging (MRI) of the coronary arteries is possible using ultra small superparamagnetic particles of iron oxide (USPIO). This study aimed to assess $^{18}$F-sodium fluoride uptake in the coronary arteries of patients with recent myocardial infarction using combined PET-MRI.

Methods: Patients with a history of myocardial infarction underwent $^{18}$F-sodium fluoride PET-MRI (Biograph mMR, Siemens). Ultra small superparamagnetic particles of iron oxide (USPIO; ferumoxytol)-enhanced magnetic resonance coronary angiography (MRCA) was performed using FLASH sequences. Fused PET and MRCA images were used to assess maximum standardised uptake value (SUVmax) in the culprit (defined by invasive coronary angiography) and non-culprit lesions. Tissue to background ratio (TBRmax) was calculated using the SUVmax from the right atrium.

Results: Ten patients with myocardial infarction underwent $^{18}$F-sodium fluoride PET-MRI (age 65±7 years, 90% male). Culprit plaques were present in the left main stem of 2 patients (20%), left anterior descending in 3 patients (30%), left circumflex in 1 patient (10%) and right coronary artery in 4 patients (40%). Mean SUVmax in the right atrium was 0.82±0.15, in culprit lesions was 1.14±0.33, and in non-culprit lesions was 0.79±0.17. Culprit lesions had a higher TBRmax compared to the non-culprit reference lesions (1.30±0.46 vs 0.94±0.18, p=0.01).

Conclusion: Combined $^{18}$F-sodium fluoride PET and USPIO-enhanced MRCA can identify the culprit disease in patients with recent myocardial infarction.

Background: Transthyretin amyloidosis (TTR) is a cause of restrictive cardiomyopathy and heart failure predominantly in the elderly. Diagnosing TTR with non-invasive tests such as ‘bone tracer’ scanning is now routine utilising diphosphono-propanodicarboxylic acid (DPD).

We aimed to determine the magnitude of referrals to a developing cardiac TTR service that may arise from incidental findings on routine hydroxyethylene diphosphonate (HDP) bone scans which also demonstrate cardiac uptake in TTR.

Methods: All HDP bone scans performed at University Hospital North Midlands from the 2017/18 financial year were reviewed (n=1530). Of these, 1399 were for oncological and musculoskeletal (oncology/MSK) indications and 37 were referred to specifically ‘exclude amyloidosis’. We excluded paediatric and duplicate follow-up imaging.

Results: Myocardial uptake was present in 7/1399 of the oncology/MSK group and 10/37 of the ‘exclude amyloidosis’ group. 43% of patients with incidental myocardial uptake displayed clinical features of heart failure and therefore likely to have cardiac TTR. Although only 0.5% of routine bone scans show incidental myocardial uptake, this group of patients make up nearly half (41%) of all bone scans diagnosed TTR in our institution. Conclusion: We suggest that patients with incidental myocardial uptake on bone scan account for a significant proportion of potential TTR amyloid treatable patients referred to a cardiac amyloidosis service. It is therefore imperative that cardiac amyloidosis services should include pathways facilitating rapid referral criteria for suitable patients with incidental cardiac uptake on bone scans.

20. Red blood cell volume measurement - can Indium replace Chromium?
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The withdrawal of $^{51}$Cr-chromate has meant that the technique commonly used for direct measurement of red cell volume has had to be replaced. Most centres moved to a $^{99m}$Tc-erythrocyte label however, $^{99m}$Tc is known to dissociate over time. We have investigated an alternative technique using an $^{111}$In chloride and tropolone solution and tested this both in-vitro and in-vivo.

Initial in-vitro work, included a check of the stability of the labelled product at one hour and demonstrated this label to be stable over this time period. The stability was subsequently confirmed in-vitro in 10 patients. Initial investigations included the behaviour of the detector (auto-gamma counter) when counting $^{111}$In; the energy spectrum of this isotope includes unusual co-incident energy peaks. The
linearity of the detector was confirmed and an assessment was made of an appropriate administered activity. This was found to ideally be between 0.6 and 1 MBq to allow immediate assay. Optimal standard dilution volume was also investigated. To date, over 30 patients have undergone this technique and results show that this technique is a viable alternative to 

Purpose: Cardiff University PET Imaging Centre (PETIC) introduced routine \[^{13}N\]Ammonia production for pre-clinical research in 2018. However, the process proved problematic due to low yields, radioactive gas releases and repeated target rinses to unload the product. The aim of this project was to optimise the IBA Cyclone 18/9 cyclotron production of \[^{13}N\]Ammonia to minimise the release of radioactive gases and maximise the final yield of \[^{13}N\]Ammonia in order to facilitate pre-clinical research at PETIC.

Methods: \[^{13}N\]Ammonia is produced by proton irradiation of a natural water target by the \(^{16}\)O(p, alpha)\[^{13}N\] nuclear reaction. In order to improve production yields, modification of several cyclotron operating parameters was investigated: target current (10–38 microA), volume of target solution (1.2–1.8ml) and helium transfer pressure (1–5 mbar) were optimised.

Results: In result of this project, optimal production parameters have been established: target current of 15-20 microA, target volume of 1.6 ml, and helium transfer pressure of 2.5 mbar. The final product yield has increased from 1 GBq to 6 GBq and gaseous stack emissions have been reduced to less than 50 MBq. In addition, it is no longer necessary to undertake a target rinse post-production to deliver the final product to the hot cells.

Conclusion: The implementation of the optimised parameters has increased the final product yield, reduced gaseous emissions and removed the requirement for multiple target rinses.

22. Optimising targeted radiolabelled nanoparticles for radionuclide therapy

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University of Aberdeen, Aberdeen, United Kingdom.

Royal Marsden NHS Trust, Sutton, United Kingdom

Purpose: Heterogeneity of dose distributions across a tumour is problematic for targeted radiotherapy. Gold nanoparticles (AuNPs) enhance dose-distributions of targeted radionuclides. This study aimed to demonstrate if tumour dose-distribution of targeted AuNPs radiolabelled with either of two radioisotopes (\(^{177}Lu\) and \(^{90}Y\)) in breast cancer cells produced homogeneous dose distributions.

In addition the importance of receptor level on cytotoxicity of EGFR-targeted AuNPs was examined in breast and colorectal cancer cells in vitro and in vivo.

Methods: AuNPs were functionalised with DOTA and OPPS-PEG-SVA to optimise labelling with radionuclide tracers and targeting with Erbitux. Radionuclides were chelated with DOTA and the uptake of the radiolabelled AuNPs and targeted activity in vitro in both cell lines measured using liquid scintillation counting. Cells with medium (HCT8) and high (MDA-MB-468) EGFR expression were incubated with targeted \(^{177}Lu\)AuNPs for 4h then washed and allowed to form colonies. Nude mice bearing tumours were used to study the biodistribution by injecting \(^{177}Lu\)AuNPs or \(^{90}Y\)AuNPs via the tail vein. Heterogeneity of dose-distribution in tumours was determined using autoradiography.

Results: Colony formation (% control) was 81±4.7% (HCT8) and 32±9% (MDA-MB-468). High uptake was observed in the liver and spleen, indicating hepatobiliary excretion. Imaging showed heterogeneity in dose-distributions for both radionuclides across the tumours.

Conclusion: The cytotoxic-effect of EGFR-targeted AuNPs is greater in cells with higher EGFR expression. Dose-distributions for individual radiolabelled nanoparticles were heterogeneous across tumours. Further strategies are required to improve the uniformity of dose-distribution prior to clinical trials.

23. Investigating the effect of sporicidal disinfection step during the preparation of \(^{99m}Tc\) radiopharmaceuticals.

Elizabeth Faminua, Megan Longworth, Shazmeen Hansrod, Fareeda Akhtar, Muhammad Ali, Thomas Wan, Sue Renn, Beverley Ellis

Manchester University NHS Foundation Trust, Manchester, United Kingdom.

Manchester University, Manchester, United Kingdom

Aim: MHRA require use of sporicides as part of the transfer disinfection process. This study aimed to validate the use of a semi-quantitative test to determine sporidal
concentrations in kits/critical components as [99mTc] radiopharmaceuticals may be oxidised by sporicides.

Method: A national survey was conducted to establish criteria and design of study. Semi-quantitative test sticks were validated and used to determine H2O2 concentration in radiopharmaceutical vials and critical components exposed to sporidal disinfectants. Testing was undertaken using varying transfer techniques. Minimum concentration of sporicide required to affect radiolabelling of kits was determined for MAG/HDP/Nanoscan prepared according to their SmPC. Radiochemical purity (RCP) testing was performed to confirm whether the use of sporicide in the disinfection process affects chemical stability of the radiopharmaceutical.

Results: The national survey found that 36% included a sporidical step within their disinfection process and the majority used H2O2 (6% v/v) as the disinfectant. The test sticks found that liquid peroxide present on the vial bung was detectable inside the vial. However, results revealed that no H2O2 was detected in vials following the disinfection process.

For kits directly exposed to H2O2, median (95% CI) RCP for MAG3 was 96.1% (91.5-99.4%), Nanoscan was 96.8% (93.5-98.0%) and HDP was 99.3% (96.5-99.9%). For kits which underwent full disinfection, median (95% CI) RCP for MAG3 was 99.5% (99.4-99.6%), Nanoscan was 99.4% (98.8-99.8%) and HDP was 99.9% (99.6-99.9%).

Conclusion: This study has found that introducing a sporidical step into the transfer process has negligible effect on the radiochemical purity of kits.

24. Validation of the use the Labnet® Digital Dry Bath for the Preparation of Radiopharmaceuticals that Require Heating

Shazmeen Hansrod, Thomas Wan, Megan Longworth, Harry Grover, Beverley Ellis
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Aim: Radiopharmaceuticals such as MAG3/MIBI require heating as part of the preparation of the technetium-bound kit. Normal practice involves use of a boiling water bath but there are increasing concerns about the regulatory non-compliance associated with the presence of water in aseptic cleanrooms. This study examines whether the Labnet® digital dry bath can be used instead of a water bath for radiopharmaceutical preparation.

Method: A calibrated temperature probe was used to determine the heating profile of saline when heated in the water bath versus dry bath over 10 minutes. Kits (n=12 per kit) were prepared with varying activity (1-3GBq for MAG3, 1-11GBq for MIBI) using both a dry bath and water bath and radiochemical purity (RCP) measured. Statistical and regression analysis was carried out to determine if there was a significant difference between the two techniques.

Results: Heating profiles established that all vials in the dry bath reached 100°C within the 10 minute period. For kits made using the dry bath, the median (95% CI) RCP was: MAG3 98.8% (93.8%-99.8%), MIBI (Cardiovis) 98.9% (98.2%-99.5%), MIBI (Technescan) 98.8% (98.4%-99.3%). Statistical analysis of the results show there is no significant difference between results obtained for the dry bath versus water bath for both MAG3 and MIBI (all p >0.05). Regression analysis shows there is no statistically significant correlation between increasing activity and RCP (p>0.05).

Conclusion: This study demonstrates that a dry bath can be used to prepare radiopharmaceuticals with comparable radiochemical purity to kits prepared with a water bath.

25. Evaluation of radioisotope injection technique for sentinel lymph node biopsy in breast cancer

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Salford University, Salford, United Kingdom

Background: Sentinel lymph node biopsies are an established method to assess axillary lymph node involvement during cases of breast cancer. Currently there is no consensus on what the preferred site and method of injection is for accurate identification and localisation.

Methods: A systematic review of studies comparing different methods of injection for imaging using lymphoscintigraphy and/or intra-operatively using a gamma probe. The detection rates of sentinel lymph nodes using lymphoscintigraphy or intra-operative means were evaluated. 95% confidence intervals and pooled odds-ratios were analysed using a fixed effect analysis if low heterogeneity was measured, or random effects if statistically significant (P<0.05) heterogeneity is detected.

Results: Seventeen studies were identified for the systematic review; twelve of these were eligible for statistical analysis. A statistically significant preference towards superficial injection methods both intra-operatively (OR: 3.28 (2.28-4.71), P<0.00001) and lymphoscintigraphically (OR: 3.23 (1.68-6.24), P=0.0005) for detecting sentinel lymph nodes. For extra-axillary sentinel lymph node detection, deep injection methods were significantly preferred (OR: 2.76 (1.77-4.29), P<0.00001). No statistically significant difference in detection rates was found when comparing areolar superficial injections with superficial techniques elsewhere on the breast (OR: 0.58 (0.27-1.27), P=0.17).
Conclusion: Both deep and superficial methods are effective at identifying sentinel lymph nodes. Axillary nodes are more likely to be identified using superficial injection techniques. The location of the superficial injection on the breast does not seem to be influential.

Robin Mark McDade, Barbara Kerr, Scott Allan, Craig Paterson, Nicholas Goodfield
Glasgow Royal Infirmary, Glasgow, United Kingdom.

Aims: Elucidate event profile using Regadenoson, examining:
- safety of using Regadenoson as a “rescue” to failing ergometric stress e.g. without a ‘cooldown’
- safety among asthmatics / COPD
- relationship between Regadenoson plus physiological stress and scan quality

Methods: A retrospective audit of 602 consecutive Regadenoson stress tests; 319 had Regadenoson “rescue”, an ergometric stress where >85% target heart rate or rate pressure product ≤25000 was unachievable. Pulmonary Function Tests were sought retrospectively. Complication rates were compared. Subdiaphragmatic uptake graded; 3 point scale, two blinded observers and relationship to stress examined via Spearman Rho.

Summary: Event rate was 15%, no cases required Aminophylline.

Table 1: Event profile (all stress modes) (*Serious events)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>No. of Events</th>
<th>%</th>
<th>Published Range</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspnea / Marked dyspnea</td>
<td>37/6</td>
<td>6.1±1.0</td>
<td>25 – 66</td>
<td></td>
</tr>
<tr>
<td>Typical chest pain</td>
<td>18</td>
<td>3</td>
<td>7 – 14.9</td>
<td></td>
</tr>
<tr>
<td>Nausea or Vomiting</td>
<td>12</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Symptomatic BP ↓</td>
<td>5</td>
<td>0.8</td>
<td>0.5 – 2</td>
<td></td>
</tr>
<tr>
<td>ACS *</td>
<td>3</td>
<td>0.5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Lightheaded</td>
<td>3</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vagal</td>
<td>2</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrhythmia *</td>
<td>2</td>
<td>0.3</td>
<td>26-30.6</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>2</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Event rate at GRI 69 PFT’s found; mean time 8.8 months. 11 had a FEV1 change >12% post-bronchodilation; range 14-34, mean 24.

Table 3: Scan quality grading

<table>
<thead>
<tr>
<th>Grade</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excellent – no GI encroachment</td>
</tr>
<tr>
<td>2</td>
<td>Adequate; minor GI encroachment; no challenge to interpretation</td>
</tr>
<tr>
<td>3</td>
<td>Poor – GI encroachment challenges interpretation (inferior / lateral wall)</td>
</tr>
</tbody>
</table>

Table 4: Scan quality v’s stress indices

Conclusions: The serious event rate using Regadenoson is lower than Dipyridamole / Dobutamine. 38% reported asthma or COPD, yet Aminophylline was not required. Regadenoson proved safe in patients with significant COPD/asthma. Rescue of ergometric tests e.g. no ‘cool down’ period proved safe. A significant relationship between absolute ergometric work (Joules) and scan quality was demonstrated.

27. How do Nuclear Medicine Radiographers and Technologists Understand the Concept of Patient Care?
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Introduction: Patient care is considered an integral component of the role of a nuclear medicine radiographer
or technologist (NMRT) in the various educational curriculum as well as in BNMS and EANM guidelines. However, little is known about what patient care actually means to an NMRT.

**Aim:** To describe the different ways NMRT understand the concept of patient care.

**Methods:** Qualitative interviews were undertaken as part of a wider study looking at professional identity. Fourteen NMRT (7 radiographers, 7 technologists) across the UK were asked to describe how patient care and diagnostic nuclear medicine imaging are related to each other. Data was analysed to identify the different meanings common to the group.

**Results:** Patient care was seen as integral to diagnostic nuclear medicine imaging. Six different meanings were attached to the concept of patient care by NMRT depending on the situation. Patient care can be seen as:

1) A tool to help the patient in order to produce diagnostic images.
2) Coaxing a patient to “go a little bit further” even if that might mean reluctantly causing them some distress.
3) Providing a net clinical benefit to the patient.
4) The scanning procedure itself, because diagnostic nuclear medicine imaging is part of the patient care pathway.
5) Putting the patient at the centre of everything an NMRT does.
6) Ensuring patient autonomy. Moreover, NMRT see this meaning as superseding all other meanings.

**Conclusion:** NMRT see patient care as central to their role. How they understand patient care is determined by contextual circumstances.

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[68Ga]Ga-DOTA-TOC scans are used to detect neuroendocrine tumour (NETs). UHCW recently started to perform these scans; thus, it is important to evaluate the quality of the image and assess for optimisation. FDG PET scans are often characterised by SNR values within the liver. The aim of the study was to assess the image quality (SNR) and whether the liver is an appropriate measure for assessment of SNR.

This is a retrospective observational study. Eight NET patients from several origins underwent [68Ga] Ga-DOTA-TOC scan acquired using a GE PET/CT 710 according to the EANM protocol. The CNR and SNR were calculated using background in healthy liver (HL) and also in the left ventricle (LV). 7 patients had a diagnosis of gastrointestinal-NETs and 1 patient lung NET. The background SUV measured in HL (3.41±0.06 g/mL) is higher than the background measured in LV (1.79±0.01 g/M); the measurements in HL were also more variable and complicated in patients who have multiple metastases in the liver. The image contrast calculated with the LV is 7.0±5.3 which indicates high contrast in most of the images, except one which revealed low lesion SUV.

This initial approach to [68Ga]Ga-DOTA-TOC scans indicates that image quality is good, the use of the liver as a measure of image noise is less appropriate because of the variation in signal and potential for disease in this organ. The LV provides more consistent values and is likely to provide a good measure for the determination of image quality/noise.

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**29. An analysis of a new parathyroid scintigraphy protocol evaluating the contribution of the different scintigraphic components: planar, SPECT, SPECT/CT and surface rendering, in comparison with histopathological outcomes.**

Hajira Ilyas, Charlotte Fowler

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**Background:** The role of parathyroid scintigraphy is to localise lesions to help guide the surgical approach. There are many different protocols in use. We aimed to evaluate the relative contribution of different components of a new protocol which comprises: 40MBq [99mTc] Pertechnetate SPECT immediately followed by 900MBq [99mTc] Tc-MIBI SPECT without patient movement, delayed [99mTc]Tc-MIBI SPECT with CT fusion at 2 hours and surface rendering of SPECT atsets.

**Methods:** 51 consecutive patients who had undergone parathyroid scintigraphy with proven parathyroid lesions at surgery were selected and their scintigraphic datasets reviewed. All 3 SPECT datasets were compressed in the coronal plane to provide reconstructed planar equivalent images. Surface rendering was performed using Syngovia (Siemens).

Datasets were considered in the following order: reconstructed early planar, reconstructed late planar, early SPECT, late SPECT, late SPECT/CT and surface rendered SPECT datasets. Cases were categorised to establish the earliest in this sequence which demonstrated a parathyroid lesion (a [99mTc] Tc-MIBI tracer avid focus which was unmatched on pertechnetate imaging) at the surgically confirmed site.

**Results:** Early planar images correctly identified 35%, with addition of late planar: 49%, with addition of early SPECT: 69%, with addition of late SPECT: 75%, with
addition of hybrid SPECT/CT: 78%, with addition of surface rendering: 92%. 4 cases (8%) could not be localised on scintigraphy.

Conclusion: Our new protocol is extremely effective in correctly localising parathyroid adenomas with successful localisation in 92% of cases. Surface rendering was required to make the diagnosis in 14% of cases.

30. Terminology used when reporting Dual Energy X-ray Absorptiometry in Premature Ovarian Insufficiency Patients.
Harini Fernando, Amy Eccles
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Guys and St Thomas’ Trust, London, United Kingdom

Statement on the purpose of the study
In this audit we aim to review terminology used when reporting of Dual Energy X-ray Absorptiometry (DXA) in patients referred from our Trust’s Premature Ovarian Insufficiency (POI) clinic. POI is the loss of normal ovarian function before 40 years of age which can be associated with low bone mineral density. World Health Organisation recommends using T scores and ‘osteopenia’ and ‘osteoporosis’ for men over 50 and post-menopausal women. In pre-menopausal women, reports should refer to the Z score. Normal physiological bone mineral loss starts around 40 years of age and POI patients are less than 40 years so do not fall into the ‘post-menopausal’ category and therefore be reported using Z score with values <-2.0 reported as ‘lower than expected for patient’s age.

Methods: Using CRIS, PACS and EPR we identified 105 DXAs performed between June 2018 and June 2019 in patients from POI clinic aged between 19 - 40 at the time of the scan. Terminology used in the report was collected and analysed.

Summary of Results: 98% of reports used T score with normal/osteopenic/osteoporotic terminology. 85% of patients with a T score <1.0 or lower had a Z score in the normal range. 2 patients did not have T scores available as they were 19 years of age.

Conclusion: There has been re-education of DXA reporters and we now use Z score for POI patients under the age of 40 and plan to re-audit in 6 months’ time.

31. Role of Bone SPECT/CT in the post-operative management of children with Slipped Upper Femoral Epiphysis.
Avyay Sharma, Sabyasachi Bandyopadhyay, James Kyle, Eleonora Manca, Maryam Jessop, Nitasha Singh, Sabina Dizdarevic
Brighton College, Brighton, United Kingdom.

Purpose: Currently, there is no clear imaging guidance on post-operative risk stratification for avascular necrosis, as MRI is contra-indicated. We aim to demonstrate the role of bone SPECT/CT in assessing femoral head vascularity and viability post-operatively in the management of children with slipped upper femoral epiphysis (SUFE).

Methods: Three patients (aged 11-13 years) with acute severe SUFE (2 unstable and 1 stable as classified by Loder RT, et al. 2006, Jan;88(1);97-105. J Bone Joint Surg Am) were scanned one week following surgical dislocation and re-alignment. Clinical outcomes were measured in terms of range of movement (ROM) and X-ray findings.

Results: Dynamic bone scintigraphy and SPECT/CT demonstrated a non-vascular, non-viable femoral head in two cases (unstable slips) and one metabolically active vascular, viable femoral head. SPECT/CT improved anatomical correlation overcoming planar and SPECT imaging artefacts particularly due to acetabular overlap.

Patients with a non-viable femoral head were stratified as high risk for complications and were started on bisphosphonates along with non-weight bearing for three months. The patient with a viable femoral head was low risk and allowed early weight-bearing without bisphosphonates.

Post-operative monitoring showed X-ray features of early collapse in one of the cases of unstable SUFE at six months with preserved ROM. The other two cases showed good ROM and no X-ray features of collapse at three months.

Conclusion: This case series demonstrates the emerging role of bone SPECT/CT in the risk stratification of post-operative SUFE for avascular necrosis and further management.

32. An Audit of DMSA scans at a busy DGH
Manish Pandit, Lucy Berwick, Joseph O’Brien
Sandwell and West Birmingham NHS Trust, Birmingham, United Kingdom

Introduction: A total of 128 DMSA scans were included in this audit, which was performed retrospectively over a 2 year period.

Aim: To analyze the percentage of interval (>3 weeks) and acute DMSA studies(<3weeks) and compare performance with the local guidelines.
Findings:

1. Female to male ratio was 81:48
2. 4/128 DMSA scans were performed at <2 weeks after the infectious episode. A further 27/128 scans were performed between 2-3 weeks interval.
3. 39/128 DMSA scans were performed on up to 20 month old babies. A further 89/128 scans were performed on up to 10 year old children.
4. 44 DMSA scans had a L:R kidney ratio worse than 45:55, i.e. abnormal, conversely, 85 scans had a normal L:R ratio.
5. Additional ultrasound scans were performed on all patients, 28 showed abnormalities including scarring, the corresponding follow-up DMSA scan showed similar abnormalities in 48/128 studies.
6. Out of the 128 DMSA scans performed, 14.8% showed more information in addition to the ultrasound studies.

Conclusion: Our study shows a preponderance of female UTIs, although we cannot exclude a possibility that more females are being referred for DMSA scans. Local guideline in the SWBH is in favour of interval scanning at 4-6 months with a minimum of an interval of 3 weeks. Our study indicates that we complied with interval scanning in the majority of cases, however, around 24% of the cases were performed earlier than our guideline would recommend.

33. Octreoscan Audit: Is the 48-hour Image Necessary? 
Ayah A Nawwar, Julian Kabala, Randeep Kulshrestha 
University Hospitals Bristol, Bristol, United Kingdom

SNMMI (2011) and EANM (2010) guidelines recommend 24-hour imaging followed by 48-hour imaging in case of bowel activity and SPECT/CT for better localisation. Potential use of laxatives to clear bowel activity was mentioned. In our trust, patients attend for dose administration and are called back 24-hours and 48-hours for imaging, with 24-hour SPECT/CT imaging; meaning patients attend 3 consecutive days.

Aim: Assess feasibility and efficacy of omitting the 48-hour imaging and whether the potential use of laxatives would’ve been helpful.

Methods: 21 Octreoscans for NET patients were retrospectively reviewed by nuclear medicine radiologist. Physiological bowel activity on 24-hour planar imaging, whether SPECT/CT allowed accurate interpretation and value of 48-hour imaging were tabulated.

Results: Bowel activity was noted in all cases, however, the 24-hour SPECT/CT confirmed it as physiological, eliminating the need for laxatives. The SPECT/CT was useful in localising disease, particularly in a case with subtle uptake in peritoneal & liver metastases that weren’t clear on planar imaging. Likewise, a pancreatic head lesion masked by kidney on planar imaging was correctly localised on SPECT/CT. The 48-hour images added no additional value to scan interpretation, except for where it helped confirm an orbital lesion in a single case. Therefore, accurate interpretation was possible with SPECT/CT, without 48-hour imaging.

Conclusion: After incorporating SPECT/CT imaging, the 48-hour planar imaging could be safely omitted without reducing the accuracy of diagnostic interpretation, potentially reducing patient inconvenience and improving scanner and staff efficiency.

34. An evaluation of whether choline PET/CT changes the restaging of biochemically recurrent prostate cancer following prior imaging with at least two other modalities.
Monique Vekeria, Randeep Kulshrestha, Amarnath Challapalli 
Bristol Royal Infirmary, Bristol, United Kingdom

Purpose: To establish whether choline PET/CT results change disease restaging in patients who have been investigated for biochemical recurrence of prostate cancer with at least two prior forms of imaging.

Methods: A list of 62 patients was generated using the departmental computerised radiology information system. Information concerning the nature of previous radical treatment and the results of relevant previous imaging was reviewed to establish whether there was a change in disease staging following choline PET/CT.

Results: The addition of choline PET/CT changed disease staging in 42 cases (68%), upstaging 39 cases (63%) and downstaging 3 cases (5%). Of the 39 upstaging PET/CT scans, 20 (51%) revealed local recurrence that had not been previously detected in 19 cases with an indeterminate preceding MRI in the remaining case. Local recurrence with regional lymphadenopathy and/or metastatic disease was found in 6 cases (15%). Regional lymphadenopathy was identified in 4 cases (10%) with additional metastatic disease in 3 cases (8%). 6 choline PET/CT scans (15%) demonstrated metastatic disease only with one prior MRI scan identifying an indeterminate bone lesion that was subsequently avid on choline PET/CT.

Conclusion: Choline PET/CT can identify sites of local, nodal and distant metastatic disease in patients with biochemical recurrence of prostate cancer with prior negative or indeterminate findings on bone scintigraphy, CT and/or MRI. It is a useful adjunct to the more traditional forms of imaging used in this patient group and can lead to significant changes in disease restaging.

35. Initial Experience of [18F] PSMA PET/CT Imaging in a District General Hospital
Rob Foley, Stewart Redman, Richard Graham, David Little
Introduction: Prostate-specific membrane antigen (PSMA) has shown great promise as a radiotracer in the staging of prostate cancer and in the localisation of recurrent disease. The use of $^{18}$F] PSMA-1007, with its longer half-life allows for PSMA imaging in centres without a Gallium generator. The aim of this study is to report our initial experience of $^{18}$F] PSMA-1007 PET/CT.

Methods: The cohort consisted of 16 patients imaged between August 2019 and January 2020. PET with low-dose CT was acquired from vertex to proximal thigh 2 hours post-intravenous injection of $^{18}$F]-PSMA-1007 with an average dose of 238 +/- 27 MBq.

Results: 9 scans were undertaken for biochemical recurrence and 7 for primary staging. In the staging cohort, average PSA 72 ng/ml, there was 1 case of local nodal recurrence and 2 cases of bone metastasis. There were 4 prostate confined cases, however 2 of these patients had indeterminate bone lesions. In the biochemical recurrence cohort, average PSA 3.8 ng/ml, sites of recurrence were identified in 6 patients, 5 of which were local recurrence while 1 patient had bone metastasis. There were sites of equivocal bone uptake in 4 patients, 3 of whom had nodal recurrence and one an otherwise normal scan.

Conclusion: Despite the increased sensitivity of PSMA in the primary staging of prostate cancer and the detection of recurrent disease, areas of ambiguity remain. Sites of non-specific bone uptake are common, demonstrated in 44% (n=7) of this cohort, and may pose a management dilemma in these patients.

Results: 176 patients were identified. 114 (65%) patients had $^{223}$RaRaCl$_2^2$ as first- or second-line treatment. 104 (59%) patients completed the recommended 6 cycles of $^{223}$RaRaCl$_2$ therapy, of which 68 (65%) had $^{223}$Ra RaCl$_2$ as first- or second-line treatment. The median OS for patients receiving $^{223}$RaRaCl$_2$ treatment as first- or second-line was 558 days, compared to 465 days in the third-line or later group (p=0.07). When 6 cycles of $^{223}$Ra RaCl$_2$ therapy are completed, median OS was 887 days in the first- or second-line therapy group, compared to 605 days for third-line or later (p=0.07).

Conclusion: At our centre, median OS improved when $^{223}$Ra RaCl$_2$ is used as first- or second-line treatment. When the recommended 6 cycles of therapy are completed, there is additional improved median OS, particularly when used as first- or second-line. Whilst not statistically significant, the results suggest a survival advantage when $^{223}$Ra RaCl$_2$ is used earlier.

Purpose: $^{223}$Ra RaCl$_2$ is a NICE approved radiopharmaceutical shown to improve survival in men with metastatic castrate resistant prostate cancer (mCRPC) with symptomatic bone metastases. Selecting appropriate patients for treatment can be challenging. We have evaluated various factors that may help predict survival outcomes within our cohort of 176 patients from a single UK centre.

Method: We retrospectively collected data on all patients undergoing $^{223}$Ra RaCl$_2$ therapy between April 2014 and April 2019. We analysed various factors that influenced survival outcomes of these patients.

Results: Median age at time of first cycle = 72 (range 49-93). We found that blood product transfusion during treatment, lower number of completed cycles, poorer performance status at presentation, prior enzalutamide use, raised pre-treatment ALP and an initial PSA >50 nm/mL were all associated with poorer survival in our cohort. Prior chemotherapy and abiraterone use did not significantly influence survival.

Conclusion: Our data identifies several factors that influence survival in our cohort of patients undergoing $^{223}$Ra RaCl$_2$ therapy. These factors are likely to be applicable to other centres and may be helpful when considering which future patients are most likely to benefit from $^{223}$Ra RaCl$_2$ treatment.

36. Radium Dichloride ($^{223}$Ra RaCl$_2$) therapy for bone metastatic castrate resistant prostate cancer: Potential survival advantage when used earlier in the treatment pathway

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Purpose: Radium Dichloride ($^{223}$Ra RaCl$_2$) therapy improves overall survival (OS) in patients with bone metastatic castrate resistant prostate cancer. A recent change in guidance suggests restricting $^{223}$Ra RaCl$_2$ therapy for patients who have had two previous therapies or if they are ineligible for other treatments. The aim of this study was to determine whether two previous treatments prior to $^{223}$Ra RaCl$_2$ therapy affects OS at our centre.

Methods: Data was collected retrospectively from April 2014 - April 2019. Inclusion criteria included patients who received at least one cycle of $^{223}$Ra RaCl$_2$. OS was calculated from administration of the first cycle.
38. Reassessing the risk of skeletal related events following [223Ra] RaCl2 therapy in metastatic castrate resistant prostate cancer.

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**Purpose**: In the light of ERA-223 study findings, we examined the incidence of skeletal related events (SRE) in patients treated with radium 223 dichloride ([223Ra] RaCl2).

**Method**: Clinical and imaging records for 171 consecutive patients treated with [223Ra] RaCl2 from 1/1/16 - 3/9/19 were reviewed. SREs were assessed by independent review of CT/MRI scans and compared with clinical findings documented in electronic patient records. The frequency of insufficiency fracture, pathological fracture (through a metastasis) and spinal cord compression was documented. Medication histories including co-administration of novel anti-androgen (NAD) and bone health agents (BHA) were noted. Results were compared with the radium treatment cohort reported in ERA-223 (RC-E).

**Results**: 866 individual treatment cycles were administered to 171 patients (~5 cycles per patient). 28/171 (16.4%) SREs were recorded compared with 29% reported in RC-E. 18/28 (64%) SREs were symptomatic and 10/28 (36%) asymptomatic, detected by imaging. Symptomatic SREs comprised 7/18 (39%) pathological fracture, 8/18 (44%) spinal cord compression and 3/18 (17%) insufficiency fracture compared with 5/10 (50%), 3/10 (30%) and 2/10 (20%) in the asymptomatic group, respectively. 13/171 (7.6%) received BHA compared with 39% in RC-E. NAD were co-administered in 9/171 (5.3%) versus 100% in RC-E.

**Conclusion**: The high fracture rate reported in ERA-223 was not reproduced despite the low percentage of patients treated with BHA in our retrospective cohort. Specifically, insufficiency fractures only occurred in 5/171 (3%) of patients. Not all imaging-diagnosed SRE were clinically significant.

Reference:

39. Incidence of raised HbA1c of ≥42 mmol/mol (Normal ≤41 mmol/mol) in patients with Neuroendocrine Tumour (NET) receiving peptide receptor radionuclide therapy (PRRT) with [177Lu] Lu-DOTATATE at Guy’s and St. Thomas’ NHS Foundation Trust.

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**Purpose**: Administration of short course corticosteroids (dexamethasone) post PRRT is recommended for selected patients to mitigate radiation-related oedema. Hence, pre-assessment of HbA1c in patients with no previous diagnosis of impaired glucose tolerance (IGT) or diabetes mellitus (DM) is important. We investigate the incidence of raised HbA1c in patients with NET receiving PRRT.

**Method**: This is a retrospective study. We included all NET patients who received [177Lu] Lu-DOTA-TATE treatment between 01/01/2017 - 31/12/2019. Patient data was obtained from electronic patient records. Of the treated 138 patients 19 were excluded as their HbA1c was not tested.

**Results**: 53% of the 119 patients evaluated had a raised HbA1c of ≥ 42 mmol/mol, while 47% had a normal HbA1c. Patients with a raised HbA1c, only 25% were already diagnosed with DM or IGT while 75% did not have a prior history of either. In patients with a raised HbA1c (including both diagnosed and undiagnosed patients with DM or IGT) the commonest primary was gastroenteropancreatic neuroendocrine tumours (GEPNETs) at 70% (gastroenteric 51% and pancreatic 19%), followed by lungs 13%, unknown primary 6%, pheochromocytomas 5%, paraganglioma 3% and both mesenteric and thymic at 1.5%.

**Conclusion**: The increased incidence (53%) of HbA1c ≥ 42 mmol/mol in NET patients for PRRT, of which 75% were not known to have DM or IGT is reaffirming the value of HbA1c pre-assessment analysis. Most common primary was GEP-NET in these patients. Statistical analysis is yet to be performed to see if increased incidence of a raised HbA1c is linked to certain primaries.

40. Utility of [18F] FDG in the management of multiple myeloma

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The International Myeloma Working Group recommends use of [18F] FDG PET/CT to investigate newly diagnosed, relapsed/refractory multiple myeloma and treatment response to guide management. According to NICE guidelines, the choice of whole-body imaging to investigate bone lesions is dependent on the local availability. In our institution, PET/CT is more widely available. It is a sensitive tool in identifying metabolically active skeletal disease and extra skeletal disease.

The primary objective is to assess if [18F] FDG PET/CT changes management of multiple myeloma. The secondary objective is to determine predicting factors for PET positive lesions. A two-year retrospective study evaluating 113 studies including patients with newly diagnosed,
pre-existing plasmacytoma/multiple myeloma and recurrence. The studies were subdivided into 2 main groups: oligosecretory/non-secretory and secretory. Serological markers and bone marrow biopsy results were reviewed.

In the oligosecretory cohort, 21/31 patients showed PET positive disease. Of these, 67% (14/21) had management changed. In the secretory cohort, 43/82 patients showed PET positive disease resulting in management change in 88% (38/43). In both cohorts, the majority of patients with negative PET findings did not result in change of management, although 18% (7/39) patients in the secretory cohort with negative PET findings had management changed based on serological findings. There was no correlation between PET positive findings with plasma cell or paraprotein levels.

41. Uncertainty calculations for $^{90}$Y SIRT absorbed doses based on the EANM guidance
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$[^{99m}Tc]$Tc-MAA SPECT imaging can be used to estimate $^{90}$Y absorbed doses for treatment planning of selective internal radiation therapy (SIRT). The aim of this work was to employ the EANM guidance on uncertainty for molecular radiotherapy absorbed dose calculations (Gear JJ. 2018, 45(13):2456-2474).

EJNMMI) to estimate uncertainties associated with calculations of predicted absorbed doses for $^{90}$Y SIRT. Method: Retrospective analysis was performed on 16 patients who underwent $^{90}$Y SIRT therapy with resin microspheres. Absorbed doses were calculated from pre-therapy $^{99m}$Tc SPECT imaging assuming local energy deposition. Target volumes were outlined on contrast enhanced CT images. Uncertainties in volumes, recovery coefficients, counts and administered activities were combined to calculate uncertainties in mean absorbed doses delivered to the normal liver and tumours. Results: Uncertainties in volume determination ranged from 3-4% for the liver and from 5-82% for tumours, while count uncertainties for the liver were 4-8% and 2-9% for tumours. Recovery coefficient uncertainties ranged from 1-58% and the administered activity had an uncertainty of 10%. Absorbed doses to the normal liver ranged from 15-49 Gy with an uncertainty range of 8-17%. 198 tumours were identified with absorbed doses ranging from 0-1374 Gy. The uncertainties ranged from a maximum of 97% for a 0.2 cm$^3$ tumour plateauing to 12% for tumour volumes greater than 80 cm$^3$.

Conclusion: Uncertainties in normal liver absorbed dose estimation can be reduced by more accurate measurement of the $^{90}$Y activity. Further investigation into reduction of the voxel size is merited to reduce uncertainties in tumour absorbed dose estimates.

42. Variation in the lesion absorbed doses calculated using different methodologies for outlining and partial volume correction for the SELIMETRY study

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SELIMETRY investigates the possibility of using the MEK inhibitor, Selumetinib, to resensitize patients with iodine refractory differentiated thyroid cancer to radiiodine therapy. Pre-/post-treatment dosimetry using $^{123}$I/$^{131}$I are performed to estimate lesion absorbed doses. rhTSH stimulation was used before $^{123}$I and $^{131}$I administrations. No standard methods exist for outlining and partial-volume correction (PVC) using SPECT.

The aim of this study was to assess the variation in the calculated absorbed doses when using different methodologies. Four SPECT/CT scans were performed following $^{123}$I after Selumetinib therapy. $^{131}$I therapy dosimetry
involved an additional four SPECT/CT scans. Scans were quantified using a system volume calibration factor. Lesion volumes were obtained from CT outlines.

Methodology 1 involves volumes-of-interests (VOIs) on SPECT while matching the CT volume and applying PVC. Methodology 2 uses large VOIs to encompass all counts including spill out. Methodology 3 employs maximum voxel dosimetry with dose calculations limited to the voxel with maximum uptake per lesion.

Preliminary results show that good correlations are observed between absorbed doses obtained using methodologies 1 and 2 in the majority of cases. Absorbed doses from methodologies 1 + 2 do not agree within the calculated uncertainties in a small number of cases.

Maximum-voxel doses are significantly higher, likely due to uncertainties in CT volume outlines and Poisson noise. All methodologies presented have advantages and disadvantages depending on lesion location, background activity, vicinity of other lesions and lesion visibility on low-dose CT. Different methodologies must be considered when performing pre- and post-treatment lesion dosimetry.

43. Errors arising from S-values for dosimetry of paediatric radionuclide therapies with \(^{131}I\) and \(^{177}Lu\)
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S-values have been published based on Monte Carlo simulations performed on reference phantom geometry. Although published S-values may be scaled for organ mass, paediatric morphology can vary widely and therefore reference S-values could be a large source of error in dosimetry calculations. The aim of this project is to quantify the errors associated with different methods for calculating S-values in a paediatric patient population for \(^{131}I\) and \(^{177}Lu\).

Organ segmentation of CT images of 9 paediatric patients was performed. The patient-specific anatomy was prepared using ImageJ and the OEDIPE software package for input into MCNPX2.50 Monte Carlo code. Monte Carlo simulations were run to calculate patient-specific S-values for \(^{131}I\) and \(^{177}Lu\). These were used as the ground truth for comparison with S-values calculated via local deposition methods and those published in OLINDA/EXM. Uncertainty in the organ mass was quantified by taking the standard deviation of multiple operator outlines. S-value errors were compared to this uncertainty in the absorbed dose calculation.

Patient-specific S-values have been calculated for liver, lungs, spleen and kidneys for \(^{131}I\) and \(^{177}Lu\). Local deposition S-values gave mean errors of (-9±6)% and (1±2)% respectively.

The mean errors associated with the application of mass-scaled OLINDA/EXM self-dose S-values were (5±2)% and (2±1)% respectively. Uncertainty in organ mass due to operator outlining gave an uncertainty of 6% in the absorbed dose calculation. Error due to the use of published S-values is within this and therefore reference based S-values are sufficient for current clinical applications.

44. Investigating the Suitability of \([^{68}Ga]\) PSMA PET/CT for a Large-Scale Epidemiological Trial in Diagnostic Nuclear Medicine – Initial Results from the SOLLID Trial
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Purpose: To use initial results from the SOLLID (Simplification of Low Level Internal Dosimetry) Trial to estimate the uncertainties introduced when considering reduced time-point dosimetry in diagnostic nuclear medicine.

Methodology: Dosimetry was performed for \([^{68}Ga]\) PSMA using an early three-phase dynamic scan, the routine clinical scan (t = 1 hour), and two additional scans (t = 2, 4 hours). Organs were delineated on CT and time-activity curves produced as per the MIRD scheme. The time integrated activity (TIA) and its uncertainty (following EANM guidelines) were calculated, then recalculated using all possible subsets of the acquired data, down to using the single clinical time-point with the population averaged half-life for each organ.

Results: Dosimetry was performed for 3 patients over 6 organs (liver, kidneys, spleen, salivary glands, prostate, and testes). When early data points were excluded and a single exponential function fitted, associated uncertainties were less than when an uptake phase was applied. However, the overall accuracy was reduced and TIA overestimated by 11.07%. Fitting to the clinical data point using the population organ half-life resulted in TIA that agreed with the fulldata method, within the respective uncertainty bounds, for 17/18 organs. However, the average uncertainty in organ TIA increased from 5.44% (0.17% - 20.42%) with full imaging to 37.32% (1.71% - 100.69%).

Conclusions and Future Work: \([^{68}Ga]\) PSMA is suitable for a large-scale epidemiological study, requiring a dosimetry regimen with minimal imaging. More patients will be included to better characterise population half-lives and analysis will be extended to full dosimetry.
45. Contamination Accidents with Tc, F, Y, I and I. Potential skin dose values to the gloved hand and the protective value of different gloves using the Delacroix droplet model and a new model for a ‘droplet’ calculated with VARSKIN v6.2.

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Aim: Skin dose for accidents needs to be in risk assessments. Delacroix et.al (Radionuclide and Radiation Protection Handbook 1998) is often referred, but does not consider gloves. Also, their droplet and contamination models are unrealistic. Skin dose is >96% electrons so the model is critical. VARSKIN v6.2 is a free program and can give skin doses with models of droplets on gloves.

Method: VARSKIN can mimic the Delacroix droplet (1 cm² area and 0.5mm thick) to check values. The model is unrealistic so photographs of a droplet on gloves were also modelled with VARSKIN using stacked cylinders 0.5mm thick. Their weighted sum gives the dose for a droplet shape. Gloves examined were Nitrile laboratory (0.05mm thick) and sterile surgical (0.2mm thick).

Results: Results using the new model are shown. Instantaneous dose rates, mSv/min, for 1MBq Delacroix values are inaccurate for Tc and I. True droplet models give reduced doses. With the exception of Y, gloves give further significant dose reductions particularly for Tc (x4.5 for surgical gloves).

Conclusion: Local procedures should ensure direct skin contamination should not occur. In an accident scenario VARSKIN shows that gloves have a significant dose protection factor except for Y due to its high energy betas.

46. Estimation of effective dose to the sensitive epithelial layer of the lens of the eye after contamination with common radionuclides

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Introduction: Currently there are no published estimates of effective dose to the lens of the eye after contamination with common radionuclides. This work aimed to create a model to calculate the effective radiation dose to inform risk assessments.

Methods: Sources of exposure were the cornea, lacrimal lake and drainage apparatus, with residence times of 1, 1 and 4.25 minutes respectively. The target was the sensitive epithelial layer of the lens. The eye was assumed able to hold 30μl of fluid prior to tear formation. Dose-rates from gamma, discrete-electron and beta emissions were derived from dose-point-kernels. The positron contribution for Rb was derived from mono-energetic electron kernels and beta-spectra due to lack of data. Point-sources were uniformly placed throughout each source region and their contribution integrated over the target volume. Radionuclides considered were Tc, I, In, Y, Lu, Fe, Ga, Rb, N and C.

Results: Validation results agreed with VARSKIN (v6.2) to within 5% for distances greater than 0.5mm. The mean dose for Tc was 2.84x10³ Gy/Bq, consistent with published values. Without intervention, all positron-emitting radionuclides required less than 30MBq to deliver the classification level of 6mSv. Doses from therapeutic radionuclides varied, with Y requiring 2MBq. Gamma emitting radionuclides would not be routinely used in concentrations required to reach this limit.

Conclusions: A model has been developed to estimate doses to the lens of the eye from contamination. Without intervention, all PET and some therapeutic radionuclides can lead to significant doses.

47. Simplifying committed dose calculations for carers and comforters

Alexander Smout, James Scuffham
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Carers and comforters of nuclear medicine patients incur radiation doses from proximity to the patient. The actual committed dose to an individual is a function of the activity administered, effective clearance from the patient, the dose rate constant of the radioisotope, a patient self-attenuation factor, the inpatient duration and the estimated contact pattern.

In this work we compiled dose rates and clearance times from literature and local measurements in order to model committed doses for all of our nuclear medicine procedures, which would be scalable to any contact pattern.

The only requirement of this technique is establishing the contact pattern, denoted ‘k’, which is the equivalent fraction of the day spent at 1m. If a carer spends 12 hours per day at 1m, then the contact pattern would be k=0.5.

The committed dose (CD) for a cycle of Lu-DOTA-TATE therapy is 1445μSv per k if the patient is discharged after 6h, or 1280μSv per k if the patient is discharged after 18h. Lu-LuPSMA therapies have the same administered activity and radioisotope, but faster clearance, which gives lower calculated committed dose factors of 425μSv per k if discharged after 6h and 320μSv per k if discharged after 18h. For a carer with contact pattern k=0.5, the estimated committed dose would then be half of these figures.
We have made these factors for all of our imaging and therapy procedures and formalised these in protocols, so that committed doses to carers and comforters can be quickly calculated and risks communicated.

48. Reducing Reporting Errors with a Simple ‘check-sum’ Based QC Code
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Following an audit on SeHCAT analysis and reports, we found a number of transcription, dictation and reporting errors. There is little protection against these errors in any study that involves transcription to other programs, such as spreadsheets, for post-processing and analysis.

To mitigate this, a custom script was developed in Aladdin (GE Healthcare) to process the images and display the results. This reduced the frequency of errors; however, we still had incidents such as results being dictated into the wrong patient’s report, or the counts-per-minute dictated as the result percentage.

We now transcribe to a spreadsheet to generate the report, avoiding dictation. The Aladdin script generates a 4 digit quality control (QC) code which encodes the result and patient surname. When the patient data and QC code are transcribed into the spreadsheet, the spreadsheet checks if the entered data corresponds to that QC code and can identify transcription errors.

The first two digits are the result (0-100%) converted into letters (“DW” for 0% to “AA” for 100%), and the last two digits are the ASCII numbers (“A” is 65) of the first two characters of the surname added together, ending in an integer from ’30’ to ’80’. For example, “Mr Aaron” with a result of 99% has a QC code of “AB30”. This simple QC code effectively protects against transcription errors and misreporting, by creating a link between imaging and reporting systems. This concept could have other applications in nuclear medicine wherever a spreadsheet, transcription or dictation is involved.

49. Paediatric gastric emptying: Factors predictive of delayed gastric emptying and clinical outcomes at 2 years follow-up
1st Place Student Prize
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cUniversity Hospital Southampton, Southampton, United Kingdom.

Aim: To better understand the role of the gastric emptying scan (GES) in the paediatric population, we set out to assess factors predictive of delayed gastric emptying (DGE). We also evaluated the 2-year outcome of children with DGE at our institution as little is known about this.

Methods: Children aged 0-18 years who had GES between 2009 and 2018 were included. Patient’s demographics (including diagnosis and symptoms) at the time of the scan were recorded. To assess clinical outcomes of children with DGE, symptoms, growth and medications before GES were collected and re-checked at 2 years follow-up.

Results: 285 children were included in the study; 182 (63.9%) had DGE. The most common underlying diagnoses were neurological (41.2%) followed by previous surgery (38.5%) and developmental delay (29.9%).

The most commonly reported symptom was vomiting/reflux (n=258). With a median follow-up of 22 months (IQR: 14-25), significant reductions in symptoms (vomiting/reflux (p<0.001), nausea (p=0.02), abdominal pain (p=0.013) and medications such as domperidone (p=0.001), gaviscon (p=0.001) and proton-pump inhibitors (p=0.002) were seen. No significant increase in height/weight parameters was found. In addition, using improvements in vomiting/reflux as proxy for improved gastric emptying, underlying allergies (p=0.026) also showed positive improvement.

Conclusion: In a large paediatric population undergoing GES, around 2/3 had DGE. Chronic vomiting/reflux in children with a genetic diagnosis should alert clinicians to DGE. Positive outcomes were found in children with DGE and underlying allergies. Paediatricians’ decision of reducing medications after clinical improvements at 2 years reflects good practice.

50. The Optimal Timing of the SeHCAT Scan in the Diagnosis of Bile Acid Malabsorption for Patients with Chronic Diarrhoea
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Background: Bile acid malabsorption (BAM) is estimated to be the cause of chronic diarrhoea in 1% of the UK population. BAM causes bile acids to be excreted in faeces. Diagnosis is performed using the SeHCAT scan. A 0.37 MBq capsule of [75Se]tauroselcholic acid (“SeHCAT”) is ingested and patients are imaged after three hours and then seven days later. A positive result has less than 15% retention after a week and severity is ranked <5% is severe; 5-10% is moderate; 10-15% is mild. Despite current guidelines patients are sent for other, more invasive procedures before the SeHCAT scan.
This study aims to determine if earlier SeHCAT scanning can be performed before other procedures.

**Methods:** The SeHCAT retention scores of 206 patients attending the nuclear medicine department were analysed along with prior attendance for other diagnostic procedures.

**Results:** 108/206 patients had a positive SeHCAT scan. 82/206 patients had other tests. 39 of these 82 patients had a positive result. 69 of the 124 patients who did not attend for other diagnostic procedures had a positive scan. No statistically significant difference was found between retention before or after other examinations. There was also no statistically significant difference in BAM severity.

**Conclusion:** Patient outcomes are similar when the SeHCAT scan is performed earlier. This results in a better patient experience and less overall cost per patient as they attend less diagnostic procedures.

**Posters**

**P1. Assessing relevance of brain MRI for malignant melanoma follow-up: a single-centre audit**
Melissa Torkizadeh, Bhaskar Biswas, Amy Eccles, Malene Fischer
Kings College London, London, United Kingdom

**P2. Pictorial Review of [18F] FDG PET/CT in Vascular Imaging**
Pheli Shan Chuah, Ruth Brown, Nagabhushan Seshadri, Rashika Fernando
Royal Liverpool University Hospital, Liverpool, United Kingdom

**P3. Imaging of tumour hypoxia using [18F]FAZA: A literature review**
William Spiller*, Lauramay Davis
*Manchester Royal Infirmary, Manchester, United Kingdom.
bInstitute of Nuclear Medicine, UCLH, London, United Kingdom

**P4. Performance of semi-quantitative reporting for [18F] FDG PET-CT in patients with head and neck squamous cell carcinoma treated with radical chemoradiotherapy using standard iterative reconstruction and higher convergent noise limiting reconstructions (advanced reconstruction)**
Guy Burkilla,b, Francesca DeFelice,c,d, Joel Dunn*, Georgios Krokos*, Nuno Martins*, Katharine Chalmers*, Manil Subasinghe*, Teresa Guerrero Urbano*, Sally Barrington*
*King’s College London and Guy’s and St Thomas’ PET Centre, School of Biomedical Engineering and Imaging Sciences, King’s College London, King’s Health Partners, London, United Kingdom.
bDepartment of Nuclear Medicine, Queen Elisabeth University Hospital, Birmingham, United Kingdom.
cDepartment of Clinical Oncology, Guy’s and St Thomas’ NHS Trust, London, United Kingdom.
dDepartment of Radiotherapy, Policlinico Umberto I, “Sapienza” University of Rome, Rome, Italy

**P5. A comparative analysis exploring international variation in [18F] FDG PET-CT service provision: an ICBP study**
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bConsult, London, United Kingdom.
cCancer Care Ontario, Ontario, Canada.
dPacific Radiology, Canterbury, New Zealand.
fNHS Grampian, Aberdeen, United Kingdom.
gDalhousie University, Halifax, Canada.
hCancer Control Alberta, Alberta, Canada.
iNHS England, Hertfordshire, United Kingdom.
jWales Research and Diagnostic PET Imaging Centre, Cardiff, United Kingdom.
kOslo University Hospital, Oslo, Norway.
lDanish Cancer Society, Copenhagen, Denmark.
mThe Royal Marsden NHS Foundation Trust, London, United Kingdom.
NHS England, Brighton, United Kingdom.
aAlberta Health Services, Alberta, Canada.
bNHS Lanarkshire, Glasgow, United Kingdom.

**P6. Rate of malignancy in incidental FDG-avid thyroid nodules detected on PET-CT: an 8-year retrospective study.**
Fang Queka,b, Christopher Green*c, Hannah Marsh*d, Steven Morgan*b, Justin Morgan*b
*aUniversity of Bristol, Bristol, United Kingdom.
bSouthmead Hospital, North Bristol NHS Trust, Bristol, United Kingdom.
cRoyal United Hospitals Bath, Bath, United Kingdom.

Mariq Weatherley, Peter O’Sullivan
Maidstone and Tunbridge Wells NHS Trust, Maidstone, United Kingdom.
P8. A requirement for a pre-determined geometry factor when counting $[^{99m}\text{Tc}]$ Tc DTPA patient samples of non-standard volumes in GFR measurement.
James Hubber, Yassine Azma
St George’s University Hospitals NHS Foundation Trust, London, United Kingdom

P9. To compare whether the Bayesian penalised likelihood (BPL) PET reconstruction algorithm is more sensitive than TOF Ordered subset expectation maximisation (OSEM) PET reconstruction algorithm, in the assessment of solitary pulmonary nodules using the Herder score in the identification of malignancy?
Jeanie Karalis, Clare Beadsmoore
Norfolk and Norwich University Hospital, Norwich, United Kingdom

P10. Pilot of the use of a Convolutional Neural Network in $[^{99m}\text{Tc}]$ Tc-DPD Imaging for Amyloidosis
Eva Sousa, Ann Tweddell, Stephen Archibald, Alexander Turner
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P11. Comparison of Left Ventricular Ejection Fraction Measurements between Anger and Solid-state Gamma Cameras
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P12. Deconvolution of septal penetration for assessment of quantification in $^{131}$I planar imaging
William Turner, Fiona Barrack, James Scuffham
Royal Surrey County Hospital, Guildford, United Kingdom

P13. $^{131}$I SPECT/CT optimised for using a 3D printed phantom
Emily Fittock, Ian Hufton, Melvyn Carroll
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P14. How long should a SeHCAT patient wait before getting pregnant?
Hannah Nelstrop, Mark Barnfield
Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom

P15. Should Super Absorbent Polymer have a place in a Nuclear Medicine spill kit?
Alexander Smout, Rebecca Hammond, Anna Veronese
Royal Surrey County Hospital, Guildford, United Kingdom

P16. Comparison of different methods of calculating relative renal function on $[^{99m}\text{Tc}]$ Tc-DMSA SPECT/CT
Joseph Manivannan, Arum Parthipun, Rabelle May Gironella, James Hubber
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P17. Improving the visualization of the superior pubic ramus in $^{99m}$Tc-MDP bone scans
Carolina Rodrigues, Caroline Findlay, Alexander David Small
Gartnavel General Hospital, Glasgow, United Kingdom

P18. ‘Enough to see the nodes?’ An audit of actual administered $[^{99m}\text{Tc}]$ Nanocolloid activity in breast sentinel lymph node scintigraphy at St. Bartholomew’s Hospital
Ronna Veluz Sahibbil, Cindy Leung
Barts Health NHS Trust, London, United Kingdom

P19. The Role of Phase Analysis and Regional Wall Motion Assessment in Cardiac Sarcoidosis
Rosalind Pliszka, Andrew Cheetham, Marko Berovic, Eleni Kalogianni, Danielle Levart, Nicola Mulholland
King’s College Hospital NHS Foundation Trust, London, United Kingdom

P20 Ergonomics in (Nuclear Medicine) practice!
Luisa Roldao Pereira, James Elliot, Tristan Barnden
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P21. An investigation into $[^{99m}\text{Tc}]$Tc-DMSA residual syringe activity and optimisation of administration technique
Denzil Hoffland, Andrea Breakell, Ruby Callister, Belinda Stiles, Adrian List
St George’s University Hospitals NHS Foundation Trust, London, United Kingdom
P22. Use of Microsoft VBA to Automate Administrative Tasks in the Nuclear Medicine Department.
Louise McFarland
NHS Highland, Inverness, United Kingdom

P23. Weight-Based [18F]FDG Administration: Patient Pathway and Financial Impact
Aimee Pearson, Matthew Morgan, Laura Perry, Luis Alves
Imperial College Healthcare NHS Trust, London, United Kingdom

P24. Kit-based 68Gallium Service Introduced at Barts Health NHS Trust Radiopharmacy Department
Jennifer Young, Margaret Cooper, Maria Tsionou, Joaquim Ramada-Magalhaes, Richard Skidmore, Busola Ade-Ojo, Jane Sosabowski
Queen Mary University London, London, United Kingdom.
Kings College London, London, United Kingdom.
Barts Health NHS Trust, London, United Kingdom.

P25. Outcomes from myocardial perfusion studies at a follow up of one year at the SWBH: An audit.
Manish Pandit, Darshana Jeyaruban, Joseph O'Brien
Sandwell and West Birmingham NHS Trust, Birmingham, United Kingdom

P26. Outcomes from an Audit of Gated data of Myocardial Perfusion studies at one year follow up
Manish Pandit, Darshana Jeyaruban, Joseph O'Brien
Sandwell and West Birmingham NHS Trust, Birmingham, United Kingdom

P27. A very rare case of pseudo pulmonary embolism detected on V/Q SPECT/CT
Haseeb Ahmed, Hajira Ilyas, Christopher Sibley-Allen, Dhruba Dasgupta
Guy’s & St. Thomas’ NHS Foundation, London, United Kingdom

P28. Review of request to report time for V/Q requests from our Emergency Department at Guy’s and St. Thomas’ NHS Foundation Trust
Michelle Akhunbay-Fudge, Hajira Ilyas, Amy Eccles
Frimley Health NHS Foundation Trust, London, United Kingdom.
Guy’s and St. Thomas’ Hospital, London, United Kingdom.

P29. The effectiveness of DAT and PET scans in the investigation of Lewy Body Dementia: a single centre retrospective study.
Rebecka Lichtenecker, Chris Green, Stewart Redman, Richard Graham, David Little
University of Bristol, Bristol, United Kingdom.
Royal United Hospitals Bath, Bath, United Kingdom

Sabina Dizdarevic, Nitasha Singh, Maryam Jessop, Jeban Ganesalingam, Mark Aplin, Patrick Begley, Yuan Lee, Romi Saha
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P31. Slow transit as a cause of 100% SeHCAT retention
Helen Davison, Alison Mackie, Catherine Sykes, Robyn Cooke
County Durham and Darlington Foundation Trust, Durham, United Kingdom

P32. Is there a correlation between patient symptoms and prevalence, or severity, of bile acid malabsorption as detected by a selenium labelled homo-taurocholic acid test (65SeHCAT)?
Sam Brook, Anil Jain
University of Manchester, Manchester, United Kingdom.
Manchester University NHS Foundation Trust, Manchester, United Kingdom

P33. A rare case of multiple intraosseous haemangiommas potentially mimicking metastases on bone scan
Jonathan Chia, Nitasha Singh, Catharine Tadros, Patricia Leite, Eleonora Mancab, Sriram Vundavalli, Sabina Dizdarevic
Neuroradiology Department, Brighton and Sussex University Hospitals NHS Trust, Brighton, United Kingdom.
Nuclear Medicine Department, Brighton and Sussex University Hospitals NHS Trust, Brighton, United Kingdom

P34. Is visual assessment important in SeHCAT reporting?
Mohamed El-Sayed, Gregory James, Daniel Lewis, Alp Notghi
Sandwell & West Birmingham Hospitals NHS Trust, Birmingham, United Kingdom
**P35. Are bone scans useful in detecting bone metastases in breast cancer patients?**
Jaspreet Gida, Anil Jain
*University of Manchester, Manchester, United Kingdom*

**P36. Our experience of 3 cases of neuroendocrine tumour (NET) patients with Ki67 >20% with good clinical, biochemical and radiological response to treatment with [177Lu]Lu-DOTA-TATE**
Hajira Ilyas, Nicolas Eftychiou, Amy Eccles, Fahim Ul-Hassan, Haseeb Ahmed, Val Lewington
*Guy’s and St. Thomas’ NHS Foundation Trust, London, United Kingdom*

**P37. Half-Dose Lung SPECT Perfusion First Scans for the Diagnosis of Pulmonary Embolism (PE) in Pregnancy: A Quality Improvement Project**
Peter Bartholomew⁵, Isobel Chen⁴, Nicholas Vennart⁵
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