POSTER ABSTRACTS

Cardiology/Respiratory

P01
COMPARISON OF GATED HEART BLOOD POOL STUDIES USING NOVEL CADMIUM-ZINC-TELLURIDE SPECT IMAGING TECHNOLOGY WITH CONVENTIONAL ANGER CAMERA PLANAR IMAGING

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Background: Novel dedicated cardiac cameras using cadmium-zinc-telluride (CZT) technology, primarily used for myocardial perfusion imaging, have dramatically higher performance than conventional Anger cameras. Using this novel technology to perform gated heart pool scans (GHPS) has the potential to improve efficiency, patient experience and dosimetry.

Aim: To compare the assessment of left-ventricular ejection fraction (LVEF) and function using CZT-SPECT imaging (GE570c) to conventional planar imaging (GE670).

Methods: 44 patients attending for GHPS were studied using conventional planar imaging (GE670), immediately followed by a 5 minute CZT-SPECT acquisition (GE570c). Planar images were manually processed to calculate the planar-LVEF (pLVEF). CZT-SPECT images were processed with an automated algorithm to calculate SPECT-LVEF (sLVEF). Wall motion was assessed visually in both studies.

Results: One patient was technically unsuccessful due large body habitus (BMI=55) causing image truncation on GE570c. In 4 patients the sLVEF measurement was unsatisfactory due to poor edge detection by the automated algorithm where there was adjacent increased gut or liver activity. However the automated algorithm for sLVEF was highly reproducible with retest correlation of 0.997. For the remaining 39 patients, using the linear regression equation y=mx+b, where y=sLVEF; x=pLVEF; Slope, m=0.95; Intercept, b=2.35%; Correlation, r=0.82. All 6 reporting physicians found CZT-SPECT useful to assess regional wall motion abnormalities in all dimensions and to quantify absolute end diastolic and end systolic volumes.

Conclusion: Measurement of LVEF using CZT-SPECT imaging correlated well with conventional planar imaging. Technical limitations arose in very large patients and in patients with increased gut and liver activity. CZT-SPECT is a useful three-dimensional imaging technique which increases reporter confidence in assessing wall motion abnormalities and in quantifying volumes. It has a promising role in GHPS to significantly reduce imaging time and dose.

P02
PROSTHETIC VALVE INFECTION AND THE USE OF F-18 FDG PET/CT

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Background: A 74 year old male with previous history of myocardial infarction, CABG, aortic valve and aortic root replacement presented with Salmonella sepsis with an unknown source. The patient commenced intravenous ceftriaxone on admission to hospital and due to his prosthetic aortic valve infective endocarditis (IE) was strongly suspected. Both transthoracic (TTE) and transoesophageal (TOE) echocardiograms showed no evidence of vegetation or aortic root abscess. CT performed of the abdomen and thorax failed to demonstrate any source of infection. On the fifth day of hospital admission he developed bradycardia due to intermittent atrioventricular block resulting in the insertion of a dual chamber pacemaker.

Method & Results: F-18 FDG PET/CT images demonstrated abnormal tracer accumulation in the root of the aorta extending to the site of valve prosthesis and in the anterior portion of the root of the aorta, at the site of an aneurysm, increased lung uptake in the upper right lobe and bilateral effusions.

Discussion: TOE has a sensitivity of between 90 and 100% when detecting vegetations associated with IE. This figure decreases to 50% in the presence of a prosthetic valve. FDG PET/CT, while nonspecific in nature, is highly sensitive for detecting foci of infection and has a high negative predictive value, and hence may have a role in detecting endocarditis/prosthetic valve infection. One week following the PET scan a repeat TOE was consistent with development of aortic root abscess.

Conclusion: This case demonstrates the usefulness of F-18 FDG PET/CT in diagnosing IE more accurately than TOE or TTE, which are usually considered the gold standard, and thereby facilitating the management of this relatively rare condition that carries significant mortality.

P03
'AIR TRAPPING' AS A CAUSE FOR VQ SPECT PERFUSION MISMATCH

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Background: The more widespread adoption of VQ SPECT and SPECT-CT has led to the increased detection of VQ mismatches. In some cases, this can be

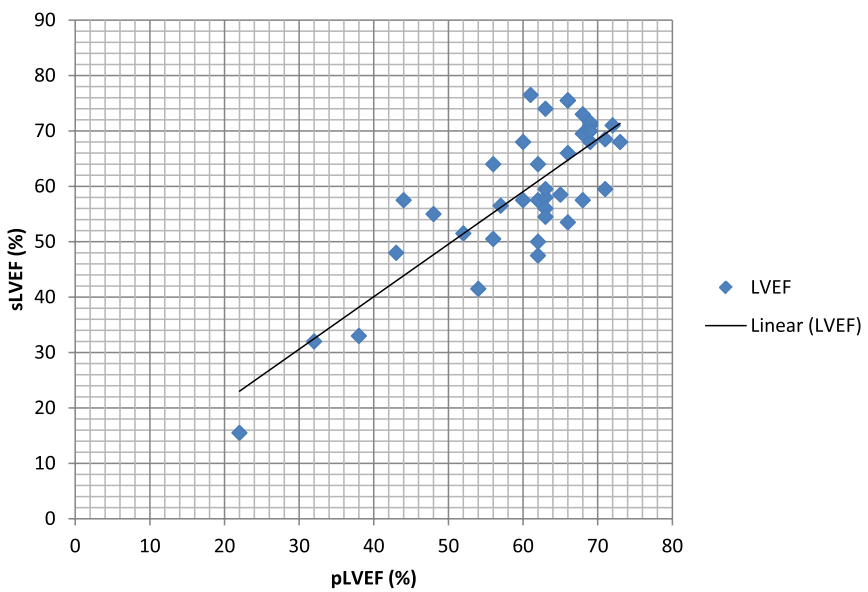

Figure 1 Comparison of LVEF measurement with CZT-SPECT (sLVEF) to planar (pLVEF) imaging.

attributed to apparent increased ventilation as seen with the physiologic 'rind' effect in VQ SPECT. A similar effect can be seen in the setting of some pulmonary parenchymal pathology which causes apparent 'air-trapping', leading to areas of marked perfusion reduction but maintained ventilation. This appears to be most common in the setting of emphysematous change. While this can be easily recognised if it is part of a diffuse emphysematous process, regional or more localised lung parenchymal change can be more difficult to recognise.

Aim: We would like to highlight the potential of this 'air-trapping' phenomenon in causing perfusion mismatch, resulting in a false positive VQ scan, and to explore features of ventilation-perfusion abnormalities on VQ SPECT that could be helpful in differentiating non-embolic versus embolic causes.

Method and Results: We present three cases where underlying lung disease leads to at least partial perfusion mismatch. Discussion regarding the underlying pathophysiology will be presented. We will explore certain unique scintigraphic features of this 'air-trapping' phenomenon and the role of the CT component of SPECT-CT or CT chest will be emphasised.
Case 1: Congenital sublobar emphysema
Case 2: Bronchiolitis obliterans
Case 3: Interstitial pulmonary fibrosis

Conclusion: These cases illustrate the fact that a variety of pulmonary parenchymal pathology can lead to pulmonary vascular changes causing perfusion mismatch. An expansile or bulging border around a ventilation or perfusion abnormality should raise the suspicion that apparent perfusion mismatch could be due to 'air-trapping' phenomenon. Correlative anatomic information from CT images is particularly useful in confirming the presence of this phenomenon as a potential mimicker of pulmonary embolism.

P04
UNRECOGNISED MYOCARDIAL ISCHAEMIA ON ONCOLOGICAL FDG-PET

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Background: Cardiac FDG uptake can be highly variable and non-uniform uptake is often dismissed as normal in this location. We present a case, where failure to recognise an important pattern almost led to adverse patient outcome.

Method: 67 y.o. man with head and neck malignancy, underwent preoperative staging PET at another institution. He was planned for partial glossectomy and neck dissection.

During the anaesthetic induction, significant ischaemic ECGs changes caused the operation to be aborted. Subsequent adenosine sestamibi demonstrated a small LAD infarct with significant peri-infract ischaemia. Coronary angiogram demonstrated triple vessel disease requiring surgical management. Semi-urgent coronary artery bypass grafts, were performed with good recovery. Patient the subsequently underwent an uneventful left partial glossectomy and neck dissection with complete clearance.

This case was identified, when he was referred for urgent inpatient myocardial perfusion study. Review of his staging FDG-PET demonstrated unreported intense LAD territory uptake. Literature review and discussion with PET specialists, confirmed the presence of ischaemic or hibernating myocardium.

Results: Cardiac uptake of FDG, during routine oncological studies can be highly variable. depending on the length of fasting. After sufficiently long fasting period (typically >12 hours) the myocardial metabolism shifts to fatty acids as a source of energy. It has been well recognised by Gropler et al (1999), the septum and anterior wall containing significantly less activity than the lateral and posterior walls.

Conclusion: Despite the limitation of variable regional cardiac uptake during routine oncological FDG-PET, it should be recognised that increased uptake in the anterior and septal walls, is abnormal, and hibernating/ischaemic myocardium should be excluded with other investigations. The failure to recognise this abnormal pattern may lead to adverse outcomes.

Molecular Imaging

P05
DEVELOPING NATIONAL CAPABILITY FOR THE PRODUCTION AND USE OF RADIOMETAL BASED RADIOPHARMACEUTICALS

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Radiometals remain key radioisotopes for radio-medicine; the mainstay diagnostic medical imaging isotope, ^{99m}Tc, and important radioisotopes for radiotherapy, ^{90}Y and ^{153}Sm. However, the worldwide growth in PET centres, driven by the wildly successful [^{18}F]-FDG, has provided a yet to be seized opportunity to deliver radiometal-based radiopharmaceuticals with clinical relevance to researchers. An ever growing set of radiometals is becoming available in Australia covering a wide range of half-lives, nuclear and chemical properties, these include ^{64}Cu, ^{68}Ga, ^{86}Y, ^{89}Zr, and looking into the near future, ^{44}Sc, ^{45}Ti and ^{90}Nb.

ANSTO's Lifesciences division is working to provide the Australian academic and clinical communities access to the following key areas.

Radioisotope supply

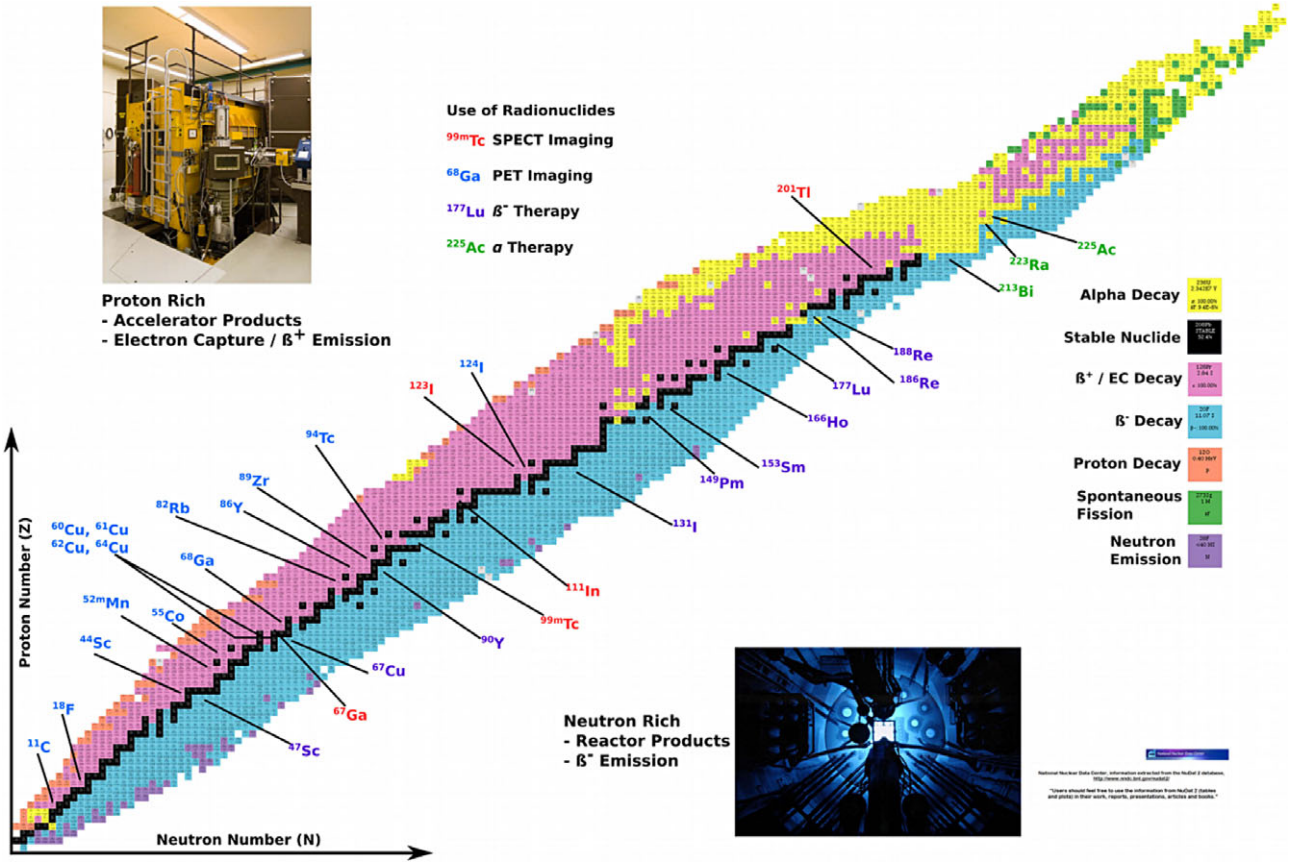
Two in-house ^{68}Ge/^{68}Ga generators; one solely for research and a larger generator for pre-clinical trials, provide access to this key radioisotope. ANSTO has provided financial and technical support to numerous cyclotron centres around Australia for development of solid targetry facilities, ensuring supply of ^{124}I, ^{64}Cu, ^{86}Y and ^{89}Zr in the short-term and ^{44}Sc, ^{45}Ti and ^{90}Nb later. In coming years the OPAL reactor will begin producing pharmaceutical grade ^{177}Lu as part of the Australian government's investment in nuclear medicine.

Radiometal Labelling Research and Development

In addition to our programs developing new ligands, tracers and improved radiometal labelling procedures, Lifesciences is supporting the development of new biomolecule treatments by providing researchers access to laboratories, procedures and expertise tailored specifically for functionalising biomolecules for radiometal labelling.

Preclinical Radiometal Tracer Development

We are working to deliver novel radiometal-based diagnostic tracers to the Australian research and clinical community by accessing the pre-clinical programs of our key international partnerships at Memorial Sloan Kettering Cancer Centre and Massachusetts General Hospital. Our initial objective is to supply the antibodies, i.e. [^{89}Zr]-J591. As our supply radiometals is diversified we will expand into proteins, peptides and other biomolecules.



P06

PERFORMANCE EVALUATION OF PRECLINICAL PET SCANNERS WITH THE NEMA NU-4 IMAGE QUALITY PHANTOM USING A COLLECTION OF RADIOISOTOPES

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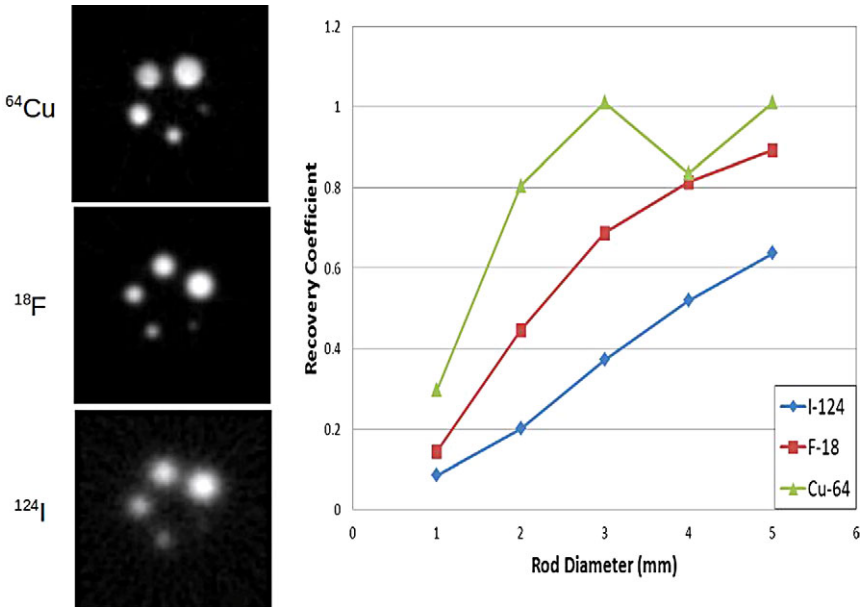
Background: The radioisotopes ^{18}F, ^{11}C, ^{124}I, ^{68}Ga, ^{89}Zr and ^{64}Cu have found numerous applications in small animal PET imaging, and this entire subset of isotopes will soon be available to Australian preclinical researchers. The suitability of an isotope for a given imaging application is determined largely by its radioactive half-life. However, other characteristic physical properties of the isotope such as the branching fraction and positron energy can severely impact image quality and the ability to accurately quantify uptake of the radio-labelled molecule. Furthermore, the specific acquisition parameters and reconstruction algorithms employed to generate the image can significantly affect the image quality and quantification accuracy.

The NEMA NU-4 2008 standards describe a method to evaluate the performance of small animal PET scanners. The information gathered through the NEMA Image Quality phantom scanning experiment is valuable for optimising the scanner usage, because it allows for the best selection of acquisition/reconstruction protocols and provides knowledge of the resolution limits of the system.

Method: NEMA NU-4 image quality phantom performance testing was performed on the Siemens Inveon with ^{18}F, ^{124}I and ^{64}Cu, using default acquisition parameters and each of the available reconstruction algorithms. Further testing will be performed using ^{11}C, ^{68}Ga and ^{89}Zr. The Bioscan NanoPET scanner will be tested with all of the mentioned isotopes.

Results: The figure shows NU-4 phantom images obtained for ^{18}F, ^{64}Cu and ^{124}I; using the Inveon preclinical scanner and FBP2D reconstruction. The relatively poor image quality obtained with ^{124}I is mainly caused by single gamma-photon contamination. Due to a higher positron range, recovery coefficients obtained with ^{124}I are well below the values measured with ^{18}F.

Conclusion: NEMA NU-4 performance testing provides valuable information about the image quality achievable for a given PET scanner and radioisotope.



P07

A TECHNIQUE TO REDUCE LUNG AND LIVER MISREGISTRATION IN PET/CT

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Background: A common problem when interpreting PET/CT results is the misregistration that occurs from breathing artefact. Artefact occurs as a result of the tidal breathing patterns throughout the PET acquisition. New technology and techniques are constantly evolving to improve breathing artefact in order to allow better interpretation of scans.

Aim: The respiratory gating system employed in our PET/CT is very time consuming and result in long scan times. In a busy department additional acquisitions create time management problems due to high patient throughput. Our aim was to find an alternative simple protocol to reduce breathing artefact.

Method: A one bed static acquisition was acquired following a whole body PET/CT scan with significant misregistration in either a lung or liver lesion. The patient is placed on the bed supine, with a firm strap around their lower chest. Instructions are given to breathe using their upper chest wall in isolation, limiting diaphragmatic motion. The patient is put on 2 litre of oxygen to allow for better oxygenation, and to reduce any distress to the patient. A1 bed PET/CT is acquired over the region of interest at 2/mins per bed to allow for enough counts but reduced time for patient.

Results: Our new breathing acquisition has vastly improved PET to CT data registration and in a majority of patients providing a more accurate localisation and SUVs of lung and liver lesions.

Conclusion: Dedicated acquisitions to reduce breathing artefact can be an effective way of reducing misregistration in departments that are time poor or respiratory gating is unavailable.

P08

PRE-CLINICAL IMAGING DEVELOPMENTS AT THE ACRF CENTRE FOR TRANSLATIONAL CANCER RESEARCH AND IMAGING

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Background: Progress on the Pre-clinical imaging capability at ACRF Centre for Translational Cancer Research and Imaging is reported following the completion of a dedicated Animal house facility and more recently, the commissioning of three key platform technologies; Optical (Bio-Luminescence and Bio-Fluorescence), micro-PET/MR and micro-SPECT/CT.

Method: Performance characteristics for the PET/MR and SPECT/CT systems are measured and reported. Image data are presented for qualitative review. Research capabilities are discussed.

Conclusion: The commissioning of state-of-the-art pre-clinical platform technologies at the ACRF Centre for Translational Cancer Research and Imaging is summarised and the discussed with respect to future pre-clinical imaging potential.

P09

APPEARANCE OF 99MTC-SESTAMIBI THYROID SCINTIGRAPHY WITH CALCULATION OF THYROID-TO-BACKGROUND RATIO IN PATIENTS WITH GRAVES' DISEASE, TOXIC MULTINODULAR GOITRE AND HYPOTHYROIDISM

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Background: ^{99m}Tc-sestamibi thyroid scintigraphy (^{99m}Tc-STS) was recently described as an accurate tool for differentiating between subtypes of Amiodarone-induced thyrotoxicosis (AIT), with important therapeutic implications. Type I AIT is due to iodine induced hyperthyroidism (increased ^{99m}Tc-sestamibi uptake), while Type II AIT is a destructive process (absent ^{99m}Tc-sestamibi uptake). Limited information is available about the appearance and quantification of ^{99m}Tc-sestamibi uptake in other thyroid disease. This study aims to describe the appearance of the thyroid (including calculation of thyroid-to-background ratio [TBR]) in patients with incidental thyroid disease following injection of ^{99m}Tc-sestamibi for parathyroid scintigraphy to provide insight into the appearance of ^{99m}Tc-STS for investigation of AIT.

Methods: Four cases of abnormal thyroid function were identified during a retrospective audit of ^{99m}Tc-sestamibi parathyroid studies performed at Royal Melbourne Hospital (Parkville, Vic) between 1st October 2011 and 31st December 2012. One patient had Graves Disease, two had toxic multinodular goitres (MNG) and a fourth patient had hypothyroidism receiving thyroxine replacement. Regions of interest were drawn around the thyroid, and background inferior to the gland, with subsequent calculation of area-normalised TBR.

Results:

Table 1 Thyroid scintigraphy following injection of ^{99m}Tc-sestamibi and ^{99m}Tc-pertechnetate with incidental thyroid disease

	Case 1	Case 2	Case 3	Case 4
	Graves' Disease	Toxic MNG	Toxic MNG	Hypothyroidism
^{99m}Tc-STS appearance	Symmetrical, diffuse ↑ uptake	Asymmetrical enlarged gland, heterogeneous ↑ uptake	Asymmetrical, heterogeneous uptake	Absent uptake
Adenoma Localisation	R lower pole	R lower pole	R upper pole	L lower pole
TBR	1.79	2.08	1.44	~1
^{99m}Tc-pertechnetate study appearance	Diffuse ↑ uptake (except R lower pole) Uptake N/A*	Heterogeneous uptake, 'hot' nodule in L upper pole Uptake=2.1%	Heterogeneous uptake (R>L) Uptake=1.9%	N/A

L, left; R, right; *derived from parathyroid subtraction study following injection 82 MBq 99mTc-pertechnetate.

Conclusion:

1. Hyperthyroidism (increased synthesis & release of thyroxine) due to Graves' disease and toxic multinodular goitre demonstrates elevated TBR following ^{99m}Tc-sestamibi injection. This is consistent with the findings of ^{99m}Tc-STS in Type I AIT.
2. Chronic hypothyroidism is associated with absent ^{99m}Tc-sestamibi uptake.

Musculoskeletal/Infection/Inflammation

P10
IMPACT OF SPECT/CT ON GALIUM-67 IMAGING

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Background: Ga-67 is a useful tool for the diagnosis of inflammation and chronic infection. Our aim was to evaluate the diagnostic value of SPECT/CT for Ga-67 studies.

Methods: Three anatomic locations were evaluated chest, abdomen and pelvis. 73 studies were performed on a 6-slice Philips Precedence camera with CT for attenuation correction and anatomic localisation. Cases were evaluated by the reporting doctor with respect to 'change in diagnosis', 'more accurate diagnosis' and 'increase in diagnostic confidence'.

CT effective dose (E) in milliSievert (mSv) was calculated for each patient using the formula, E=EDLPxDLP, where EDLP is the region-specific, DLP is normalised effective dose and DLP is dose length product.

Result: SPECT/CT changed diagnosis in 6 patients, increased accuracy of diagnosis in 45 patients, and increased diagnostic confidence in 60 patients. Effective CT dose ranged from 1.1 mSv to 3.01 mSv, with a mean of 2.11 mSv.

Conclusion: CT provided helpful diagnostic information which was beneficial in 70% of patients with little additional radiation.

P11
18F-FDG PET IN THE EVALUATION OF INFECTION IN THE EXTREMITIES – INITIAL EXPERIENCE

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Background: Referrals for query infection of the extremities are common and increasing in number. The Gold Standard method for evaluating osteomyelitis in the extremities is a 99mTc-HDP Bone scan with either 99mTc-HMPAO or 111In labelled white blood cells. These procedures are both complex and time consuming for both staff and patients. Labelling white blood cells involves handling of blood products with all the associated risks and takes 36 hours before obtaining results. Imaging time on SPECT/CT gamma cameras can take 40–60 minutes with even the smallest patient movement resulting in artefacts which may compromise diagnosis.

18F-FDG is used predominantly for oncology, but increased 18F-FDG activity is also associated with infection. Using 18F-FDG to assess infection in diabetic feet could potentially reduce imaging time, remove the risks associated with handling blood products, reduce the likelihood of motion artefacts, and reduce inpatient stay by providing results on the same day.

Aims: The aim of this study is to initially assess the feasibility and utility of 18F-FDG in infection of extremities.

Method: Patients referred to our department query infection of extremities who clinically require a bone scan (99mTc HDP) and a WBC scan (111In Oxine or 99mTc HMPAO) and fit within certain inclusion criteria will be invited to participate in this study. Each patient will undergo an additional 18F-FDG PET scan of the area in question and will be followed for 3 months for treatments and outcomes. Their scans will be assessed independently and the randomly assigned Physicians will be blinded to patient outcome.

Results: Sample initial images of 18F-FDG in infection of extremities and experiences of staff and patients will be displayed.

Conclusion: This study is incomplete and ongoing and results will be reviewed upon conclusion.

P12
FDG PET/CT AND LARGE VESSEL VASCULITIS: A CASE STUDY

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Background: PET/CT FDG provides a non-invasive, accurate way for diagnosis of disease, especially in cases of pyrexia of unknown origin. PET/CT is also cementing its place as a useful diagnostic tool for patients with suspected vasculitis. PET/CT can be used to diagnose cases of large vessel vasculitis in patients who otherwise have had no successful diagnoses.

Aim/Method: Presented here is a case of a 60 year old woman with suspected vasculitis. She had undergone an extensive workup in the search for a diagnosis, including a left temporal biopsy, repeated pathology and a gallium scan, all of which yielded negative results. The patient underwent a PET/CT scan which finally diagnosed large vessel vasculitis, allowing for the patients treatment to go ahead.

Conclusion: This case highlights that for diagnosis of vasculitis, PET/CT FDG provides a highly sensitive and specific diagnosis tool. PET/CT is also useful for follow up imaging in these cases.

P13
AN INTERESTING APPEARANCE OF OFUJI'S DISEASE ON A F18 FDG PET/CT SCAN

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Background: FDG PET imaging is a well-known and established imaging tool in the fields of oncology, neurology, cardiology and infection. Its other uses and applications are still being discovered in research and findings around the world.

Aim/Method: A patient was referred for a routine staging PET scan for left upper lobe malignancy. The patient underwent the PET scan as per protocol and the images were quite interesting. The report notes low to moderate uptake throughout the skin of the trunk as well as the lower limbs. On further questioning of the patient and investigation of past histology, these lesions were in fact eosinophillic pustular folliculitis, also known as Ofuji's disease.

Conclusion: No other reported or published images could be found of a PET scan showing this chronic skin condition.

P14
PHYSIOLOGIC APPEARANCE OF POROUS ORBITAL IMPLANTS AT F-18 FDG PET-CT – PICTORIAL ESSAY

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Background: The most common indications for orbital enucleation include the treatment of intraocular malignancy, severe traumatic injury and a blind, painful eye. Modern porous orbital implants are used following enucleation to achieve a more cosmetically acceptable result. Physiological processes that occur during integration of these implants affect the imaging appearances on F-18 FDG PET-CT.

Aim: To illustrate the appearance of porous orbital implants on FDG PET-CT imaging.

Method: From patients scanned in the Western Australian PET Service over the past 5 years, 5 patients were identified with porous orbital implants. These patient's images were reviewed and clinical follow-up was performed to assess any adverse outcomes in regard to the prostheses.

Results: The porous orbital implants showed significantly increased FDG uptake within the prostheses in all 5 patients. No significant periorbital uptake was identified apart from physiological orbital muscle activity. Increased glucose metabolism within the orbital implant was not associated with evidence of infection, tumour recurrence, or implant extrusion on follow-up of all 5 patients.

Discussion: Porous orbital implants are made from materials including hydroxyapatite, aluminium oxide and polyethylene. The crystalline structure of the porous prostheses allows ingrowth of healthy vascular connective tissue within 4 weeks, a process referred to as "fibrovascularisation". This process has several theoretical advantages over biologically inert prostheses including (1) better prosthetic movement due to development of soft tissue attachments; (2) lower risk of prosthetic infection due to higher blood flow; and (3) less chance of extrusion or prosthetic migration. Direct comparison studies however, have not demonstrated a significant outcome difference for porous implants over inert acrylic implants.

Conclusion: Physiological high-grade FDG activity within porous orbital implants should not be misinterpreted as implant infection or recurrent/residual tumour.

P15
SPECT/CT: A VALUABLE TOOL IN THE DIAGNOSIS OF INFECTED CYSTS IN POLYCYSTIC KIDNEY DISEASE

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Background: The infection of a cyst (pyocyst) within a polycystic kidney is a well-known and serious complication of Autosomal Dominant Polycycstic Kidney Disease (ADPKD). Diagnosing a pyocyst can be difficult because such a cyst can produce signs and symptoms that are non-specific. Diagnostic imaging tests are not always reliable for distinguishing pyocysts. A 61 year old woman presented to ED with nausea, vomiting, and lower back pain. Past medical history included a renal transplant due to PKD. She had a history of recurrent UTI. The patient developed fevers and decreased oxygen saturation, and had a raised CRP. Renal ultrasound, chest and abdomen x-rays found no source of infection. The patient was referred for a 67-Gallium-Citrate scan.

Results: In this patient, no appreciably abnormal uptake is noted on planar imaging. On SPECT/CT, low-grade gallium uptake is seen within several cysts in the upper and mid poles of the right kidney. They suggest the cyst infection.

Conclusion: Historically, gallium scans have a low sensitivity and specificity for localising renal cyst infections. Because gallium is normally distributed in the liver, spleen and bone marrow, and is excreted through the kidneys and bowel, it is generally not preferred for abdominal infection. With the addition of SPECT/CT, gallium scans may be used to accurately delineate infected renal cysts complicating PKD. Such scans have advantages over standard diagnostic modalities and are very helpful in planning appropriate therapy.

P16
INCIDENTAL FINDING OF A SOFT TISSUE SARCOMA ON BONE SCAN

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Preamble: The incidental diagnosis of a soft tissue sarcoma from a Tc99m-MDP bone scan in our department has reinforced to us the importance of assessment of extra-osseous bone tracer uptake. Extra-osseous uptake of methylene diphosphonate (MDP) can occur in several physiological but also pathological processes hence its presence should always be accounted for.

Case: A 75 year old male was referred for a bone scan by his GP for investigation of a 3 month history of weight loss and anorexia. Planar imaging was performed and an area of amorphous tracer uptake was noted in the proximal medial left thigh. A dedicated SPECT/CT revealed the tracer accumulation to be within a large rounded mass in the thigh musculature which contained both soft tissue and fat components. These radiological appearances were consistent with a soft tissue sarcoma. On direct questioning, the patient recalled that he had recently noticed an enlarging mass in that location. Following diagnostic imaging, a biopsy proved it to be a malignant spindle cell sarcoma. It was thought that this represented dedifferentiation of liposarcoma. The liposarcoma had presumably been present for many years before undergoing malignant transformation and thus causing the patient's symptoms.

Discussion: Soft tissue sarcomas are uncommon mesenchymal tumours which demonstrate a spectrum of histologic differentiation. Their presenting symptoms are often vague but they most often occur in the thigh or retroperitoneum. Most sarcomas accumulate Tc-99m MDP due to hypervascularity, dystrophic calcification and/or direct tumour cell formation of osteoid matrix. The calcification may range from microscopic to macroscopic and correlates with MDP uptake.

Conclusion: Several primary and secondary malignancies accumulate MDP. Assessment of the soft tissues on a bone scan is thus essential, and will not only improve its diagnostic value but also reduce the risk of a missed diagnosis of a malignancy particularly in patients in whom there is a high clinical suspicion.

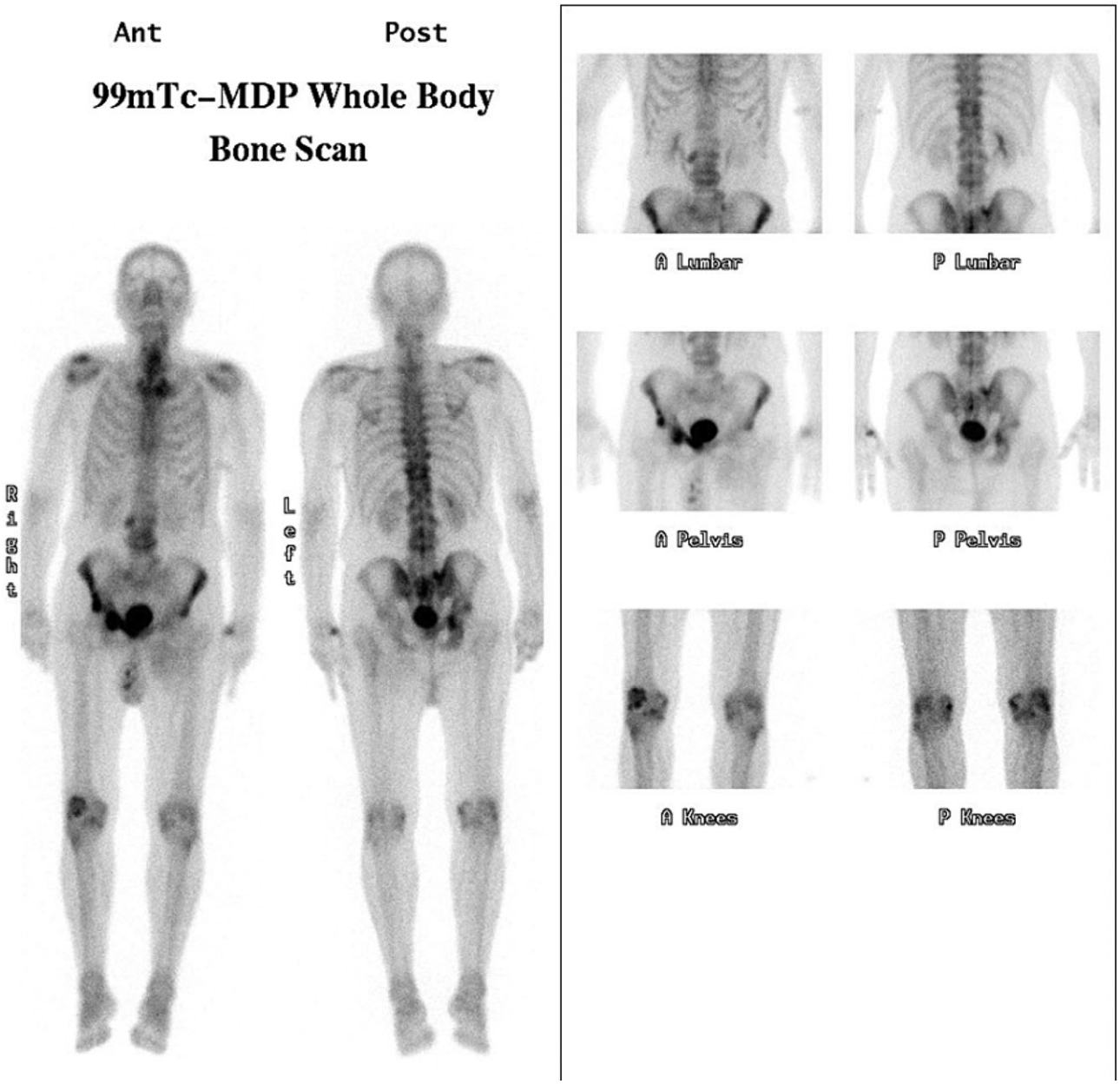

Figure 1 Tc99m-MDP Whole Body Bone Scan obtained 2 hours following intravenous administration of 937 MBq of Tc99m-MDP.

Neurology

P17
OPTIMISING BRAIN IMAGING ACQUISITION: HOFFMAN PHANTOM ANALYSIS

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Background: For a number of years our department has been performing as many as 20 brain SPECT studies per week. A gamma camera upgrade in late 2012 necessitated a new protocol for brain imaging and the optimisation of new acquisition and reconstruction parameters incorporating new reconstruction algorithms and attenuation correction methods.

Method: A Hoffman brain phantom was filled with 40 MBq of activity to generate the same count rate found in the brain following a standard 700 MBq dose of ^{99m}Tc ECD. Multiple acquisitions were then performed for differing times with both low energy high resolution (LEHR) and low energy ultra-high resolution (UHR) collimators. Acquisition Step times were at five second increments from 15–30 seconds, resulting in four acquisitions for each collimator set. Visual assessment was then performed by a senior Nuclear Medicine Consultant for resolution, noise level and patient considerations.

Using the optimised acquisition parameters a number of reconstructions of the phantom studies were performed using Flash 3D. A variety of numbers of iterations and subsets, as well as a range of Gaussian filter values from 6.0–10.0 mm FWHM were used. Reconstruction was performed using both CTAC and Chang attenuation correction. Assessment was performed by the

same senior consultant, and the settings producing the best image quality were implemented. Further refinements were made once a number of clinical studies had been performed.

Results: Initial assessment of the phantom studies led to the selection of a 20 sec/step protocol with UHR collimators. Gaussian filters of 10.0 mm FWHM were decided on for the CTAC and Chang reconstructions. Following evaluation of some clinical studies, high levels of image noise required the filter values to be increased to 11.0 mm and 12.0 mm.

Conclusion: Through the use of a Hoffman phantom we have developed an optimised brain acquisition and processing protocol which requires only minimal alteration for individual patients.

P18
IMPLEMENTATION OF 3-DIMENSIONAL RESOLUTION RECOVERY AND CTAC RECONSTRUCTION ALGORITHMS IN BRAIN SPECT IMAGING

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Background: Implementation of new technologies such as 3-dimensional resolution recovery algorithms (Flash 3D®, Siemens Medical Systems) and measured CT attenuation correction (CTAC) can potentially improve image quality in the clinical arena. Validation of these technologies against previous methodologies is required to ensure correct image interpretation. As a centre with a strong neurology focus, this study seeks to demonstrate changes in Brain SPECT image quality that occur from these techniques.

Method: Hoffman phantom images and 10 sequential, clinical patient studies were processed using both OSEM and Flash3D. Attenuation correction was performed using both Chang's Algorithm and CTAC. The Chang Algorithm used manually set 4-point ellipses in phantom studies, and automatic threshold edge detection in clinical studies. Four datasets were generated per patient and analysed using PMOD, a statistical analysis program. ROI analysis was performed. Scaled, rigid matching was performed prior to subtraction analysis to demonstrate regional changes in count intensity between techniques.

Results: No significant difference in counts was demonstrated between the Flash 3D and OSEM datasets for both phantom and clinical studies. CTAC resulted in a 20% increase in average counts compared with Chang's Algorithm in the phantom images. Clinical studies demonstrated the same effect, with an average increase of 17%. Subtraction analysis showed Hoffman phantom images using Chang's algorithm for attenuation correction demonstrated increased activity in frontal regions compared with the CTAC, most prominently seen using OSEM reconstruction. Similar results were seen in the clinical studies, as shown in Figure 1.

Conclusion: Flash 3D and CTAC in Brain SPECT imaging have an effect on image quality in comparison to our previous methodology, with regional changes in counts evident. Further investigation of this is required and will be presented at the meeting.

Oncology/Therapy

P19
OUTCOME OF IODINE-131 THERAPY FOR HYPERTHYROIDISM IN HOSPITAL KUALA LUMPUR MALAYSIA

Abstract withdrawn

P20
THE ROLE OF THE CLINICAL RESEARCH NURSE: A SIR CHARLES GARDINER HOSPITAL NUCLEAR MEDICINE DEPARTMENT AND WA PET SERVICE PERSPECTIVE

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Conducting clinical trials has lead to evidence based gold standards of treatments and imaging within nuclear medicine. Trials are run in conjunction with other specialities or within the department. Over the past 5 years the number of internal departmental clinical trials has increased and this has lead to the role of the Clinical Research Nurse (CRN). The poster will cover the CRN role in the clinical trials of:

- ^{11}C-Methionine and ^{18}F-Fluorothymidine PET-CT imaging in suspected residual or recurrent glioma.
- Apoptosis Imaging in Malignant Pleural Mesothelioma.
- Evaluation of FDG PET-CT in the Infection of Extremities.
- Comparison between Ga-68 citrate PET-CT and Ga-67 citrate SPECT/CT for Infection Imaging.

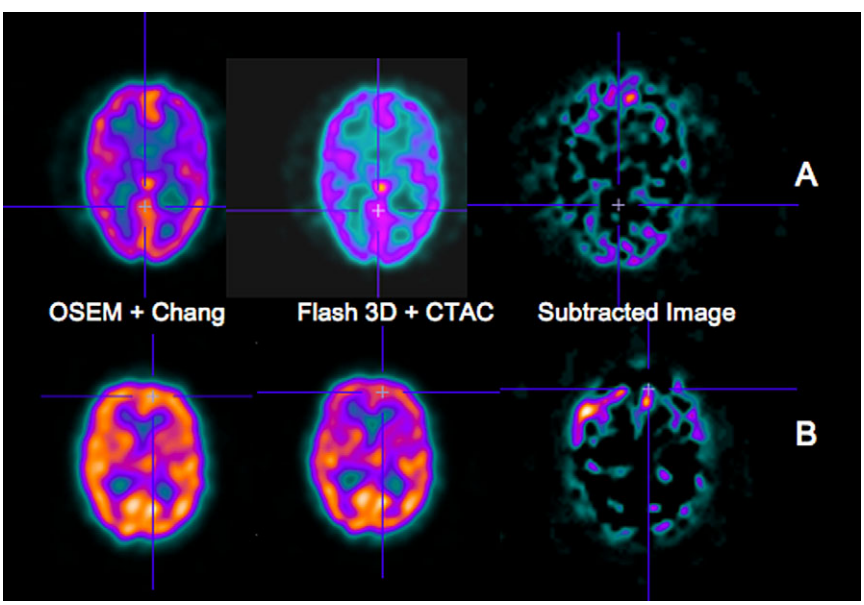

Figure 1 Effect of reconstruction on image quality. (A) Hoffman Phantom images. (B) Patient data demonstrating similar effects.

The CRN role is multifaceted and varies between trials. Each trial has its own requirements and demands.

In this new and developing role many areas covered are protocol development and evaluation, recruitment and consenting of patients in trials, administering radiopharmaceuticals. Trials involve covering one or more sites, often multiple departments and personnel. Meeting the demands of the CRN role a nurse requires knowledge of nuclear medicine, positron emission testing, good clinical practise, epidemiology and biostatics.

P21
INCIDENTAL FINDING OF METASTATIC MEDULLARY THYROID CARCINOMA DEMONSTRATED ON PARATHYROID SCINTIGRAPHY WITH 18F-FDG PET CORRELATION

Abstract withdrawn

P22
MINIMISING BROWN FAT UPTAKE IN 18F-FDG PET SCANS

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The uptake of 18F-FDG by brown adipose tissue (BAT) in adult humans has been documented in the literature since about 2002. Initially thought to be prevalent only in younger, slim females and dependent on ambient temperature, more recent reports include a wider range of patient demographics and dependence of uptake on ambient temperature has not been proven. Uptake of FDG in BAT may lead to false positive PET scans, especially in the regions of the neck and diaphragm. Although the use of a concurrent CT scan for anatomical localisation is now the norm and can improve confidence in reporting abnormal uptake in these regions, there are many cases where reduction of BAT uptake of FDG is the best or only strategy for certainty. The administration of 20 to 80 mg of propanolol, 60 to 120 minutes prior to FDG administration is reported to be effective. We present recent cases where 20 mg of propanolol administered 60 minutes prior to FDG administration with patient warming from the time of propanolol administration to the time of the PET/CT scan has greatly reduced or eliminated the BAT uptake of FDG, and has influenced scan interpretation. Our standard practice is now to flag patients with significant BAT uptake (and no contraindications) for a propanolol protocol for follow-up scans.

P23
LIFE CHANGING LUTETIUM-177

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Background: 59 year old woman with metastatic neuroendocrine tumour (NET) complicated by; high volume diarrhoea (~4 L/day); hypotensive episodes; exacerbation of flushing; weight loss – 16 kg in 4 months; and hospitalised continuously for 3 months. She remained poorly responsive to very high doses of somatostatin antagonist (SSA) and failed Trans Arterial Chemo Embolisation (TACE). Total Parental Nutrition (TPN) with extra SSA was prescribed. She was referred to The Queen Elizabeth Hospital, South Australia, for Peptide Receptor Radionuclide Therapy (PRRT).

Method: The patient received 4 cycles of 7000 Mbq 177 Lu (Lutetium Octreotate) every 8 weeks. Pre-medications for nausea were given and intravenous amino acids were administered for renoprotection. Whole Body SPECT/CT imaging was performed 24 hrs post 177 Lu administration. Serial Quality Of Life (QOL) data was recorded over the 6 months of therapy.

Results: There was dramatic clinical and biochemical response as early as 3 weeks post first dose of 177 Lu. This enabled cessation of TPN, with reduction and eventual cessation of the high doses of SSA. She was able to resume a normal diet, the diarrhoea was markedly reduced and she began to put on weight. Throughout her 4 cycles, imaging and QOL surveys documented the improvement in both tumour burden and quality of life, respectively.

Conclusion: This patient had exhausted all standard treatment preferences in an attempt to control her severe complications from progressive metastatic NET – rendering her hospitalised. Treatment with PRRT offered this patient a dramatic improvement in her quality of life; enabling discharge from hospital; cessation of costly TPN+SSA; resumption of oral dietary intake and a functional return to activities of daily living.

Although PRRT is rarely given with curative intent, it is an invaluable means of improving QOL. Lutetium should not be underestimated as a worthwhile treatment benefiting both the patient and the healthcare system.

P24
EFFECTS OF ALTERED INJECTION TECHNIQUE ON BREAST LYMPHOSCINTIGRAPHY RESULTS

Stephanie O'Donnell, Georgina Santich, Geoffrey Bower
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Background: Mount Nuclear Medicine performs a large number of breast lymphoscintigraphy studies for Sentinel Lymph Node (SLN) localisation. We were asked to change our primary injection technique from peritumoural (PT) using 4×0.25 mL, total 40 MBq to periareolar (PA) with 1×0.5 mL, total 30 MBq of antimony sulfide colloid as part of a planned study substituting radiolocalisation with an ^{125}Iodine seed instead of hookwires for locating impalpable tumours. Intradermal injections were used when time was limited and no SLN had been visualised.

Method: We reviewed results from a previous six month period of PT injections and then for the following six months of subcutaneous PA injections. Our standard SLN imaging protocol was used for both groups of patients. Imaging was performed on a dual head GE Myosight gamma camera or a single head DigiRAD Ergo gamma camera. We then resumed PT injections and reviewed the most recent six months of results.

Results: The success rate of visualisation of a SLN remained reasonably high (87.5% of 96 PA versus 93% of the 167 PT injection groups) and the time taken to identify the SLN was similar. Both groups showed 99% visualisation of the SLN following intradermal (ID) injection. The rate of drainage to internal mammary lymph nodes was considerably reduced however as PA showed only 6% of patients with IM nodes (PT showed 23%). In the recent six months SLN visualisation was 73.3% PA and 87.2% PT. With ID injection results were 87.5% and 98.3% respectively.

Conclusion: We found that the depth and / or site of injection makes a significant difference to SLN drainage patterns. PT injection or deeper PA injection, at the same depth as the cancer, as well as delayed imaging should identify an appropriate rate of internal mammary node drainage.

P25
68GA-DOTA-OCTREOTATE PET AND PET PROBE-GUIDED SURGERY IN THE LOCALISATION AND TREATMENT OF GASTRINOMA

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Background: We report a case of gastrinoma that was successfully resected under radio-guidance following ^{68}Ga-DOTA-Octreotate PET imaging. The case highlights the early sensitivity of ^{68}Ga-DOTA-Octreotate PET in spite of normal anatomical imaging studies (MRI, CT, EUS), and the utility of Octreotate PET and PET probe-guided surgery in the localisation and treatment of gastrinoma.

Methods: The patient presented with Zollinger-Ellison syndrome diagnosed on clinical and biochemical grounds with a diagnostic secretin stimulation test. Initial anatomical imaging (CT, MRI and EUS) was unable to detect a lesion. The treating team requested ^{68}Ga-DOTA-Octreotate PET imaging.

Results: ^{68}Ga-DOTA-Octreotate PET demonstrated a persistent Octreotate-avid focus between the uncinate process of the pancreas and the inferior vena cava with no further Octreotate-avid lesion identified to suggest disseminated disease. The patient underwent surgical exploration following re-administration of ^{68}Ga-DOTA-Octreotate. A 6.5 mm neuroendocrine tumour within a lymph node posterior to the uncinate process of the pancreas was successfully detected with a PET probe and removed. The patient reported significant clinical improvement in the early post-operative period. We are awaiting clinical follow-up to confirm a complete biochemical and PET response.

Conclusion: ^{68}Ga-DOTA-Octreotate PET has high early sensitivity in the localisation of gastrinoma and other types of neuroendocrine tumour and may facilitate surgical localisation. Early anatomical imaging modalities were negative despite early visualisation of the Octreotate-avid lesion with PET imaging. The surgical team acknowledges that resection of the lesion would have been extremely difficult without assistance of a PET probe.

P26
INCIDENTAL FOCAL THYROIDAL 18F-FDG UPTAKE ON PET-CT: HISTOPATHOLOGICAL CORRELATION

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Background: Increasing use of 18F-fluorodeoxyglucose (FDG) positron emission tomography-computed tomography (PET-CT) has resulted in increased incidental findings of focal thyroidal FDG uptake. Previous studies performed overseas suggest a high risk of malignancy in these incidentally detected thyroid lesions.

Aims: To determine (i) the proportion of patients undergoing PET-CT for assessment of nonthyroid cancer in an Australian metropolitan hospital setting who have focal thyroidal FDG uptake; (ii) the proportion of these patients who undergo fine needle aspiration biopsy (FNAB) of the thyroid lesion, hemithyroidectomy or total thyroidectomy; and (iii) the proportion of these patients with incidentally detected thyroid malignancy.

Methods: A retrospective audit of all PET-CT studies performed at Southern Health between February 2011 and January 2013 was performed. Patients undergoing PET-CT for assessment of nonthyroid cancer with an incidental finding of focal thyroidal FDG uptake were identified from our database. Patient medical records, Radiology and Pathology databases were reviewed to identify patients who had been further investigated with FNAB of the thyroid lesion, hemithyroidectomy or total thyroidectomy.

Results: Of 4395 PET-CT studies performed at Southern Health, 2.5% (112/4395) demonstrated focal thyroidal FDG uptake. 42% (35/84) of patients undergoing PET-CT for assessment of nonthyroid cancer with focal thyroidal FDG uptake had been further investigated with FNAB, hemithyroidectomy or total thyroidectomy. 17% (6/35) had a malignant cause for their focal thyroidal FDG uptake. Causes included follicular thyroid carcinoma (n=2), papillary thyroid carcinoma (n=2), medullary thyroid carcinoma (n=1), and metastatic lung carcinoma (n=1). The remaining 83% (29/35) were benign. Causes included hyperplastic nodules, colloid nodules and follicular adenomas. The average SUV max of malignant lesions (8.9) was not significantly different from that of benign lesions (6.2).

Conclusion: All patients undergoing PET-CT with an incidental finding of focal thyroidal FDG uptake should be recommended for further investigation with ultrasound-guided FNAB of the thyroid lesion in the first instance.

Paediatric

P27
IMAGING PITFALL – RETRACTILE TESTIS IN PAEDIATRIC LYMPHOMA: CASE REPORT

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Aim: To highlight an imaging pitfall in characterising groin masses in male paediatric patients on PET-CT and to discuss the differential diagnosis.

Method: A 5 year old male patient underwent PET-CT imaging with F-18 FDG under general anaesthetic for restaging of treated Hodgkin's disease of the left inguinal region.

Results: PET-CT demonstrated mildly increased FDG activity in a new 12mm soft tissue mass in the left groin that was suspicious for recurrent disease. The lesion had an elongated ovoid appearance and the low dose CT localised the mass to the left inguinal canal. Further analysis revealed only one testis within the scrotum, although a previous PET-CT scan had shown both testes within the scrotum. The left inguinal mass was therefore correctly identified as a retractile (rather than undescended) testis, which is a physiological finding at this age. In the absence of abnormal uptake elsewhere, the diagnosis of a complete metabolic response was confidently made and inappropriate biopsy of the left inguinal mass was avoided, saving the young patient and his family significant distress and another general anaesthetic.

Discussion: The differential diagnosis of an inguinal mass in male patients includes lymphadenopathy (malignant, infective or inflammatory), hernia, aneurysm (false or true), varicocoele, spermatic cord lipoma/hydrocoele, as well as a malpositioned testis. Assessing the metabolic activity increases specificity in characterising the mass on PET-CT.

Conclusion: A retractile or undescended testis should always be considered in the differential diagnosis of a metabolically active soft tissue mass along the line of the inguinal canal in the appropriate clinical setting.

P28
MANAGING PATIENT ANXIETY IN PAEDIATRIC NUCLEAR MEDICINE

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[2]Centre for Health Promotion, Women's and Children's Health Network, South Australia, Australia

Background: Paediatric Nuclear Medicine requires patient cooperation to obtain an optimal scan. We have observed high levels of patient anxiety inducing lack of cooperation. This is caused by injection fear and the necessity to remain still and can be exacerbated over multiple appointments. Environment, lack of availability of distraction devices and failure to explore alternatives are contributing factors. We aimed to promote a healthy outcome psychologically for children attending our department.

Method: In response to this identified need, we applied for a Health Promotion grant which funded the project and allowed us to work with a mentor from Health Promotion. Evidence in the literature demonstrates the benefits of employing distraction techniques for painful procedures including venipuncture on children. We purchased an IPad, bubble machine and "Buzzy Bee" injection distractor and documented the benefits of these devices in our department.

Results: Qualitative evaluation was conducted through surveying patients, parents and staff. Responses showed that the use of distraction devices in Nuclear Medicine was helpful to reduce patient anxiety levels. Using interactive applications on the IPad allowed for effective distraction of children to reduce their focus on the injection. Through working with the Health Promotion unit, staff in our department improved research and project skills. We were able to adjust our working practice to accommodation our patient's needs through applying health promotion methodology.

Conclusion: High patient anxiety levels may compromise the quality of a Nuclear Medicine study, particularly in the paediatric cohort. Through research and stakeholder consultation, we have implemented effective techniques to reduce patient anxiety. This collaborative project has encouraged our staff learn about health promotion and associated models of healthcare relevant to reducing anxiety in children having Nuclear Medicine scans. It has enabled us to employ a holistic approach to health within our department for the benefit of our patients.

P29
FLT IN PAEDIATRIC BRAIN TUMOURS

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We present 2 children with brain stem gliomas who were evaluated with F18 FLT PET imaging.

Background: Patient 1. A 13yo boy on holiday in Singapore presented to hospital semi comatose. MRI showed a 3×2.6cm mass in the posterior fossa with hydrocephalus. He underwent emergency EVD insertion and was transferred to PMH. A Neurosurgical opinion advised against biopsy.

An F18 FLT study showed moderately intense uptake with Maximum SUV 1.56 supporting a high grade tumour.

The patient was commenced on radiation therapy with a rapid and marked response supporting the presumption of a high grade tumour (likely glioma).

Patient 2. A 2 yo girl with progressive stridor onset at 6 months of age. ENT review with fibreoptic exam following adenotonsillectomy noted vocal cord paralysis. Urgent MRI showed a large cervicomedullary tumour. One year following initial treatment tumour progression was diagnosed. F18 FLT imaging showed moderate uptake with SUV max 0.86 (intermediate).

Debulking surgery was undertaken and pathology revealed ganglioglioma with ki-67 positive in up to 5% of tumour cells. There was tumour progression in keeping with high grade tumour. Patient commenced on focal radiotherapy and oral temozolomide.

Methods: F18 FLT PET-CT imaging was undertaken 1 hour post tracer injection. Uptake within the tumour was identified and maximum SUV was measured.

Results: The tumours were clearly identified in both patients. Maximum SUV measurements were in the non low grade range.

Clinical progress for both patients was in keeping with high grade tumours.

Conclusion: PET assessment of brain tumours has the potential to be a useful assessment tool.

Greater uptake on an FLT study may predict a high grade tumour and allow commencement of therapy prior to tumour progression. Assessment of appropriate quantitation parameters and cut off values in further paediatric studies would be helpful.

Physics/Instrumentation

P30
ACTIVITY MEASUREMENT OF YTTRIUM-90 MICROSPHERES IN DOSE CALIBRATORS – THE INFLUENCE OF VOLUME AND DENSITY

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Background: Yttrium-90 labelled microspheres, used in the treatment of liver cancer, have historically been difficult to calibrate in nuclear medicine departments. A recommended method is to measure the activity of the microspheres in the glass shipping vial using a dose calibrator and then measure residual activity after drawing out the required volume for treatment. This research examines how the response of the dose calibrator varies with the volume and density of solution in the vial.

Method: To determine the dependence of the dose calibrator's (Capintec 55TW) response on the volume of the sample, a solution of ~1100 MBq of Yttrium-90 chloride was assayed in a standard microspheres shipping vial while increasing the volume in 0.2 mL intervals, but keeping the total activity constant. In addition the solution on top of an unused dose of Yttrium-90 labelled microspheres was removed and the microspheres were shaken until they reached a uniform suspension and then the activity in the vial was assayed as water was added in 0.2 mL increments, while the total activity remained constant.

Results: The dose calibrator overestimated activity as the volume of the solution was decreased. When the activity was in the microspheres suspended in water an almost identical over-response was observed as the volume changed. No significant effects of density of spheres in the dose calibrator response were observed.

Conclusion: The dose calibrator has a significant relative response variation with volume of the measured sample, and measures of residual activity following with withdrawal of Yttrium-90 treatment dose should be corrected for the change in volume. If the density of the microspheres in the suspension did have an effect on the response of the dose calibrator it was too small to be observed in this experiment.

P31
THE AUTOMATED MONITORING TOOL FOR MANAGEMENT OF QC/QA RESULTS IN NUCLEAR MEDICINE/PET SERVICE – SCGH

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Background: The Nuclear Medicine and PET service at Sir Charles Gairdner Hospital is a large department with three SPECT/CT and two PET/CT scanners, and has a QC program that includes daily and other, less frequent, tests. Results are saved on separate acquisition computers, making monitoring and analysis time-consuming and laborious. Moreover, results are kept only for a certain period, after which they are automatically deleted. We designed and implemented an automatic QC monitoring system that logs and analyses QC results to (i) ensure a permanent record of QC data, and (ii) check not only the immediate conformance, but also the trend of QC results over time.

Method: Visual Basic and Windows Scripts were written to automatically back up QC results from the acquisition computers to a network drive. The

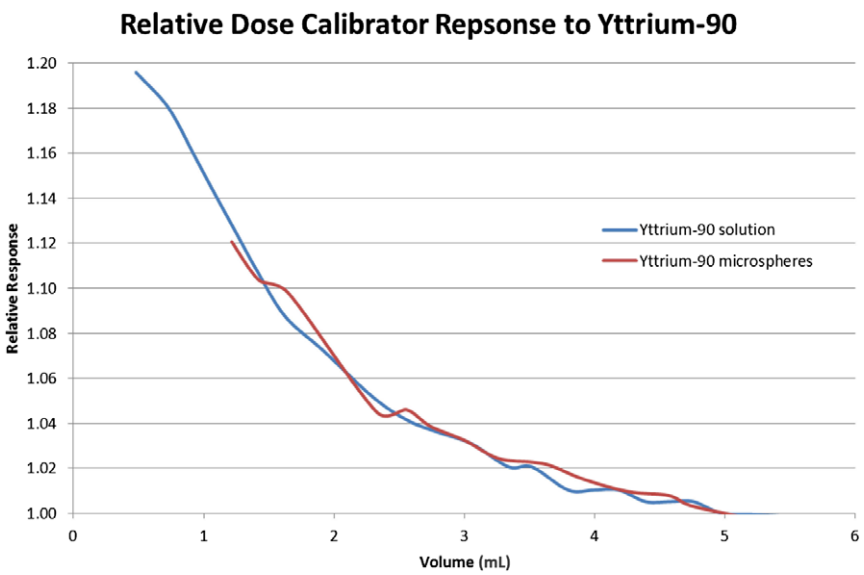

Figure 1 Relative dose calibrator response for Yttrium-90 in solution and Yttrium-90 microspheres.

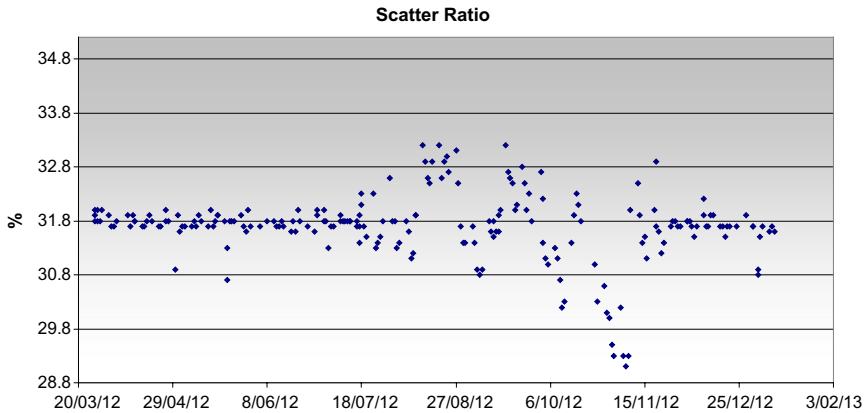

Figure 1 Scatter Ratio – Biograph mCT.

back-up files were assessed using front-end tools developed in MS Access and MS Excel to extract relevant QC information, insert it into the database and manage results.

Results: A permanent, backed-up record of all scanners QC data was created on a department shared drive. Tabulated data facilitated analysis and the scheduling of tests. The ability to view trends in QC results at a glance assisted in the timely detection of problems, even if results were within the tolerance interval, e.g. a sudden variation on the trend of Scatter Ratio Values was detected on a PET/CT scanner:

Conclusion: The automated monitoring tool has become an integral part of our QC program. It facilitates the organisation and control of QC testing, and the monitoring of QC results warns of possible problems with the equipment before they manifest, allowing timely intervention. Faster detection of QC problems has improved communication and feedback of technical issues to vendors and technologists.

P32
NEMA NU2 2007 PERFORMANCE MEASUREMENTS AND COMPARISONS OF 2ND AND 3RD GENERATION GEMINI TIME-OF-FLIGHT PET/CT SCANNERS

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Background: In this study we present a comparison of the performance of two recently installed Philips GEMINI TF PET/CT scanners, one Gemini TF Generation 2 scanner (TF64) and one Gemini TF Generation 3 scanner (TF128). The PET component in both of these scanners uses lutetium-yttrium oxyorthosilicate (LYSO) crystals in a fully 3-dimensional mode with good timing resolution to operate as a time of flight scanner.

The TF128 also incorporates High Throughput Acquisition (HTA), which increases the high-count rate capabilities of the TF128 compared to the TF64. The timing resolution of the TF64 and TF128 is reported to be 575 ps and 495 ps respectively [1].

Method: Performance measurements on the scanner were made using the National Electrical Manufacturers Association (NEMA) NU2-2007 procedures to benchmark the scanners conventional imaging capabilities.

Results: It was found that with the incorporation of HTA and faster electronics a higher noise equivalent count rate was maintained for the TF128 compared to the TF64. The spatial resolution and image quality of both scanners was increased compared to the PET department's original Gemini PET/CT scanner.

Conclusion: The installation of these new PET/CT scanners is a valuable addition to the departments imaging capabilities. The incorporation of HTA into the TF128 PET/CT is particularly valuable for clinical studies that require a high injected activity for example Rb-82 cardiac studies.

1. NEMA Standards Publication NU 2-2007. "Performance Measurements of Positron Emission Tomographs", Published by National Electrical Manufacturers Association (NEMA), 2007.

Radiation Safety

P33
A PRELIMINARY REVIEW OF PET DOSE DISPENSING PRACTICES WITH EXTREMITY MEASUREMENTS

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Background: Due to handling unsealed radioactive sources, extremity doses are a major concern to nuclear medicine staff. The hand exposure to radiopharmacists dispensing PET doses was reaching maximum allowable limits and a semi-automated syringe dispenser was instigated for dispensing FDG doses. A significant twenty-five times reduction in doses resulted.

However it is not practicable to use the dispenser system for research compounds and it is estimated that this was now contributing around 70% of extremity doses. Thus a preliminary review of PET dose dispensing practices was undertaken.

Method: Two experienced operators manually dispensed 20 syringes of PET radiopharmaceutical each, 10 syringes without a syringe shield and 10 with. The activity to be dispensed was 10 mCi (370 MBq), a commonly used dose for research. The operators were timed and the dispensed activities recorded. Exposure measurements were recorded using the instadose™ dosimeter worn around the wrist of the dominant hand.

Results: The results show the same extremity exposure rate and time taken by both operators to dispense unshielded syringes. Operator A's exposure rate was 30% less when dispensing using a syringe shield, however their dispensing time increased threefold. Operator B's exposure rate only decreased by 10.5% when dispensing shielded syringes, probably due to the syringe being removed from the shield when removing the air bubble because of difficulty with visualisation through the syringe shield lead glass. However the easier air removing procedure resulted in only doubling the unshielded syringe dispensing time.

Conclusion: Dispensing PET radiopharmaceuticals with shielded syringes can lead to a significant reduction in hand exposure. However there is a significant increase in dispensing time due to the awkwardness of handling a heavy shield and difficulties with visualisation through the lead glass. Decreasing exposure time is not as effective as shielding. Further investigation is warranted.

P34

AUDIT OF RADIOTRACER DOSING IN 'DAY BEFORE SURGERY' BREAST SENTINEL NODE LYMPHOSCINTIGRAPHY

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Background: A 60 yr old female with breast cancer underwent 'day before surgery' breast lymphoscintigraphy at Royal Perth Hospital. As per the departmental protocol an intradermal peri-areolar injection of 100 MBq of 99 mTc colloid was administered. The next day the surgeon noted a tender area of erythema around the injection site and raised his concerns regarding possible radiation injury to the skin.

A review of current protocol was undertaken and it was concluded that a skin dose of >20 Gy could cause radiation induced injury to the skin. The hospital Radiation Safety Officer recommended that the administered dose for intradermal injection in a single site be capped at a maximum of 40 MBq. A 40 MBq dose would give a skin dose of approximately 17 Gy. An audit was undertaken to ensure the reduced dose did not impact upon the detection of sentinel lymph node(s) intra-operatively.

Method: A review of the medical notes of 10 patients who received 100 mBq and 10 patients who received 40 mBq was undertaken. Data was collected relating to the dose of radiotracer administered and the subsequent detection of the sentinel node(s) both on nuclear imaging and intra-operatively.

Results:

1) Of the patients receiving the new dose of 40 mBq, all of the sentinel nodes identified on nuclear imaging were also identified intra-operatively with the gamma probe.
2) During the audit period no negative feedback was received from the breast surgeons at Royal Perth Hospital.
3) There was no notable difference in the ex-vivo counts when comparing the two different doses of radiotracer (Figure 1).

Conclusion: The reduction in dose from 100 MBq to 40 MBq for intradermal peri-areolar 'day before surgery' breast lymphoscintigraphy did not negatively impact on the detection of sentinel node(s) intra-operatively.

Radiopharmacy/Radiochemistry

P35

PRECISE MEASUREMENT OF THE PRIMARY PROTON BEAM ENERGY OF AN ISOCHRONOUS 18 MEV CYCLOTRON USING A STACKED FOILS TECHNIQUE: BEFORE AND FOLLOWING A MAJOR ENGINEERING UPGRADE

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Background: In 2003, an 18/9 MeV cyclotron was installed at SCGH Perth. Since then, PET radiopharmaceutical doses have risen from 1000 to 9000/yr. In 2012 the cyclotron underwent a major upgrade to a dual-proton beam, plus doubling of total beam-current (from ~80 to ~160 μA). Beam-energy before and after upgrade was measured using the stacked-copper (Cu) foils technique, plus investigating the effects of foil thickness and beam-straggling on energy measurement accuracy & precision.

Method: Stacked ^{nat}Cu foils (^{65}Cu & ^{63}Cu), purity >99.99% and nominal thicknesses 100, 75, 50 or 25 μm were proton-bombarded in separate experiments, each consisting of a particular foil-size and multiple runs. In separate determinations, activities of ^{63}Zn, ^{65}Zn and ^{62}Zn produced in each foil were measured by γ-spectroscopy. Together with stopping-power and reaction-specific cross-sectional data these activities were used to calculate beam-energy. The method uses a simple model for predicting activity of the chosen Zn-isotope in each foil of the stack, then compares this distribution with measured values, with beam-energy as a least-squares fitting-parameter (1).

Results: Figure shows combined data without energy-straggling correction (negligible). The grand-mean primary-beam energy (combining both EXFOR and IAEA cross-section data sets, as well as all foil thicknesses plus ^{63,65}Zn data) was 18.08 MeV±0.09(SD)(0.5%CV) and 18.07MeV±0.12(SD)(0.6%CV) before and following upgrade, respectively (ns). 62Zn-derived results (not shown) were very similar.

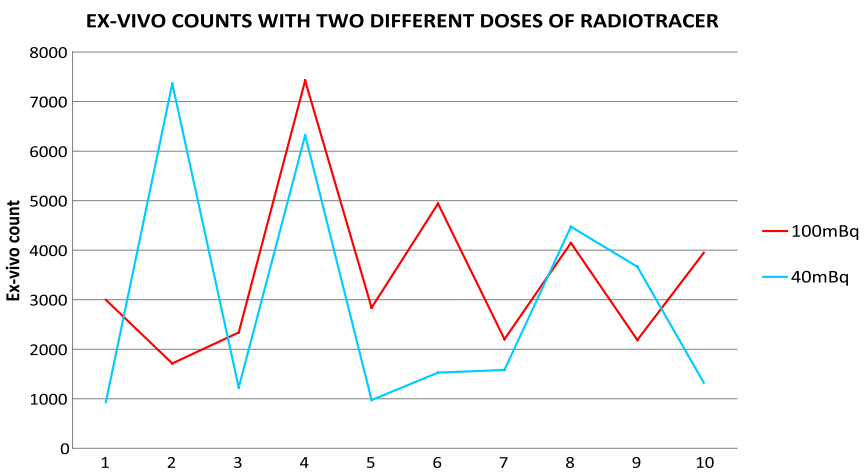

Figure 1 Ex-vivo counts with two different doses of radiotracer.

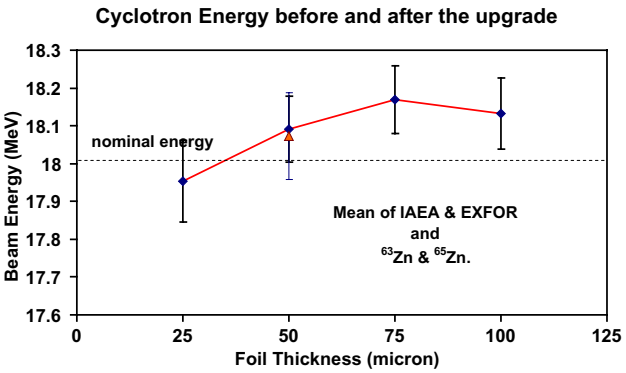

Figure Beam energy vs. Cu-foils thickness (μm), before and following cyclotron upgrade, After upgrade, only 50 μm foil thickness used. Mean data before upgrade shown as diamonds; that following, a triangle.

Conclusion: The stacked-foils method is a simple and reliable measurement of beam-energy. Its application before and following a major engineering upgrade to the cyclotron showed very good agreement, whether the measurement was based on ^{62}Zn, ^{63}Zn or ^{65}Zn production, for each foil thickness.

1. Burrage JB, Asad AH *et al. Austr Phys Eng Sci Med* (2009) 32:92–97.

P36
EFFICIENT CYCLOTRON-BASED PRODUCTION & PURIFICATION OF THE PET ISOTOPE 61CU USING NATURAL-ZN OR ELECTROPLATED 64ZN-ENRICHED TARGETS

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Background: The PET isotope copper-61 (^{61}Cu; $T^{1/2}$=3.4 h; β^{+mean} range=0.242–0.527 MeV) is suitable for radiolabelling diacetyl-bis(N^4-methylthiosemicarbazone) [^{61}Cu-ATSM], for imaging of hypoxic tissue. ^{61}Cu can be produced using several nuclear reactions, including ^{61}Ni(p,n)^{61}Cu, ^{62}Ni(p,2n)^{61}Cu and ^{64}Zn(p,α)^{61}Cu. Natural abundance of ^{64}Zn (48.6%) makes it a cheaper target than Ni isotopes. A challenge is developing a rapid, efficient separation to isolate the desired ^{61}Cu, including removing Zn target-material and co-produced Ga radioisotopes.

Method: Natural-Zn (^{nat}Zn) foils were purchased (d=15 mm; thickness=50 μm; 99.99% purity; Goodfellow). Alternatively, enriched ^{64}Zn (99.8%; Isoflex) was electroplated onto Al, Ag or Au backing discs. Collectively, these Zn-targets were irradiated for <60 min using 11.7 MeV protons at 30 μA. At end-of-bombardment, target was transferred to a fume-hood and dissolved in 1 mL of 10 M HCl at room-temperature. Digest was quantitatively transferred to a cation-exchange column AG 50W. Cu & Zn isotopes were eluted with 25 mL of 10 M HCl; Ga isotopes were retained on the column. Eluted fraction of Cu & Zn transferred onto an anion-exchange AG 1X8 column and ^{61}Cu was finally eluted with 20 mL of 2 M HCl. Zn fraction was eluted using 0.05 M HCl, to yield enriched ^{64}Zn for re-use.

Results: All targets (^{nat}Zn disc or ^{64}Zn electroplated onto either of 3 substrates – Al, Ag or Au) showed excellent stability under irradiation. Separation of ^{61}Cu was complete within 120 min. Final product had >98% radionuclidic purity. Recovery of enriched ^{64}Zn for recycling (for relevant targets) was >95%. In a recent improvement, we used a single-column method to separate Zn & Ga from Cu fraction within 30 min (results not shown).

Conclusion: A rapid, efficient separation process for production of ^{61}Cu from Zn targets with high radionuclidic purity has been demonstrated, based on two-column separation; recently refined to one-column. When relevant, this included recycling enriched ^{64}Zn for re-use. ^{61}Cu is now available for preclinical imaging studies.

P37
DEVELOPMENT OF NOVEL LIGANDS FOR EMERGING RADIOMETAL ISOTOPES

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Background: The use of radiometals (non-Tc, non-Re) in targeted diagnosis and radiotherapy of different disease states has increased significantly over the last 15 years. ANSTO LifeSciences radiometals program seeks to provide a suite of radiometal tools for use in PET imaging and therapeutic modalities to improve upon the existing technologies which are currently dominated by ^{99m}Tc. This will enable researchers and clinicians to study and diagnose diseases with a greater efficacy and efficiency.

Method: Many of the ligands currently available for radiometals have numerous drawbacks , including unfavourable *in vivo* properties such as thermodynamic and kinetic stability and poor lipophilicity. We are developing new ligand systems to have improved radiometal specificity while including design flexibility allowing us to manipulate properties such as biodistribution patterns, excretion rates, pharmacokinetics, thermodynamics and *in vivo* stability. The synthesis should be straightforward and cost effective and have the potential for bioconjugation in the initial design. Complexation studies are performed *in vitro* to assess the ligands suitability.

Results: We are developing ligand systems for ^{68}Ga, ^{89}Zr, ^{64}Cu, ^{90}Y and ^{177}Lu. We have prepared a novel analogue of the ubiquitous ligand NOTA (Figure 1, b); our system replaces the biologically labile carboxylic acid with a corresponding, biologically inert isotere, a tetrazole. This manipulation should provide additional stability and increased complex lipophilicity. Our studies have shown that a tetrazole analogue of NOTA (Figure 1, b) forms stable cold-metal complexes with potential PET metals of interest such as Ga3+.

Conclusion: ANSTO LifeSciences provides a complete synthetic ligand and metal complex program, complementing its broader Radiometals Program. The aim of which is to provide an array of clinically relevant ligands that can be used in multiple applications for specific metal radiopharamceuticals for improved patient outcomes.

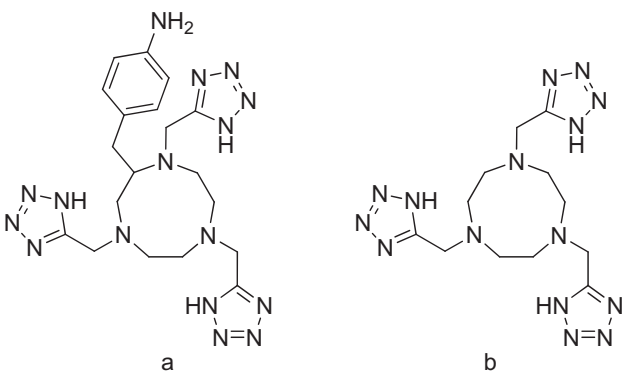

Figure 1 Structures of bioconjugation p-NH^{2}Bn-NOTET (a), and NOTET (b).

P38
SIMPLIFIED PROCEDURE FOR THE PREPARATION OF 68GA-MAA

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Background: Macroaggregated Albumin (MAA) labelled with [^{99m}Tc] $NaTcO^{4-}$ is well established. [^{68}Ga]-labelled MAA (^{68}Ga-MAA), a PET radio-

pharmaceutical, has many advantages. Although there are a number of methods of ^{68}Ga-MAA production and quality control (QC) in the literature, they are often difficult to reproduce in the lab. We describe an easy-to-follow, detailed method.

Methods: $^{68}GaCl^3$ was eluted from an Eckert & Ziegler® IGG100 1.5 GBq ^{68}Ge/^{68}Ga generator with 0.1 M HCl onto a Strata X® ion exchange cartridge. The $^{68}GaCl^3$ was then eluted from the cartridge with 0.4 mL of acidic acetone into a reaction vial. The acetone was evaporated from the reaction vial (110°C for 600 sec). Normal saline (1.0 mL) was then added to the reaction vial to reconstitute the $^{68}GaCl^3$.

1M Ammonium acetate buffer was prepared: 3.85 g in 50 mL water and 1 mL of conc HCl. pH was adjusted to 4.5 using glacial acetic acid. 0.1 M sodium phosphate buffer (pH 7.0) was prepared.

One vial of MAA (Drax Image®) was washed (twice) by suspending in saline (10 mL), centrifuged for 5 mins at 190 g, and the supernatant removed. Ammonium acetate buffer (0.4 mL) was then added to the washed MAA and resuspended. The $^{68}GaCl^3$ was then manually added (500 MBq in 1.5 mL) to the MAA vial via 0.22 µM filter. The vial was boiled for 7 min and 2 mL of phosphate buffer was added once completed.

^{68}Ga-MAA QC: ITLC-SG in 0.4 M Citric Acid. Particle sizes were verified using a haemocytometer.

Results: The MAA was labelled with 350 MBq $^{68}GaCl^3$. Mean QC was 95.3%. Particle sizes were approximately 20 µM–100 µM. Accepted limits >90% of particles between 10 µM and 90 µM) and none >150 µM. Total synthesis time was approximately 35 mins from start to finish.

Conclusion: The procedure successfully allows a convenient preparation of ^{68}Ga-MAA which can readily be adapted for clinical use.

P39
COMPARISON OF AG1-X8 RESIN AND CU RESIN FOR RADIOCHEMICAL SEPARATION OF COPPER-64 FROM NICKEL AND COBALT

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Background: Copper-64 is a radioisotope that has satisfactory physical characteristics for PET imaging ($t^{1/2}$ = 12.7 hr, β^{+avg} = 278 keV, β^{+max} = 652.9 keV, β^+ abundance = 17.87%). It can be coupled with a variety of specific cell markers for diagnostic imaging. Copper-64 has been routinely produced at the Sir Charles Gairdner Hospital cyclotron facility since 2011, via the $^{64}Ni(p,n)^{64}Cu$ production pathway[1].

Radiochemical separation is required to isolate copper-64 from target nickel-64 and co-produced cobalt isotopes (cobalt-55,-57,-61). This has been achieved using anion exchange chromatography, using BioRad AG1-X8 anion exchange resin with low concentrations of hydrochloric acid in aqueous/alcohol solution. A new resin, CU Resin, has been developed specifically for radiochemical separation of copper isotopes produced via proton bombardment. A trial was undertaken to compare i) the performance of the resins, and ii) the purity of the subsequent copper-64.

Method: 32 batches of copper-64 were produced utilising BioRad AG1-X8 (Nov 2011 to Nov 2012). CU Resin was trialled from Jan 2013. Each product was evaluated for radionuclidic purity (HPGe gamma spectrometry) and metallic purity (ICP-MS).

Results: The average processing time, from receipt of irradiated nickel-64 to packaging of copper-64 product, using AG1-X8 resin is 2 hours. Using CU Resin halves the processing time to 1 hour. The AG1-X8 resin copper-64 is 99% isotopically pure, with metallic species in low parts per million concentrations. Evaluation of the CU Resin product has not been completed.

Conclusion: Radiochemical separation using CU Resin is straightforward and faster than the process using AG1-X8 resin. Results are still being collated for the purity of copper-64 produced using CU Resin; therefore no comparison of purity has been made.

1 CM Jeffery, SV Smith, AH Asad, S Chan and RI Price, 'Routine Production of Copper-64 Using 11.7 MeV Protons', *American Institute of Physics Conference Proceedings*. 1509, pp. 84–90; doi:http://dx.doi.org/10.1063/1.4773946 (2012).

P40
ESTABLISHMENT OF ROUTINE PRODUCTION OF 68GA-OCTEOTRATE IN PERTH: ONE YEAR ON

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Background: ^{68}Ga-Octreotate (PET/CT), commonly used for the visualisation of somatostatin receptor (SSTR)-positive neuroendocrine tumours is more sensitive and offers higher spatial resolution compared to the conventional ^{111}In-DTPA-octreotide (SPECT/CT) SSTR imaging. The RAPID Laboratories routinely produce ^{68}Ga-Octreotate using the ITG silica based ^{68}Ge/^{68}Ga generator coupled to the iQS Ga-68 Fluidic Labelling Module.

Method: The generator is eluted with 4 mL of HCl0.05M into a preheated reactor (95°C) containing 25 µg of Octreotate peptide in 1 mL of sodium acetate 0.1 M. After 10 min reaction, the reaction mixture is transferred to a C-18 Sep-Pak cartridge pre-conditioned with Ethanol 70% and water. After washing with 5 mL of NaCl0.9%, ^{68}Ga-Octreotate is eluted off the Sep-Pak with 2 mL of 30% Ethanol followed with 5 mL NaCl0.9%, through a sterile filter into the collection vial. Radiochemical purity (via HPLC analysis and TLC analysis), pH measurement and radionuclidic purity analysis are assessed before release for patient injection.

Results: In the year 2012, the RAPID Laboratories performed 108 ^{68}Ga-Octreotate syntheses for a total of 267 patients. The average synthesis yield was 67% and the radiochemical purity >95%. The synthesis time is <15 min. from time of generator elution.

The cost for a ^{68}Ga-Octreotate dose was $287 per patient, compared to a cost of $3,300 for a dose of ^{111}In-DTPA-octreotide. Only two ^{111}In-DTPA-octreotide scans were performed in WA in 2012 while 65 were performed in 2009.

Conclusion: The development of the routine production of ^{68}Ga-Octreotate to the WA PET Service not only improved the diagnostic performance of patients with neuroendocrine tumours but also created cost saving benefits to the WA Health system. ^{68}Ga-Octreotate (PET/CT) has superseded the conventional ^{111}In-DTPA-octreotide (SPECT/CT) in Western Australia.

P41
OPTIMISATION OF PRODUCTION & PURIFICATION OF THE LONG-HALFLIFE RADIOMETAL PET ISOTOPE 89ZR: TOWARDS PROVISION OF A NATIONAL RESOURCE FOR PRECLINICAL IMAGING APPLICATIONS

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Background: The radiometal positron-emitter ^{89}Zr, with its long half-life (78 hr) is a candidate for PET imaging. Hitherto, challenges in its production and separation had restricted its use, but recent advances have enabled the capacity for transcontinental shipping of significant (ie; ~GBq) activities of purified product, initially for preclinical research. This study reports optimisations that facilitate this objective in the Australasian context.

Method: A semi-automated in-house external beamline was attached to a port of an IBA 18/9 cyclotron. A target comprised of two stacked pure (99.9%) yttrium foils, each (mean) 127 µm thick and 15 mm diameter was

proton-bombarded at <40 μA at 11.7 MeV for 120 min to produce ^{89}Zr via reaction ^{89}Y(p,n)^{89}Zr. Yttrium foils are cradled in an aluminium backing plate and sealed with a front disc insert, as shown in Fig. Following target insertion, the front face of the target assembly is pressed pneumatically against a Viton® O-ring seal. Helium-gas cools on the beam side, and chilled water on the rear.

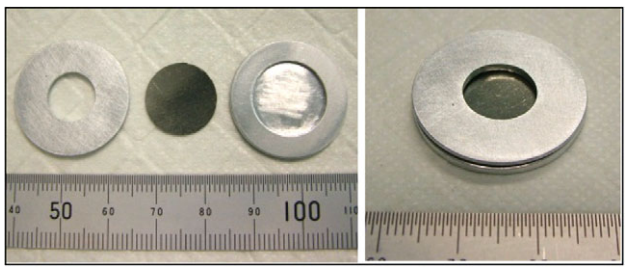

Figure Assembly of yttrium stacked-discs target.

Results: Increasing the beam energy from 11.7 MeV to 16 MeV increased the EOB activity by 40%. Doubling the beam current, doubled the end-of-bombardment (EOB) activity. Doubling irradiation time also doubled the EOB activity (applies to 'thin'-targets, 'short' irradiation-times). It was more convenient to change beam current and irradiation time than to irradiate at 16 MeV. EOB activity (by HPGe γ-spectroscopy) of ^{89}Zr in target discs was 1.36 GBq (±0.53 GBq[SD], n=3), 64% (±25%, n=3) of theory, with a maximum of 1.84 GBq. Using published techniques based on hydroxamate column-extraction, with some original innovations, ^{89}Zr was recovered from the target with 93% (±17%[SD], n=3) efficiency, with a radionuclidic purity of >99% and chemical purity 0.2 ppm Zr (±0.3 ppm[SD], n=3, ICP-MS), comparable to published data. Effective specific activity via titration-by-chelator method was 408 MBq/μg (±26 MBq/μg, n=3). All results were comparable to published data.

Conclusion: This study has demonstrated capability for production of radionuclidically and chemically pure ^{89}Zr of acceptable specific activity. Zirconium-89 has been routinely produced in our laboratory since June 2012. This capability permits the transport of product across Australasia of sufficient activity and reliability for preclinical applications, at least.

P42
THE RADIOMETAL ISOTOPE TITANIUM-45 AS A CANDIDATE FOR PRECLINICAL PET IMAGING: PRODUCTION, PROCESSING & POSSIBLE APPLICATIONS

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Outline: Platinum complexes are an industry standard against some refractory cancers. However, their therapeutic range and persistence are limited; side effects are significant. Titanium(IV) organo-complexes are promising alternatives. However, lack of understanding of their biological pathways prevents comprehensive clinical trials.

Context: By substituting an atom of natural titanium (Ti) in an organo-complex with the PET- isotope ^{45}Ti ($T^{1/2}$=3.1 hr; β^+ ratio=85%) it may be possible to study the radiopharmacokinetics of Ti-complexes in preclinical models. An interesting application would be labelling apotransferrin, because of its avid chelation with Ti(IV), and its apparent role in tumour development. ^{45}Ti can be produced by solid-targetry using a medical cyclotron, utilising reaction ^{45}Sc(p,n)^{45}Ti with a proton energy of ~14.5 MeV (1).

Objective: To produce ^{45}Ti with high NCA specific activity, suitable for chelation to bifunctional ligands. Radiolabelled complex in turn to be used in microPET studies. Cyclotron production of ^{45}Ti follows the solid-targetry methods of Scharli *et al*, developed partly in our laboratory (2). There are two main methods for subsequent chemical separation and purification of ^{45}Ti from the ^{45}Sc target disc; solvent-solvent extraction and hydroxamate-resin (1,3), the latter very similar to methods of (2). Thus, our existing procedures for ^{89}Zr are adapted for ^{45}Ti, based on hydroxamate-resin column separation using HCl & water washes and finally 1M oxalic-acid product elution. Since reaction cross-sections for ^{89}Zr and ^{45}Ti are similar in magnitude and energy-dependence, produced activities are likely similar, at ~2 GBq.

Conclusion: ^{45}Ti as a PET-imaging isotope has not been widely studied, however it can be readily produced in a 'conventional' radiometal solid-targetry laboratory. Its 'intermediate' half-life, high positron-emitting efficiency and interesting biological applications make it an attractive area of study.

1. Vavere AL & Welch MJ *JNM*(2005) 46:683–690
2. Scharli RK et al *AIPConfProc*(2012) 1509:101–107. doi:10.1063/1.4773949
3. Gagnon K et al *AIPConfProc*(2012) 1509:211–214. doi:10.1063/1.4773949

P43
THE ESTABLISHMENT OF A PET RADIOPHARMACEUTICAL RESEARCH AND PRODUCTION FACILITY AT THE CENTRE FOR ADVANCED IMAGING

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Background: The Centre for Advanced Imaging (CAI) was created in 2009 and reflects the growing role of multi-modality imaging in cutting-edge biotechnology and biomedical research at the University of Queensland (UQ). An initiative of the CAI is the establishment of a PET radiopharmaceutical research and production facility which includes a state-of-the-art cyclotron and radiopharmaceutical research and production laboratories. The installation and commissioning of the cyclotron, hot-cells, and radiochemistry synthesis equipment will be described and the results presented.

Equipment and Method: A 'Cyclone Twin' 18 MeV dual ion source cyclotron (*IBA, Belgium*) was procured along with 14 hot cells (*TEMA, Italy*), 6 automated radiochemistry modules for research and a further 2 modules for GMP [^{18}F]FDG radiosynthesis (*IBA*). The cyclotron has 8 target ports and is equipped with [^{18}F]fluoride, [^{11}C]CO^2, [^{11}C]methane, and [^{13}N]nitrogen targetry along with a solid target station for [^{124}I]iodine and [^{64}Cu]copper production. The suite of hot-cells include laminar flow isolators for radiopharmaceutical dispensing to GMP standards, and a specialised hot-cell equipped with tele-manipulators for solid target processing. The research radiochemistry modules include 3 'MeI-Plus-CO^2' and a 'MeI-Plus-CH^4' modules (*Synthra*) for [^{11}C]methyl iodide synthesis and subsequent radiolabelling and 2 nucleophillic [^{18}F]radio-fluorination modules (*Synthra, Germany*).

Following the installation and commissioning of the equipment, site acceptance testing was performed including cyclotron target saturation yields and the manufacture of a range of [11C] and [18F] based radiopharmaceuticals.

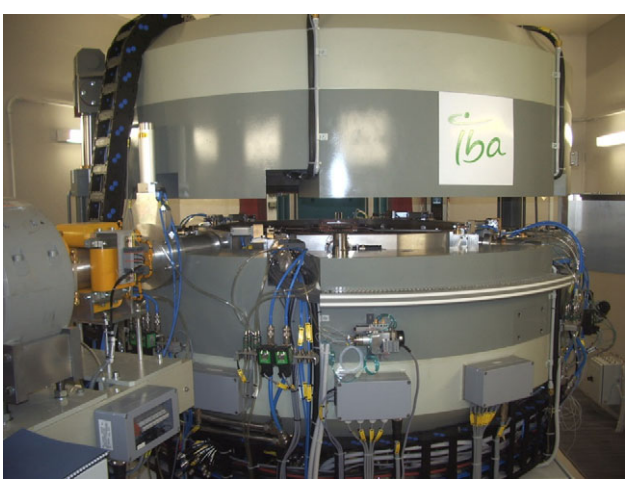

Figure 1 'Cyclone Twin' 18 MeV Cyclotron depicting open vacuum chamber and solid target beam-line.

Results and Conclusion: To this end, the CAI has procured a cyclotron, hot-cells and radiochemistry synthesis modules. The commissioning data for the former will be presented with a brief summary of the installation and commissioning procedures of both the cyclotron and radiochemistry synthesis modules. Further, the challenges encountered during this work will be described.

P44
AUTOMATED PRODUCTION OF 124I AND 64CU USING IBA TERIMO AND PINCTADA METAL ELECTROPLATING AND PROCESSING MODULES

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Background: There is worldwide interest in long-lived positron emitters for molecular imaging and the development of novel immuno-PET techniques. This has led to the recent installation of a new lab dedicated to automated solid target isotope production including ^{124}I and ^{64}Cu.

Method: ^{124}I is produced by the ^{124}Te(p,n)^{124}I reaction using the IBA Nirta target. Highly enriched $^{124}TeO^2$ is mixed with 6% Al^2O^3 (~300 mg) and melted using the IBA Terimo module at a furnace temp of 780°C for 10 min into the circular cavity of a platinum target disk.

Following irradiation, thermochromatographic separation of radioiodine is performed using the same Terimo module. The target disk is heated to 780°C with a 75 mL/min sterile filtered air flow to release the ^{124}I, which is recovered in 1 mL of 0.01 M NaOH.

^{64}Cu is produced with the IBA Nirta target by the ^{64}Ni(p,n)^{64}Cu reaction. The target is produced by electroplating highly enriched ^{64}Ni onto a silver disk.

Following irradiation, the disk is loaded into the IBA Pinctada module and the plating layer dissolved in recirculating 3 mL 12 M HCl at 70°C. The solution is purified on AG 1-X8 anion exchange cartridge, washed with 12 M HCl and EtOH, and ^{64}Cu eluted with ~2 mL of water.

Results: Table 1 show the target irradiation parameters and production yields of ^{124}I and ^{64}Cu obtained to date.

Conclusion: We have successfully implemented fully automated production of ^{124}I and ^{64}Cu at Austin P.E.T. Centre. Future work will focus on the QC methods.

Acknowledgment: The Solid Target facility is an AUSTIN/ANSTO/LICR partnership.

Table 1 Production of ^{124}I and ^{64}Cu

Radioisotope	Irradiation	Production @ EOS MBq (mCi)
^{124}I	12 μA 3.5 hrs	455 (12.3)
	15 μA 18 hrs	2479 (67.0)
	10 μA 8 hrs	400 (10.8)
	12 μA 10 hrs	984 (26.3)
	12 μA 8 hrs	828 (22.4)
^{64}Cu	25 μA 2.5 hrs	100 (2.7)
	20 μA 5.5 hrs	155 (4.2)
	35 μA 4 hrs	636 (17.2)
	35 μA 6.2 hrs	1191 (32.2)

P45
RECOIL AND CONVERSION ELECTRON IMPLICATIONS TO BE TAKEN INTO ACCOUNT IN THE DESIGN OF THERAPEUTIC RADIOPHARMACEUTICALS UTILISING IN VIVO GENERATORS

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Background: The use of radionuclides as potential therapeutic radiopharmaceuticals is increasingly investigated. An important aspect is the delivery of the radionuclide to the target whereby the radionuclide is not lost from the chelating agent. For *in vivo* generators it is important whether the daughter radionuclide stays inside the chelator after decay of the parent radionuclide.

Method: A fully relativistic equation has been derived for calculating the kinetic energy of the recoiling nucleus assuming that the chemical bond between DOTA and a radionuclide is 4 eV. It indicates that the classical recoil effect for β-decay only applies to decays with a Q value higher than 0.6 MeV. The ^{166}Dy/^{166}Ho generator (Q=0.486 MeV) and the ^{90}Sr/^{90}Y generator (Q=0.546 MeV) were prepared by the standard DOTATATE labelling procedure and then loading on a C-18 cartridge. DOTATATE is adsorbed on the cartridge while free metal cations and metal DTPA complexes can be eluted. Due to the high thermodynamic stability and kinetic inertness of metal-DOTA type complexes, the release of the parent radionuclide is inhibited. If recoil of the daughter nuclide (during the decay) took place it leads to the release of the daughter radionuclide which is eluated with DTPA.

Results: It was found that 72% of the daughter (^{166}Ho) was liberated from the DOTA chelator, in contrast to our recoil calculations but corresponding to the ratio of transition of holmium atoms via the Auger process. For the β ^{90}Sr/^{90}Y (transition via the Auger process is absent) generator a 1% release from the DOTA chelator was recorded as compared to the estimated 10.2% from the β continuum spectrum of ^{90}Sr.

Conclusion: The discrepancy between the experimental and theoretically calculated release can be explained by a correction of the chemical bond energy to 4.4 eV.

Renal/Gastroentology

P46
RELATIVE RENAL FUNCTION MEASUREMENT FROM SUPINE DUAL HEADED GEOMETRIC MEAN

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Background: Total and relative renal function measurement from a DTPA scan is an essential part of live kidney donor assessment because although left nephrectomy is favoured for its longer vein, the donor should always be left with a normal well functioning kidney. For many years at Westmead Hospital, a seated single head posterior view scan (SH) has been performed and if there was asymmetry of greater than 45:55% function, a subsequent DMSA scan with geometric mean analysis was used as the gold standard. This revealed the limitations of the SH even with depth correction.

Aim: To compare DTPA relative renal function measurement from supine dual headed geometric mean (GM) studies with those obtained from SH.

Method: We analysed the GM relative function results of 26 potential kidney transplant donors and compared them with an independent group of 31 donors who had SH studies. We calculated the standard deviation of the percentage right kidney relative function (100*R/R+L). The standard deviation was 2.8% for the SH and 1.1% for the GM. Four normal SH studies (as confirmed by DMSA) were incorrectly classified as abnormal.

Discussion: The significant ($p<0.01$) reduction in standard deviation from SH to GM was attributed to difficulties in determining kidney depth from lateral images acquired from SH studies, a reduction in patient motion and variability of kidney position when supine and improved background correction from the GM image. The small standard deviation in our results indicate that an incorrect abnormal classification is very unlikely for a GM study ($p<0.01$).

Conclusion: Measurement from supine dual headed geometric mean significantly increases the reliability of a DTPA scan for live kidney donor assessment.

P47
CR-51 EDTA GLOMERULAR FILTRATION RATE ASSESSMENTS ON LIVE KIDNEY DONORS TO BUILD A REFERENCE DATA SET

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Background and Aim: The assessment of glomerular filtration rate (GFR) is clinically important for the staging of renal disease and for evaluating live kidney donors.

The gold standard for GFR assessment uses renal clearance of inulin, however this method is considered too impractical for routine clinical use. Therefore the GFR is frequently evaluated from the plasma clearance of Cr-51 ethylene-diaminetetraacetic acid (Cr-51 EDTA).

When compared to the inulin infusion method, – the GFR calculated with Cr-51 EDTA is reported to be up to 15% lower, – so inulin normalised population data sets are not equivalent.

Sir Charles Gairdner Hospital has routinely assessed GFR for live kidney donors using Cr-51 EDTA, – so used this population to obtain normalised data.

Method: This was a retrospective study of 135 subjects (39 male, 96 females; aged 20–80 years) assessed as live kidney donors. The GFR was evaluated from Cr-51 EDTA plasma clearance using blood samples taken at 1.5, 2.5 and 3.5 hours. The slope-intercept GFR was corrected for body surface area using the Haycock formula and for the fast exponential using the Brochner-Mortensen equation.

Results: There was no significant change in GFR for both males and females between the ages of 20 and 40. Males having a mean GFR of 103.4 mL/min 1.73 m^2 and females having a mean of 104.9 mL/min 1.73 m^2.

After the age of 40, GFR reduced linearly using the following equations:

$$\text{Male GFR} = -0.458 \times (\text{Age}) + 121.5 \text{ (4.35 mL/min 1.73 m}^2 \text{ per decade)}$$

$$\text{Female GFR} = -0.936 \times (\text{Age}) + 141.5 \text{ (7.7 mL/min 1.73 m}^2 \text{ per decade)}$$

Conclusion: Cr-51 EDTA is cleared by the kidneys up to 15% slower than inulin, – and also shows good agreement with Gurmandeep et al, (similar study in 2005). This normalised data set can aid in determining renal disease and identifying eligible donors.

P48
PROTEIN LOSING ENEROPATHY

Abstract withdrawn

P49
EVOLVING TREND OF THE UTILITY OF HEPATOBILIARY SCINTIGRAPHY IN A TERTIARY INSTITUTION

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Background: Hepatobiliary scintigraphy (HBS) continues to provide valuable physiological and functional information in evaluation of hepatocellular function and biliary system patency for over 40 years. During this time concurrent advances in ultrasound and cross-sectional imaging have continued to compete with HBS for diagnostic utility.

Aim: To explore the vicissitudes in HBS referrals over five years to determine its evolving role in clinical practice.

Method: A retrospective review of HBS patients at our institution in 2008–2012. Inclusion criteria comprised of patients having undergone HBS with ^{99m}Tc-DISIDA, +/-CCK (Cholycystokinin), with appropriate patient preparation and imaging. Scans were excluded if study results were suboptimal due to patient noncompliance or inappropriate physiology.

Patient details were categorised into scan year, sex, age, CCK use, referral indication and report findings. Statistical analysis was performed to quantitatively review referral tendencies.

Results: There were 513 HBS scans reviewed of which, 508 met inclusion criteria. Results per annum analysis by referral indication are summarised in Figure 1.

There has been a 2-fold increase in HBS performed from 2008–2012. The most common referral type is investigation of gallbladder function(eg right upper quadrant pain and cholecystitis), accounting for >80% studies per annum, which decreased slightly over time from 90.2% of total referrals in 2008 to 81.3% in 2012. There has been a significant increase in Sphincter of Oddi Dysfunction(SOD) and residual liver volume referrals, with these 2groups representing 3.3% of referrals in 2008 and 16.3% in 2012, demonstrating a trend for new uses of HBS. The use of HBS for investigation of bile leaks remained constant over this period.

Conclusion: HBS referrals have not decreased over time despite increasing use of competing modalities. The most common indications are still for investigating gallbladder function, but increases in SOD evaluation and residual liver volume referrals indicate an evolving use of this imaging technique.

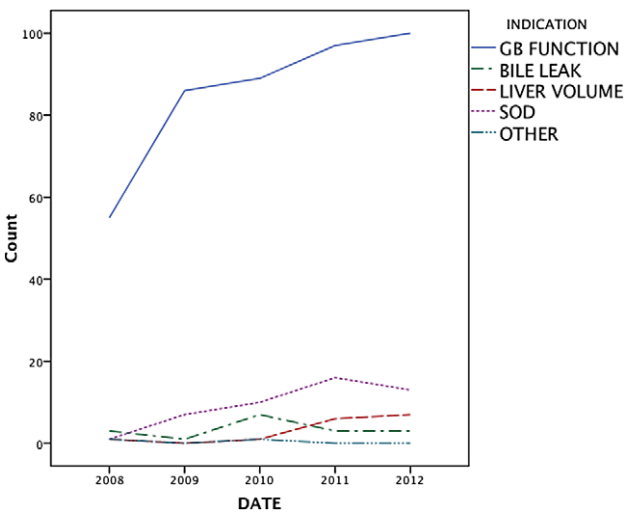

Figure 1 HBS referrals indication per annum.

P50
ACCURACY OF RAPID SPECT-CT IN PATIENTS WITH ACTIVE GASTROINTESTINAL BLEEDING

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Background: Labelled red blood cell imaging with rapid SPECT-CT has been shown to be a valuable diagnostic tool in patients presenting with active gastrointestinal bleeding at Sir Charles Gairdner Hospital, particularly in increasing the accuracy of localisation of bleeding sites and reporter confidence.

Method: With iterative reconstruction algorithms, 6-slice CT, LEAP collimators and resolution recovery, diagnostically acceptable SPECT-CT scans can be performed in less than 8 minutes, minimising artefacts and registration errors from mobile gut activity and allowing accurate localisation of bleeding sites. An audit has been undertaken on all gastrointestinal bleeding studies performed at SCGH in 2012 to compare reported bleeding sites with findings on CT angiography and/or repeat colonoscopy, endoscopy, capsule endoscopy or surgery.

Results: The audit revealed 22 studies performed on 20 patients and 7 of these studies showed active bleeding. All reported sites of bleeding on Nuclear Medicine studies closely correlated with actual sites of bleeding on subsequent investigations or surgery.

Conclusion: Labelled red blood cell imaging with rapid SPECT-CT allows fast and accurate localisation of the bleeding site in patients presenting with active GI bleeding. Current Diagnostic Imaging Pathway guidelines recommend labelled red blood cell imaging in this clinical setting and a rapid SPECT-CT protocol should be considered by Nuclear Medicine departments providing this service.

Technologist Symposium

P51
THE WAY TO THE CHEST IS BETWEEN THE TOES

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Background: There are few successful reported cases of lymphoscintigraphy used to localise a chylothorax. Common causes of chylothorax are surgical and trauma, but idiopathic cases also occur. Early detection of chylothorax is imperative to prevent complications such as malnutrition, anaemia and hypoproteinaemia. The aim of this case study was to localise the source of chylothorax in a 68 year old male with a past history of severe Barrett's oesophagus and poorly differentiated oesophageal cancer.

Method: 62 MBq of 99mTc-antimony colloid was injected into the left foot webbing between the first and second toes. Planar images were acquired for 10 minutes through the thorax and abdomen, demonstrating abnormal accumulation of radiotracer in the superior mediastinum. The presence of a gastric hernia prevented accurate localisation of the chyle leak. To assist with localisation delayed SPECT/CT imaging was performed immediately following injection of 50 mL iodine contrast through a central venous catheter. A chyle leak was visualised originating from the thoracic duct in the superior mediastinum, tracking to the left costophrenic gutter. The patient subsequently underwent thoracic duct ligation and surveillance of chylothorax resolution.

Conclusion: This case study successfully demonstrated the role of nuclear medicine in localising post-surgical chylothorax. The combined use of 99mTc-antimony colloid, SPECT/CT and iodine contrast is unprecedented, demonstrating a novel approach to iodine contrast use in nuclear medicine.

P52
THE IMPORTANCE AND BENEFIT OF PERFORMING A TC-MAA BREAKTHOUGH SCAN PRIOR TO SIRT: A CASE STUDY

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Background: Selective internal radiation therapy, or SIR-Spheres, is an effective treatment for primary and secondary tumours localised to the liver. A hepatic artery perfusion scan, or 99mTc-MAA-breakthrough study, is performed prior to administration of the spheres and is an effective way to manage therapy dose and predict tracer distribution. The primary aim of this poster is to highlight both the importance and benefits of performing the breakthrough study. The secondary aim of this poster is to increase knowledge of scan appearance and causes for unexpected tracer distribution.

Method: 24 99mTc-MAA hepatic artery perfusion scans were performed at our site in 2012. Several of these cases exhibited unexpected tracer distribution and will be presented as interesting cases to discuss the reasons behind altered biodistribution and how this affects therapy planning and reporter confidence.

Results: It was found that altered biodistribution in the hepatic artery perfusion scan was caused by liver/lung shunting, inadvertent delivery of 99mTc-MAA to other organs, free pertechnetate in the 99mTc-MAA dose, reflux of hepatic arterial blood to abdominal organs as well as delay in imaging (greater than 1 hour) following administration of 99mTc-MAA.

Conclusion: The 99mTc-MAA-breakthrough study is an essential part of the SIRT patient's management. The study enables quantification of liver/lung shunting for SIRT dose calculation. In addition to this, the scan can highlight problems that have occurred during 99mTc-MAA administration that will need to be rectified prior to the therapy administration. Finally, the scan can identify patients that have reflux of hepatic arterial blood to the stomach and other abdominal organs which facilitates the knowledge of potential side effects.

P53
IMPACT OF USING AN [18F]-FDG AUTO-DISPENSER ON STAFF RADIATION EXPOSURE – COMPARISON TO A MANUAL METHOD

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Background: Previous studies have shown that the use of an automated dispensing and delivery system for [^{18}F]-FDG has resulted in a significant reduction in staff radiation exposure, of up to 25%. We compared the use of a combination of unit doses and manual dispensing with a fully automated dispensing and delivery system to determine the impact on radiation exposure to nuclear medicine technologists.

Method: Nuclear Medicine Technologists working in the PET suite were asked to wear personal dosimeters (Panasonic, Japan) at chest level to monitor their whole body radiation exposure. Staff recorded the date and time of the reading, dose in mSv, length of the reading and the number of patients injected. These results were tabulated using an Excel spreadsheet. The average number of patients injected and the average dose received by the technologist per day were calculated for each method of injection. The technologist dose rate was divided by the number of patients injected to determine the dose received per patient, allowing direct quantitative comparison between the two delivery methods. Other factors such as changes in workflow, ease of use, staff acceptance, average patient dose and specific concentration were reviewed through the use of a technologist survey and database search.

Results: Following a review of 484 patients using the combination method, the mean administered dose was 304 MBq (196–565 MBq) as compared to the automated system giving 246.5 MBq (246.6–295.9 MBq). The total technologist dose per day for an average of 10 patients injected decreased from 0.03 to 0.016 following implementation of the automated system. The average dose received by the technologist per patient using the combination method was 0.003 mSv compared with the automated system being 0.0015 mSv. This showed an overall dose reduction to Technologists working in the PET suite of 48%.

Conclusion: A significant reduction in staff radiation exposure was seen following the implementation of an automated dispensing and delivery system. Administered activity decreased by approximately 18%, which may contribute to dose reduction. This system improved the overall accuracy of the dispensed dose with a resultant increase in workflow and efficiency.

P54
"THREE CLICK" SEMI-AUTOMATIC CREATION OF PATIENT NOTES IN G.E.CENTRICITY R.I.S. INFORMING USERS OF RADIONUCLIDE ADMINISTRATION WITH PRECAUTIONS APPROPRIATE TO RISK. NOTE EXPIRY IS SET AUTOMATICALLY

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Aim: To inform RIS users about patient radionuclide administrations

Method: A free windows macro tool, Auto Hot Key (AHK) was programmed so that on pressing the F9 key it checks for the presence of CENTRICITY RIS. If present, AHK displays radio button choices for these radionuclide administrations.

^{99m}Tc <= 200 MBq	delay 2 hrs
^{99m}Tc 200 – 500 MBq	delay 3 hrs
^{99m}Tc 500 – 1500 MBq	delay 6 hrs
^{99m}Tc >> 1500 MBq (CALARA)	delay 10 hrs
^{131}I <= 600 MBq	delay 4 days – slow clearance
^{131}I 600 – 2000 MBq	delay 8 days – slow clearance
^{131}I 2000 – 4000 MBq	delay 14 days
^{131}I > 6000 MBq	delay 14 days
^{131}I Lipiodol	delay 20 days – slow clearance
^{67}Ga ~200 MBq	
^{90}Y	

On choosing one and pressing the O.K. button, AHK calculates a precaution period and simulates a mouse click which opens the RIS note field of the selected patient. AHK copies both advice text and precaution period appropriate for the radionuclide administration into the note and sets the note expiry in days. The operator may then cancel, save, or modify and save the note.

Variation in note mouse click co-ordinates may be required on workstations with different screens. These are easily determined with the AHK utility "Au3_spy.exe".

Results: The note insertion tool proved easy to use and configure. Consensus was needed between RSO, Physicians and Technologists on the texts to be inserted for the radionuclide choices. RIS users within our institution and at other district hospitals appreciated the notifications.

Conclusion: AHK is a flexible tool, free under the GPL which may be used to easily provide tailored department specific RIS advice on patients who have undergone radionuclide administration. The method works with G.E. CENTRICITY RIS and the notes expire after a settable period. Keystrokes are few.

P55
QUALITY ASSURANCE IN NUCLEAR MEDICINE AND PET

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Background: Quality Assurance (QA) in Nuclear Medicine is rapidly becoming an integral aspect of providing a professional and high quality diagnostic imaging service to patients. International regulatory bodies such as the Human Health Division of the International Atomic Energy Agency (IAEA) as well as national and international societies such as the Australian New Zealand Society of Nuclear Medicine (ANZSNM) and Society of Nuclear Medicine (SNM) are playing an active role in aiding implementation of successful QA programs in nuclear medicine practices.

Purpose: The purpose of QA programs is to continually evaluate the quality of all components in nuclear medicine departments including professional competence, with a view for quality improvement. QA programs will ensure all examinations are justified, ALARA principles are adhered to, written protocols are followed for procedures, self-evaluation is conducted regularly and continued education is encouraged.

Method: The first step in QA is documentation of procedures, which can take the form of Standard Operating Procedures, Work Instructions or Protocols. Proper documentation ensures that staff follow an accepted protocol for performing procedures so that consistency is always maintained. Review of contemporary work practices, Radiation safety practices, Occupational Health and Safety Practices, Staff training and development program and Staff accreditation status must be documented and reviewed regularly. If deficiencies or nonconformities are found, follow-up actions and a remedial schedule must be established and a time frame should be formulated to enforce remedial action and conformance.

Conclusion: Quality Assurance if undertaken in a methodical and consistent manner will greatly assist the department in ensuring the highest standards of patient care and staff well-being are met. Since Nuclear Medicine is a practice that involves the use of radiation, it is imperative that transparent and traceable documentation is maintained to ensure best practice standards are being met.