

a phantom using single tracer injection. This work builds upon a previous 3D printed phantom inserts design [1] to introduce a more complex design including heterogeneous uptake patterns with minimal phantom preparation time. **Materials and Methods:** 4 cm gyroid cubic grids were 3D printed (75% Infill) in Acrylonitrile butadiene styrene (ABS). Spherical voids of 17mm and 28mm were incorporated centred on the cube. A second region with different infill (50% or 100%) was added leading to primary targets (Target Background Ratio ~ 4) of either a sphere or crescent shape. Heterogeneity was either multifocal (TBR ~ 2) or necrosis (TBR ~ 0) based on second regions density. These inserts were placed in a conventional QC phantom and filled with water, soap and [¹⁸F] FDG (96 MBq). Acquisitions were performed on two different PET/CT scanners (β:650). Recovery coefficient (RC) was evaluated for quantitation of primary lesion along with TBRMax of overall insert. Additionally, standardised uptake value (SUV) profiles were extracted on Transaxial slice for heterogeneity impact analysis. **Results:** Heterogeneity was apparent visually on PET images for all 28mm targets whereas only primary lesion was predominant for 17mm targets due to partial volume effects on secondary regions. TBRMax for 17mm set were in the range of 1.22 - 4.21 and for 28mm targets were 1.34 - 4.52. Mean RC for primary lesions ranged from 0.71 - 0.82 (PET 1) and 0.61 - 0.73 (PET 2) for 17mm, and 0.81 - 0.88 (PET 1) and 0.74 - 0.82 (PET 2) for 28mm. Maximum RC ranged from 0.65-1.02. SUV profiles showed reduced / shifted peak values and evident transitions between multiple regions. Reference cubes without targets yielded SUV values of 0.19-0.27 against expected 0.25 (SUVWater ~1). SUVNecrosis were slightly higher than 0. **Conclusion:** Our results highlight that 3D printed inserts effectively model mixed uptakes while demonstrating the impact of lesion size and heterogeneity on PET/CT visual interpretation and quantitation. **References:** [1] Nalla, S.K.K., Maronnier, Q., Kennedy, J.A., Palchan-Hazan, T. and Caselles, O., 2025. Enhancing PET/CT Assessment with Porous 3D-Printed Grids-A Pilot Study. medRxiv, pp.2025-04.

EP-0950

Quantitative accuracy of clinical PET systems in the UK (2019-2023)

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Aim/Introduction: Quantitative accuracy in PET is a critical factor when considering multi-centre comparability. To assess the comparability of PET systems in the UK a specialised traceably calibrated solid phantom was designed and distributed to 16 centres. The results were analysed centrally and are reported. **Materials and Methods:** The phantom was adapted from the NEMA NU-2 Image quality phantom which consists of 6 spheres ranging in size from 10 mm to 37 mm diameter. A seventh sphere with a 5 mm diameter was added to the phantom in a position optimised using monte carlo techniques. The phantom was prepared with ⁶⁸Ge spiked epoxy resin with a total activity of 99.0(30) MBq (k=2) with a sphere:background ratio of 4:1. The Phantom was shipped to 16 sites for measurement between 2019 and 2023 with images acquired using a decay-corrected acquisition time simulating a 3 min per bed position scan. An additional scan with a single frame centred over the sphere axis was also obtained at most sites. The phantom was periodically returned to NPL and scanned to confirm stability of the phantom. Images were reconstructed using typical clinical protocols at the participating site, and image analysis was performed centrally by two individuals (independently). Results were calculated for quantitative accuracy of background and sphere activities and recovery coefficient curves were generated for each scan made. **Results:** The results showed good agreement between sites with all participants complying with EARL recommended recovery

coefficient curves. uncertainty analysis was included to provide comparative data. **Conclusion:** This study has demonstrated the comparability between clinical PET/CT sites in the UK using a standardised phantom and has created a dataset which can be used in future studies when investigating performance capability and for validation.

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Development and Evaluation of a 3D-Printed Thyroid Phantom for Simulating Hot and Cold Nodules in SPECT Imaging

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Aim/Introduction: Thyroid scintigraphy is among the most frequently performed procedures in nuclear medicine; therefore, robust quality assurance protocols tailored to SPECT imaging are essential. These protocols often rely on phantom-based evaluations. However, commercially available thyroid phantoms typically represent only healthy tissue, limiting their relevance for simulating pathological conditions such as hot or cold nodules. [1,2] Recent advances in 3D printing technology enable the design and fabrication of customized phantoms, including those that mimic pathological features. In this study, we present a modified anthropomorphic thyroid phantom capable of simulating both hot and cold thyroid nodules. **Materials and Methods:** A commercially available 3D thyroid phantom was redesigned using 3D modeling software to alter anatomical volumes and incorporate pathological structures. Spherical nodules (1 cm diameter) were added: a solid (cold) nodule was embedded in the left lobe, and a fillable hollow sphere (0.3 ml) representing a hot nodule was placed in the right lobe. The models were printed in two sizes (20 ml and 40 ml fillable thyroid volumes) using PLA material via fused deposition modeling (FDM) technology. Reproducibility of the manufacturing process was assessed through repeated printing and CT imaging. For realistic attenuation and scatter conditions, the thyroid phantoms were placed within a standard neck phantom. SPECT/CT acquisitions using Iodine-131 were performed on a triple-head SPECT/CT system equipped with a multi-pinhole collimator. The activity concentration ratio between the thyroid tissue and the hot nodule was set at 1:10. **Results:** The fabrication process demonstrated high reproducibility, with no leakage observed during phantom preparation. The printed phantoms were fully compatible with conventional neck phantoms. Reconstructed SPECT images clearly depicted both nodules, with the hot and cold lesions showing 88% higher and 28% lower uptake, respectively, compared to the uniform thyroid background. **Conclusion:** Results confirm that fillable 3D-printed thyroid phantoms can reproducibly simulate pathological conditions, providing a valuable tool for image quality assessment in SPECT imaging. **References:** 1. <https://doi.org/10.1097/HP.0000000000000995> ; 2. <https://doi.org/10.1016/j.radphyschem.2019.108462>.

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Manufacturer improvement of ^{99m}Tc scatter correction for its long bore collimator CZT ring SPECT-CT

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Aim/Introduction: The manufacturer of the long bore collimator CZT-based ring SPECT-CT is currently releasing an upgraded version of its reconstruction software where dual energy window scatter correction is performed in the iterative loop of the reconstruction whereas it was previously a subtraction at the projection level. Phantom data of our past study of this system

[1] were reprocessed with the new (25) software and results were compared to those obtained with the past version (23). **Materials and Methods:** Previously recorded data of ^{99m}Tc filled cylindrical NEMA NU2-94 phantom (NEMA), custom hot and cold bar contrast phantom (TOM) and uniform phantoms of two different sizes (L and XL) were reconstructed using manufacturer OSEM (10 subsets and 20 iterations), attenuation correction, resolution recovery with (SC) or without (NoSC) scatter correction. Considered parameters were residual fraction (RF) in NEMA, recovery coefficient (RC) in TOM bars, coefficient of variation (COV) in TOM uniform area and quantification error (QE) in L using XL as calibration phantom. Parameter values were compared to those obtained previously [1] as well as those obtained using a single 136-145 keV narrow energy window (NW) to spectrally reject scattered photons. **Results:** Both software versions led to very similar NoSC values for all parameters. In NEMA, RF-SC25 < RF-NoSC in all three inserts with RF-NoSC < RF-SC23 in air and RF-SC23 < RF-SC25 in TOM bars and Teflon. RC-NW > RC-SC23 > RC-SC25 > RC-NoSC in TOM cold rods. RC-NW > RC-NoSC > RC-SC25 > RC-SC23 in TOM hot rods but RC-SC25 \geq RC-NoSC when only considering the central part of the rods. SC25 very moderately increased COV and the increase was lower than with SC23. In large hot areas, SC25 removed a total number of counts which amounted only to roughly one half of the counts removed by SC23. QE was in the range $\pm 3\%$ depending on the size (smaller or larger than the phantom physical size) of the regions of interest. **Conclusion:** The upgraded scatter correction removed much less acquired counts in large hot areas than the past version. Cold contrasts were slightly lower whereas hot contrasts were much larger especially in the thinnest rods which were not present (RC=0) on the SC23 images. Nevertheless, the contrast obtained with a single narrow energy window were higher. Quantification with SC25 in uniform phantoms was very satisfactory with error below 3%. **References:** 1. Seret A, Bernard C. EJNMMI Physics 2025; In Press.

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FDG Extravasation in PET/CT Imaging: A Visual Grading Approach Based on Clinical Observations

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Aim/Introduction: FDG extravasation is a frequently overlooked issue in PET/CT imaging, potentially impacting standardized uptake value (SUV) measurements used in clinical interpretation. This study aims to introduce a visual grading system to classify FDG extravasation severity and assess its quantitative impact on reference SUV values in oncologic patients [1,2]. **Materials and Methods:** A total of 235 consecutive FDG PET/CT scans performed for oncologic indications were retrospectively analyzed. Patients were categorized into four groups based on extravasation severity (Grade 0-3), using a newly proposed visual grading system. Liver and mediastinal blood pool regions were selected as reference sites for SUV analysis. Mean SUV_{max} and SUV_{mean} values were recorded and compared across extravasation grades. One-way ANOVA and Kruskal-Wallis tests were used for group comparisons, followed by post-hoc testing to identify statistically significant differences. **Results:** FDG extravasation was observed in 75 patients (31.9%), with 43 classified as Grade 1, 26 as Grade 2, and 6 as Grade 3. Compared to Grade 0, both Grade 1 and Grade 2 patients exhibited statistically significant increases in liver and mediastinal SUV values ($p < 0.001$ for all parameters). For instance, liver SUV_{max} increased from 3.13 ± 0.44 (Grade 0) to 3.58 ± 0.50 (Grade 1), and mediastinal SUV_{mean} rose from 1.80 ± 0.31 (Grade 0) to 2.17 ± 0.40 (Grade 2), representing a relative difference of up to 20.6%. Grade 3 cases showed variable results without consistent trends, likely due to small sample size [1,3]. **Conclusion:** Low-to-moderate FDG extravasation (Grades 1-2) can significantly elevate reference SUV measurements in PET/CT imaging, which may affect

response assessments. Incorporating a structured visual grading system into routine clinical practice could improve diagnostic accuracy and reduce unnecessary repeat imaging. These findings highlight the need for heightened awareness and standardized reporting of FDG extravasation in quantitative PET/CT analysis [2,3]. **References:** Osman MM, Muzaffar R, Altinyay ME, Teymouri C. FDG Dose Extravasations in PET/CT: Frequency and Impact on SUV Measurements. *Front Oncol.* 2011;1:41. doi:10.3389/fonc.2011.00041. Wong TZ, Benefield T, Masters S, Kiser JW, Crowley J, Osborne D, et al. Quality Improvement Initiatives to Assess and Improve PET/CT Injection Infiltration Rates at Multiple Centers. *J Nucl Med Technol.* 2019;47:326-331. doi:10.2967/jnmt.119.228098. Kiser JW. The decision to reimagine following extravasation in diagnostic nuclear medicine. *Front Nucl Med.* 2023;3:1171918. doi:10.3389/fnume.2023.1171918.

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Evaluation of Costs and Accuracy a 3D-Printed Four-Organ Phantom Using a Commercial Desktop Printer for Standardized Dosimetry in Molecular Radiotherapy

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Aim/Introduction: Accurate dosimetry in molecular radiotherapy (MRT) is essential to optimize therapeutic outcomes while minimizing radiation to healthy tissues. However, substantial inter-institutional variability persists due to differences in imaging protocols, segmentation methods, and software. While digital phantoms are useful for software validation, physical phantoms are critical for evaluating the full clinical workflow, including imaging and dose calculation. Three-dimensional (3D) printing enables low-cost and flexible production of customized physical phantoms, especially valuable in multicenter studies where standardized, reproducible models are required. To address these needs, we aimed to evaluate the production time, cost, and geometric accuracy of a proposed 3D-printed physical phantom for MRT dosimetry using commercially available printing technology. **Materials and Methods:** We utilized the 4-organ phantom developed as part of the MRT dosimetry Challenge, which includes anatomically representative models of the liver, spleen, kidneys, and a tumor. In this study, we employed polygon mesh in STL file format derived from the ICRP 110 adult female phantom, provided by Robinson AP et al., specifically designed for ^{177}Lu -DOTATATE dosimetry [1]. The phantom was fabricated using a FlashForge Adventurer 5M Pro printer with PLA filament, maintaining cost-efficiency. **Results:** Geometric accuracy was evaluated by comparing the printed organ volumes to ground truth values, with an average deviation of -0.8%, indicating high fidelity. Phantom fabrication required approximately 41 hours of printing time. The initial setup cost was estimated to be €2,560 for a 3D printer and related equipment, and the material cost per phantom was €70 (1€ = ¥162), making the method accessible and scalable. **Conclusion:** Our results suggest that cost-effective organ phantoms, as proposed by the MRT dosimetry project and fabricated using commercially available 3D printing technology, represent a promising tool for validating dosimetry workflows. Future studies will evaluate the effects of different printer models and filament types on accuracy, and examine the reproducibility of repeated prints using the same 3D printing settings. **References:** [1] Ferreira KM, Lassmann M, Tran-Gia J; MRT dosimetry Collaboration. Development of a validation imaging dataset for Molecular Radiotherapy dosimetry multicenter intercomparison exercises based on anthropomorphic phantoms. *Phys Med.* 2023 May;109:102583.